DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1926

[Docket No. H-004L]

Lead Exposure in Construction

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

ACTION: Interim final rule.

SUMMARY: This interim final rule amends the Occupational Safety and Health Administration (OSHA) standards for occupational health and environmental controls in subpart D of 29 CFR part 1926 by adding a new § 1926.62 containing employee protection requirements for construction workers exposed to lead.

This standard reduces the permitted level of exposure to lead for construction workers from 200 micrograms per cubic meter of air (200 μg/m³) as an 8-hour time weighted average (TWA) to an 8-hour TWA of 50 μg/m³. The standard also includes requirements addressing exposure assessment, methods of compliance, respiratory protection, protective clothing and equipment, hygiene facilities and practices, medical surveillance, medical removal protection, employee information and training, signs, recordkeeping, and observation of monitoring. An action level of 30 μg/m³ as an 8-hour TWA is established as the level at which employers must initiate certain compliance activities. In instances where employers can demonstrate that employee exposures are below 30 μg/m³ as an 8-hour TWA, the employer is not obligated to comply with most of the requirements in this interim final rule.

This interim final rule is mandated by, and issued under the exclusive authority of, title X, subtitle C, sections 1031 and 1032, Worker Protection, of the Housing and Community Development Act of 1992.

DATES: This interim final standard shall become effective June 3, 1993. Start-up dates for various provisions are set forth in paragraph (r) of the standard (§ 1926.62(r)).

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SUPPLEMENTARY INFORMATION:

I. Background

In 1971, in accordance with section 6(a) of the OSH Act, OSHA adopted standards incorporating a permissible exposure limit (PEL) of 200 μg/m³ to regulate occupational exposure to lead in general industry (29 CFR 1910.1000) and in the construction industry (29 CFR 1926.55). In both standards, the PEL had to be achieved by engineering and work practice controls. Some years later in 1978, after a section 6(b) rulemaking, OSHA promulgated a final lead standard for general industry (29 CFR 1910.1025), which lowered the PEL to 50 μg/m³. The 1978 lead standard also required that the PEL be achieved, to the extent feasible, by engineering and work practice controls and in addition included a number of ancillary provisions requiring employers to provide medical surveillance, medical removal protection (MRP), hygiene facilities, appropriate respirators, and air monitoring, among other things.

The 1978 lead standard in paragraph (a) excluded the construction industry from its coverage. OSHA in the preamble explained that it had exempted the industry because of insufficient information in the record to resolve issues raised about the applicability of the standard to conditions in the construction industry. OSHA said it would request the Construction Advisory Committee (ACCSH) to review the record and make recommendations for a lead standard for the construction industry (43 FR 52986, November 14, 1978).

Subsequently, OSHA's exemption of the construction industry was challenged in litigation involving the lead standard for general industry. In response to that challenge, the court upheld OSHA's decision. Although the court declared that "OSHA would be shirking its statutory responsibilities if it made no effort to protect workers in the construction industry from lead exposure * * *" the court accepted OSHA's assurances at the time "that it will take reasonably prompt steps to fashion this protection", and indicated that "So long as it does so, OSHA has met its duty." "Nothing in the Act," the court said, "prevents the agency from exercising discretion in delaying specific standards according to the unique problems of specific industries. * * *" (*United Steelworkers of America* v. *Marshall*, 647 F.2d 1189, 1310 (DC Cir. 1980).)

Since 1979, employers have been required to comply with a PEL for lead in the construction industry that is four times the PEL for general industry. Employers have also been required to take other actions to protect construction workers from excess lead exposure to the extent that employers' obligations to provide respirators, protective clothing, hygiene facilities, training, and the like were imposed by generic standards that covered construction (e.g., 1910.20; 1910.94; 1910.134; 1926.20; 1926.21; 1926.28; 1926.51; 1926.55; 1926.57; 1926.59; 1926.103; 1926.200; 1926.353; 1926.354). However, there has still been no comprehensive standard regulating occupational lead exposure in construction.

In 1990, NIOSH set as a national goal the elimination of exposures that result in workers having blood lead concentrations greater than 25 μg/dL of whole blood. Under these circumstances, OSHA in the fall of 1990 announced it would begin to develop a proposal for a comprehensive standard regulating occupational lead exposure in construction. In addition, on June 12, 1992 OSHA proposed to amend its existing air contaminants standards by, among other things, reducing the PEL for occupational lead exposure in construction from 200 μg/m³ to 50 μg/m³ (57 FR 26001). However, progress on that air contaminants proposal was suspended because of the decision by the U.S. Court of Appeals for the Eleventh Circuit vacating an earlier rule on air contaminants for general industry (*AFL-CIO* v. *OSHA* 965 F.2d, 962 (1992)).

The Housing and Community Development Act of 1992

Because Congress did not anticipate publication of OSHA's proposed comprehensive lead standard for the construction industry before late spring of 1993 or publication of a final standard before 1996 (House Report on H.R. 5730, pp. 14-15), Congress in October 1992 passed Sections 1031 and 1032 of Title X of the Housing and Community Development Act of 1992 ("the Act," Pub. L. 102-550, signed by the President on October 28, 1992, 106 Stat. 3924).

In those sections, Congress included worker protection provisions expressly requiring that:

(1) No later than 180 days after enactment (April 26, 1993), the Secretary of Labor must issue an interim final lead standard covering the construction industry.

(2) The standard must be as protective as the worker protection guidelines for identification and abatement of lead-based paint in public and Indian housing issued by the Department of Housing and Urban Development

(Revised Chapter 8, "HUD Guidelines"; 55 FR 38973, Aug. 1991).

(3) The interim final standard is to take effect upon "issuance," except that the standard may include a reasonable delay in the effective date.

(4) The standard will have the effect of an OSH Act standard and will apply until a final standard becomes effective under Section 6 of the OSH Act.

(5) The Secretary of Labor in developing this standard must consult and coordinate with the Environmental Protection Agency (EPA) to achieve maximum enforcement of the Toxic Substances Control Act (TSCA) and the OSH Act while minimizing duplication.

Congressional Intent

From its language and legislative history, the broad Congressional intent behind the Act of 1992 is clear. OSHA is required within 180 days after enactment to issue an interim final regulation that provides protection to construction workers from occupational exposure to lead that is as effective as the HUD guidelines and OSHA's lead standard for general industry.

Congressional intent is clear as well with regard to many particular provisions. OSHA is mandated, for example, to include medical surveillance provisions similar to the HUD Guidelines and OSHA's lead standard. Engineering controls are to continue to be preferred, to the extent feasible, over respirators as the method of choice for compliance. More generally, most of the provisions of the interim final standard, such as those concerning housekeeping, air monitoring, record keeping, and hazard communication, are to be like those in the Guidelines and general industry lead standard, except insofar as it was necessary to adapt requirements of the interim final to conditions in the construction industry.

To determine Congressional intent, OSHA looked to the relevant language in the worker protection provisions of Section 1031 of title X of the Housing and Community Development Act of 1992 and to the legislative history of that section of the Act. As can be seen below, the language of the Act provides help in resolving many of the issues raised. Nonetheless, OSHA has had to rely at times on the legislative history to clarify Congress' mandate.

The legislative history is embodied in and essentially limited to three sources. First, the primary source is the House Committee on Labor and Education Report on H.R. 5730, which is the origin of the worker protection requirements that were then incorporated in House housing bill, H.R. 5334 and were adopted without objection by the conference committee. Second, there is a statement concerning the conference bill H.R. 5334 on the House floor by Rep. William D. Ford, the author of the worker protection provisions, which repeats verbatim relevant portions of the House Report on H.R. 5730 (138 Cong. Rec., H11475-76; daily ed. Oct. 5, 1992). And third, there is a statement by ranking minority member Representative Paul B. Henry (138 Cong. Rec. H11470; daily ed. Oct. 5, 1992).

II. Key Issues

(A) Procedural Requirements

Aside from the general requirement that the Secretary of Labor consult and coordinate with EPA, Congress in the 1992 Act did not impose any procedural requirements that must be followed in developing and promulgating the interim final standard. Furthermore, the legislative history of the Act makes it clear that Congress intended the Secretary to be free to follow whatever procedures he chooses. Specifically, the Secretary need not follow the procedural requirements of the OSH Act or the Administrative Procedures Act ("APA"; 5 U.S.C.A. 551, 553).

The Secretary's freedom from procedural constraints imposed by this legislation is clear from the Report on H.R. 5730, p. 16, where the House Committee states:

(1) "[T]he procedural requirements of section 6 of the OSH Act do not apply to the promulgation of the interim final regulation."

(2) "Nor * * * do the notice and comment provisions of the Administrative Procedures Act apply."

(3) Indeed, "the Secretary is not required to follow any specific notice and comment procedures before issuing the interim final regulation * * *."

Nonetheless, the Committee does say that "it is the Committee's hope that the Secretary [will] solicit input from and consider the views of affected industry and labor representatives as well as public health and industrial hygiene experts in fashioning an interim lead regulation for the construction industry." But here again, the Committee declares that "The Secretary is free to select whatever method she feels is best suited to obtain public input into the development of the interim final regulation, so long as the procedures she selects do not have the effect of delaying publication of the regulation."

Prior to issuing this interim final rule OSHA consulted members of the Lead Work Group of the Construction Advisory Committee, which included representatives of labor, management and the public health community. In the process, OSHA provided the work group with a draft of the interim final, listened to members' comments on the draft, and made modifications to the draft in response to their comments. The chairman of the work group was sufficiently satisfied with the results that in his report to the full ACCSH on February 16, 1993, he made a motion recommending that the full Committee support OSHA's efforts, which was unanimously passed by the Advisory Committee.

In addition, in accordance with Congress' mandate, OSHA has established a dialogue with EPA in order to coordinate the actions of the two agencies to maximize effectiveness and minimize duplication. This began with a preliminary meeting on February 22, 1993. Subsequently, OSHA and EPA are sharing working documents and will continue this cooperative effort throughout the ongoing EPA work on its rulemaking, also mandated by the Housing and Community Development Act of 1992.

(B) Scope

The language of the 1992 Act, in conjunction with the legislative history, leave little doubt that Congress intended the interim final rule to extend to all lead exposed construction workers, not simply to those removing lead-based paint. Thus, the worker protection section of the Act uses all-inclusive language: It requires OSHA to issue "an interim final regulation regulating occupational exposure to lead in the construction industry". Moreover, by its terms, the interim final is to "apply until a final standard becomes effective under section 6 of the Occupational Safety and Health Act of 1970." As Congress knew, OSHA has been developing a lead standard for all workers in the construction industry, not simply those engaged in lead paint abatement. Nowhere in the 1992 Act or the legislative history does Congress say that it intended the interim final regulation to have a narrower scope than OSHA's final standard.

In addition, from the legislative history it is clear that the gap Congress sought to fill by passing this Act was nothing less than the gap left when OSHA exempted the construction industry as a whole from the 1978 general industry standard for lead. The Committee report repeatedly refers to the general failure to protect construction workers and does not limit its focus to workers engaged in lead paint abatement. Indeed, the HUD Guidelines, which apply only to lead-

based paint abatement work, are first raised in the Report only as the "most significant" effort to provide "alternative forms of protection to construction workers * * * [i]n the absence of a comprehensive OSHA lead standard protecting workers in the construction industry * * *" Thus, the protections Congress mandated OSHA to incorporate in its interim final rule are to be extended to all construction workers exposed to lead.

There are a few indications in the 1992 Act and legislative history that Congress might have intended to protect only construction workers engaged in lead paint abatement, but they are not persuasive. For example, the short title of title X of the Act is the "Residential Lead-Based Paint Hazard Reduction Act of 1992" and the short title of Subtitle C—Worker Protection is the "Lead-Based Paint Exposure Reduction Act." Moreover, the criterion in the Act for assessing the sufficiency of the interim final regulation is the HUD guidelines, which apply only to lead paint abatement in housing. Furthermore, related sections of the Act focus on lead paint abatement (e.g., Sec. 1032). Finally, remarks by Representative Paul Henry suggest that he thought the scope of the interim standard would be limited to residential lead-based paint abatement work (138 Cong. Rec. H11470; daily ed. Oct. 5, 1992).

Nevertheless, conventional rules of legislative interpretation give considerably more weight to the express language in legislation than to its title. Moreover, the fact that the source of the criterion for determining the level of protection to be afforded workers is guidelines for abating lead paint in residential housing does not necessarily mean or imply that the intention was to protect only those engaged in such abatement. Finally, Representative Henry's views on scope seem to misunderstand and diverge from the views on scope of the majority. Indeed, Representative Henry was not present when the provisions that became section 1031 were discussed, did not seek clarification of the scope issue, voted against the conference agreement, and did not sign the Conference Report to H.R. 5334. His views, then, can hardly be taken to represent the intention of the majority. This understanding is confirmed by a letter from Representative William D. Ford, the Chairman of the originating House Committee on Education and Labor written on November 26, 1992, after the fact, to then Secretary of Labor, Lynn Martin.

(C) The Justification and Explanation Required for the Interim Final Rule

The in the Act of 1992 does not impose an independent duty to justify the interim final rule. Without such a duty in the authorizing legislation, if OSHA has a duty to provide a justification or explanation, it must come from two sources: First, the common law or generic legislation like the APA; and second, any other applicable specific law or regulation, such as the OSH Act or Executive Order ("EO") 12291. As to the first of these, the Agency believes that it is inherently obligated under the APA to give a reasonable explanation for its actions in order to provide a basis for judicial review (5 U.S.C.A. 551, 553(C)).

As to the second, because the interim final is being issued under the authority of the Housing and Community Development Act of 1992 and not under the OSH Act, OSHA is not required to comply with any of the requirements of the OSH Act for 6(b) rulemakings. Consequently, for example, OSHA need not undertake and provide a formal analysis of economic and technological feasibility. Nor need the Agency make a determination of significant risk. As a result, no quantitative risk assessment is required.

The Act does state that the interim final regulation "shall have the legal effect of an Occupational Safety and Health Standard * * *." However, by that, Congress seems only to mean that the interim final is to be enforced by OSHA as a 6(b) standard. There is no reason to infer from such language that OSHA must justify the interim final in accordance with the legal tests developed under the OSH Act. On the contrary, precisely because the interim final is not a 6(b) standard it was necessary for Congress to give it that "effect." If Congress had expected OSHA to justify the interim final in the same manner that OSHA justifies 6(b) standards, the legislature could hardly have expected OSHA to issue the interim final in 180 days.

However, the 1992 Act does not appear to exempt OSHA from any other preexisting duties to explain the interim rule. Thus, OSHA still might be required to perform some form of regulatory impact analysis ("RIA") under Executive Order 12291. The extent of that obligation is limited in this case by three considerations: (1) Congress ordered OSHA to produce this rule. OSHA did not, based upon its own priorities, decide to issue it at this time. The Agency therefore should not be responsible for justifying the rule as if it were a typical OSHA determination. (2) Congress also broadly decided the level of protection that must be provided. OSHA, therefore, should not be responsible for justifying that decision as if it were a typical OSHA determination. For all practical purposes, whatever the costs and benefits, OSHA must issue the interim final with the level of protection determined by Congress. (3) The duty to perform an RIA may be further limited by the time constraints imposed by the Congressional deadline. The EO by its own terms is inapplicable to any regulation for which performing the analysis required by the Order "would conflict with the deadlines imposed by statute or by judicial order * * *." (EO 12291, sec. 8(a)(2)). As a result, in the event of conflict, the duty to perform an RIA is limited by the statutory deadline."

In summary, in issuing this interim final rule, OSHA must: (1) comply with the Congressional mandate in Section 1031 of Title X of the Housing and Community Development Act of 1992; and (2) provide a sufficiently reasoned explanation for the rule to permit judicial review (5 U.S.C.A. 551, 553(C); and see note 198).

That is the focus of what follows in this preamble. First comes a general discussion of the criteria for compliance with the Congressional mandate. That is followed by a conventional "summary and explanation" to help employers, employees and others understand the particular provisions in the interim final standard and to help them and the courts understand why OSHA chose to require certain things and not others.

(D) Complying With the Congressional Mandate That the Interim Final be as Protective as the HUD Guidelines

Applying Congress mandate to issue an interim final standard that provides workplaces that are "as safe and healthful as those that would prevail under" the HUD Guidelines raises a number of questions. Some are relatively easy, but others are difficult, to answer.

In the first place, the HUD Guidelines (Revised Chapter 8) are neither sufficiently comprehensive nor sufficiently clear to be translated directly into an enforceable OSHA standard regulating occupational exposure to lead in the construction industry. Second, the HUD Guidelines were written exclusively with regard to lead paint abatement in housing and therefore have to be adapted to the diverse conditions in the construction industry as a whole. Third, the HUD Guidelines expressly incorporate many provisions of the OSHA lead standard

for general industry, but the extent to which the lead standard is incorporated differs in different provisions.

Fourth, there is the question of what criterion should be used to trigger application of the standard in the first place. Although the HUD Guidelines refer to the OSHA general industry standard, there is no explicit reference to a general action level or PEL. In fact, there is no reference to any trigger level or in Chapter 8 of the Guidelines. The only such reference is in the Introduction to the Guidelines and that reference is not in the context of worker protection. (This issue is discussed later in more detail).

Thus, OSHA has to fill in the gaps, clarify, modify, make choices, and adapt the Guidelines to conditions in the construction industry at large. Based upon the Committee report, Congress clearly understood this and signalled that it did not intend for OSHA to simply adopt the HUD Guidelines whole cloth. Rather, the Guidelines are to serve "as the basis" for developing the interim final rule, but "the Secretary may alter the provisions of the HUD Guidelines, so as long as the interim regulation provides workers with health and safety protections which are equally as effective." (House Committee report on H.R. 5730, pp. 15–16). Thus, Congress provided OSHA with flexibility to determine what modifications should be made to those Guidelines, in part based upon the need to adapt the HUD Guidelines to the broader construction industry. So Congress expected that OSHA would have to exercise judgement in determining the contents of the interim final rule.

OSHA considered somewhat different interpretations of how Congress intended the Guidelines to relate to the OSHA general industry standard with regard to such issues as trigger levels. After careful consideration, OSHA has concluded that the Guidelines were intended to be understood in conjunction with OSHA's lead standard for general industry.

The Guidelines are based on, and to a substantial degree repeat, much of the language of the standard. In most respects the Guidelines and the lead standard can be read to be consistent. The close relationship between the two is attested to by the many, often sweeping references in the Guidelines to OSHA's lead standard. For example, the introduction to the worker protection chapter in the Guidelines declares that the Guidelines "are intended to provide, at a minimum, the level of protection afforded by * * * OSHA['s] general industry lead standard" (55 FR 39874). Similarly, in paragraph 8.6 concerning MRP, the Guidelines say that public housing agencies should "refer to OSHA's general industry standard for lead for complete guidance on this subject." Again, in paragraph 8.8 regarding worker training, the employer is required to inform workers of the content of the OSHA lead standard and its appendices. Likewise, just preceding a list of the major elements that employers are advised to include in their employee protection plan, the Guidelines note that "Employers can refer directly to the OSHA lead standard * * * for complete requirements." Finally, near the end of the Guidelines, HUD says, "In addition to the lead standard, there are many standards that abatement employers must comply with." But abatement employers need not comply with OSHA's lead standard, which exempts construction, unless "required" to do so by the HUD Guidelines. These and other similar references to OSHA's lead standard give the strong impression that HUD Guidelines either incorporate that standard or are so dependent on it that they cannot be understood separately from it.

The legislative history of the 1992 Act makes clear that Congress regarded the Guidelines as very similar in essentials to OSHA's lead standard for general industry. Thus, the Committee Report states that "The HUD guidelines are based on, and in most respects mirror, OSHA's general industry lead standard." It further adds that, "Where the guidelines differ from OSHA's standard, the differences are intended to reflect the unique circumstances of the construction industry." Moreover, by requiring OSHA to issue an interim final regulation as protective as the HUD Guidelines, Congress' overriding intention appears to have been to extend to construction workers the protection afforded by OSHA's lead standard for general industry: "By relying on the HUD guidelines as the basis for the Secretary's interim final regulation, the Committee expects that construction workers will gain the same benefits available to general industry workers under the lead standard, i.e., a PEL of 50 $\mu g/m^3$, medical surveillance, medical removal protection, etc." The reference to a PEL of 50 $\mu g/m^3$ is repeated elsewhere in the legislative history: "the HUD guidelines recognize that compliance with a 50 $\mu g/m^3$ PEL in the construction industry likely will require greater reliance on respirator use than is accepted in general industry."

The references to the PEL are important. If the HUD Guidelines were not understood by Congress to have incorporated requirements from the general industry standard, Congress could not have expected a PEL of 50 $\mu g/m^3$ to apply to construction since there is no explicit reference to a PEL in the language of the Guidelines. Thus, from the legislative history it is clear that Congress intended the interim final regulation to incorporate the PEL and other provisions from the general industry standard. This interim final standard is patterned very closely on the HUD Guidelines and the general industry standard for lead.

OSHA is confirmed in this position by its understanding, based upon the language of the Act and its legislative history, that Congress conceived of the interim final standard within a broader perspective. First, Congress intended the interim final as a long overdue protective measure which generally would not break significant new ground. Second, Congress expected that the interim final would involve an adaption of OSHA's lead standard for general industry to the construction industry along the lines of the HUD Guidelines, which incorporate much of OSHA's lead standard. Finally, Congress assumed that a stricter construction standard or one that breaks new ground, if OSHA determines that one is needed, should be the product of a future 6(b) rulemaking, which provides for extensive notice and comment.

(E) Reasons for Differences With HUD Guidelines on Certain Provisions

In the previous discussion, issues involved in satisfying Congress' mandate that the interim final standard should be as protective as the HUD Guidelines were outlined. In what follows, the resolution of some of these issues is discussed with particular reference to where and why this interim final standard may differ somewhat in specific instances from the HUD Guidelines and/or from the OSHA lead standard. Further detailed discussion of the contents of each of the individual provisions of the standard is provided in the Summary and Explanation below.

Trigger Levels

One of the most important of these issues concerns the criteria by which applicability of the standard and of particular provisions of the standard are triggered. The most basic trigger determines whether an employer is covered by the standard at all. In addition, specific provisions of the standard can be triggered by other criteria or exposure levels.

The trigger criteria for the OSHA general industry standard and the HUD Guidelines appear to be different. For

example, the general industry standard triggers are the PEL of 50 μg/m³ and the action level of 30 μg/m³. Exposures above the PEL require implementation of feasible engineering and work practice controls, and provision of personal protective equipment and hygiene facilities supplemented by the use of respirators, if necessary, to reduce exposures to below 50 μg/m³. For employees exposed at or above the action level of 30 μg/m³, employers must provide biological monitoring. Additional medical examinations are required for those with elevated blood-lead levels, and upon development of signs of lead intoxication. Exposures at or above the action level also require implementation of exposure monitoring and training.

Chapter 8 of the Guidelines seems to require the employer to comply with all provisions where there is any potential of exposure to lead at any level. These provisions include use of respirators (Section 8.2), medical surveillance (Section 8.5), protective clothing (Section 8.3), hygiene facilities (Section 8.4), medical examinations (Section 8.53) and training (Section 8.8) for all employees who work where there is any potential of exposure to lead at any level. Chapter 8 further states that engineering controls, where feasible, must be used to minimize employee exposures (Section 8.1) without regard to the specific air level. That could mean that if it is feasible, engineering controls must be used to reduce exposures to zero.

Thus if OSHA were to adopt the seeming requirements of Chapter 8 without modification, it would apply all of the above provisions to people who are exposed at any level as well as to people who are exposed to higher levels. This would not only be unduly costly but would be impossible to comply with. For example, nearly every person on nearly every lead-related construction site would have to wear protective clothing and a respirator, and would have to be provided an annual medical examination even if they were only exposed to an air lead level of 5 μg/m³ for less than one hour per day and for one week per year. OSHA does not believe this is what Congress intended; nor is it what HUD intended in its Guidelines.

Although the HUD Guidelines do not address a specific trigger in the context of worker protection, the Introduction to the Guidelines states that wherever the lead concentration in a painted surface exceeds 1 mg/cm², abatement is required. This level is based on the hazard which the painted surface presents to occupants of the building, and the abatement is for their protection. It is only where abatement is already required in the Guidelines that most provisions in Chapter 8 are triggered by "any potential exposure". Since abatement is required only when the surface concentration of the painted surface exceeds 1 mg/cm², this level effectively establishes a trigger for the worker protection provisions.

On the basis of the foregoing, several options were theoretically open to OSHA in deciding the basic trigger for application of the standard and its provisions. The first was to trigger the standard, as Chapter 8 of the Guidelines appears to, at any potential exposure. In this case, requirements would be triggered in cases where little risk can be shown to exist. Every workplace where any lead can be shown to exist would be covered, even if the exposures could be shown, for example, to be 1 or 2 μg/m² of lead in the air. Such a requirement could not be justified in terms of substantial adverse health effects and would involve unprecedented annual costs.

An alternative option that would follow the Guidelines would be to trigger the standard based on a minimum lead concentration in paints or coatings of 1 mg/cm³ in any surface coated with lead-containing material. However, there is no reliable connection between such a concentration and any risk of adverse health effects. That connection would have to be established by relating the surface concentration to an air concentration. Where this has been tried, the results were so variable as to be impossible to apply.

For example, in preparing a proposal for a standard for lead in construction, the state of California developed a mathematical model with which they calculated the air lead levels that would arise in certain specific work situations as a result of having 1 mg/cm³ of lead in a painted surface. (Draft proposed standard: Occupational Exposure to Lead in Construction Operations, May 11, 1992, Department of Health Services/Department of Industrial Relations, State of California). The results are highly variable, depending in part on the method of removing the paint from the surface. For example, in the case of wet scraping of paint containing 1 mg/cm² it was calculated that an air lead level of about 37 μg/m³ would result. However, dry scraping of the same surface was estimated to result in an exposure level of about 371 μg/m³. Therefore, in the latter case, if OSHA were to follow the HUD guidelines approach, it could permit exposures to 371 μg/m³ of lead in the air before the standard would be applicable. Thus in the absence of a firm correlation between lead-in-paint concentration and air lead levels, OSHA would have no idea what health effects might be produced by such a surface concentration. Moreover, the trigger applies only to lead painted surfaces. It does not deal at all with the broad range of jobs in the construction industry that involve lead that is not in paint. As a result, the incorporation of this trigger from the HUD Guidelines into an OSHA standard would not be appropriate. Nor did Congress intend such a result. To quote the conference report once more, "By relying on the HUD guidelines as the basis for the Secretary's interim final regulation, the Committee expects that construction workers will gain the same benefits available to general industry workers under the lead standard, i.e., a PEL of 50 μg/m³ * * *." Thus, Congress intended OSHA to incorporate a PEL of 50 μg/m³ into the interim final standard regardless of whether such a PEL was part of the HUD Guidelines.

This approach follows the general industry standard for lead and establishes that a potential hazard must exist prior to requiring an employer to implement the standard. As described above, some provisions will be triggered by the 50 μg/m³ PEL, while others will be triggered by a 30 μg/m³ action level. These trigger levels are taken from the OSHA lead standard for general industry and are based upon health effects data generated for that standard and thus have a health-related foundation.

Task-related Triggers

In response to Congress' mandate that OSHA should modify the HUD Guidelines in this interim final standard as needed to adapt to the particular conditions in the construction industry, OSHA has added a provision included in neither the HUD Guidelines nor the general industry standard. This approach is consistent with the approach taken in the HUD Guidelines. The air lead levels that trigger the standard are determined by an employee exposure assessment, most often containing air sampling. However, there is often a time lapse between taking the sample and receiving the results. Certain construction tasks are known to commonly produce exposures above the PEL—sometimes many orders of magnitude above the PEL. In such tasks, workers could be exposed to high concentrations of lead in air during the period between sampling and receipt of the results without sufficient protection. In addition, because many construction jobs are of short duration, workers could

complete one job before monitoring results are in and go on to another, again in a high exposure situation, still without adequate protection in the absence of monitoring results.

To address this problem, OSHA has included within the regulatory text three lists of tasks, the performance of which in the presence of lead trigger basic protective provisions prior to air lead monitoring. The first consists of tasks which commonly produce a substantial proportion of exposures above the PEL of 50 $\mu g/m^3$, but less than 10 times the PEL. The second consists of tasks which commonly produce a substantial proportion of exposures greater than 10 times the PEL (500 $\mu g/m^3$), but less than 50 times the PEL (2500 $\mu g/m^3$). The third set of tasks consists of those which commonly produce a substantial proportion of exposures greater than 50 times the PEL (2500 $\mu g/m^3$). For all three sets of tasks, employers are required to provide respiratory protection appropriate to the tasks' anticipated exposure level, protective work clothing and equipment, change areas, hand washing facilities, training, and initial medical surveillance consisting of blood sampling and analysis. OSHA believes that these basic provisions are essential where employees are exposed to air levels above the PEL. In the absence of monitoring results to the contrary, tasks which commonly produce air levels above the PEL must be assumed to continue to do so and, thus, it is necessary to require these provisions. The only difference in the provisions among task categories is in the kind of respirators which are required. For example, abrasive blasting workers need a much higher performance respirator than do workers doing spray painting.

Criteria for selection of the tasks in each category were based on three sources—advice from the Department of Labor Advisory Committee on Construction Safety and Health (ACCSH) Lead Workgroup; recommendations of the Society for Occupational and Environmental Health (SOEH) in conference proceedings entitled Protective Work Practices for Lead-Based Paint Abatement; and limited exposure data provided to OSHA by a firm contracted to perform an assessment of lead exposure levels encountered in the construction industry.

The first set of tasks, consisting of those which commonly produce exposures between 50 $\mu g/m^3$ PEL and 500 $\mu g/m^3$, includes manual demolition; manual scraping; manual sanding; heat gun applications; general cleanup; power tool cleaning with dust collection systems; and spray painting. This selection of tasks was suggested by the chairman of the ACCSH Lead Workgroup. It is further supported by the SOEH recommendation that, when these tasks are performed, halfmask air purifying respirators—with a protection factor of 10—should be used. In addition, the selection of these tasks is based partly on limited exposure data available to OSHA.

Since the data which OSHA has obtained indicate a wide range of exposure levels in particular tasks, and are sometimes based on a limited number of samples, OSHA had to consider the data in relation to recommendations from knowledgeable people or organizations. For example, in the case of spray painting, available data showed exposures ranging from 1 $\mu g/m^3$ to 460 $\mu g/m^3$. However, the average exposure was 74 $\mu g/m^3$, and a level of 101 $\mu g/m^3$ would be expected to be exceeded only five percent of the time. Moreover, SOEH recommends using halfmask negative pressure air purifying respirators for this task, i.e., respirators with a protection factor of 10. Therefore, spray painting seems to belong in the task category with anticipated exposures between 50 $\mu g/m^3$ and 500 $\mu g/m^3$. In general, the other tasks in this category also entail a likelihood of exposures in this range, which is supported both by the contractor data and the SOEH recommendations.

The second category, from 500 $\mu g/m^3$ to 2500 $\mu g/m^3$, includes the use of lead-containing mortar; lead burning; rivet busting; power tool cleaning without dust collection systems; cleanup of dry expendable abrasives; and abrasive blasting enclosure movement and removal. Following is a discussion of why these tasks were selected for this exposure range and why powered air purifying respirators (PAPRs) are required to be used when performing them.

The only information OSHA has on the use of lead-containing mortar and lead burning comes from its contractor report which suggests control exposure levels for both that are greater than 600 $\mu g/m^3$, greater than would be safe with an air purifying respirator with a protection factor of 10. ("Control exposure levels" here refers to levels that would not be expected to be exceeded in 95% of the time the activity was monitored.) With an assigned protection factor of from 25 to 50, depending on which specific type is used, a PAPR will provide adequate protection in an exposure range from 1250 to 2500 $\mu g/m^3$, and thus appears to be effective for these applications.

Rivet busting falls under the SOEH category of "Chipping and Breaking with Pneumatic Tools". SOEH recommends that powered air purifying respirators be used for this group of tasks. Since such respirators have protection factors greater than 10, OSHA infers that SOEH regards likely exposures for rivet busting to be greater than ten times the PEL—greater than 500 $\mu g/m^3$. Data reflecting actual exposures in this task, however, were not provided to OSHA by its contractor.

Without the use of dust collection systems, the use of power tools for grinding, sanding and wire brushing can raise large concentrations of lead in the air. The OSHA contractor report suggests control exposure levels of more than 1000 $\mu g/m^3$. SOEH recommends the use of powered air purifying respirators. Thus, placing this task in the 500 $\mu g/m^3$—2500 $\mu g/m^3$ category is consistent with both sources.

Clean-up after abrasive blasting when the blasting involves dry expendable abrasives, while not characterized by exposure data available to OSHA, was identified by SOEH as a task with potentially high exposures. SOEH consequently recommends powered air purifying respirators as the minimum respiratory protection. OSHA has classified it accordingly.

In addition to the high concentrations of air lead produced by abrasive blasting operations, the enclosures within which the work is done are left with a substantial accumulation of lead when the blasting is completed. Therefore, movement and removal of these enclosures can themselves create high air lead concentrations, although not to the same extent as the blasting. Available contractor data show a control exposure level for this operation to be between 1100 and 1200 $\mu g/m^3$. On this basis OSHA has included abrasive blasting enclosure movement and removal in the category where exposures between 500 and 2500 $\mu g/m^3$ can commonly be expected.

The final category requiring interim protection prior to receiving exposure assessment covers tasks commonly associated with air lead exposures greater than 2500 $\mu g/m^3$ (50 times the PEL). This category includes abrasive blasting as well as welding, cutting and torch burning on steel structures. In the case of abrasive blasting, the possibility of extremely high exposures is well known and documented by data which show control exposure levels between 20,000 and 40,000 $\mu g/m^3$. Consistent with these numbers, SOEH recommends the use of supplied air respirators.

Data obtained by OSHA's contractor regarding welding, cutting and burning

show control exposure levels to be from about 970 to about 1560 $\mu g/m^3$, depending on the specific operation involved. Such levels would not seem to qualify these tasks for the over-2500 $\mu g/m^3$ exposure category. The numbers, however, represent estimates from a very wide spread of data points, thus providing a high degree of uncertainty. The data show that actual exposures can reach 28,000 $\mu g/m^3$. Further, SOEH recommends use of supplied air respirators during performance of welding, cutting and burning on steel structures. Therefore, based on exposure data showing that exposures often exceed 2,500 µg/m3 and based on the SOEH recommendation, OSHA has chosen to be conservative and has assigned these tasks to its highest hazard category with respect to required interim protection.

OSHA believes that it has taken a well-reasoned approach to identifying tasks in the foregoing categories, given the limited amount of firm data available at the time of promulgation of this standard. Because the interim protection of workers in these tasks is very important, the approach has been conservative. If the Agency has erred in selecting these tasks, it has erred as authorized by the U.S. Supreme Court on the side of overprotection (*IUD* v. *API*, 448 U.S. 601 (1980)). In any event, once the monitoring results are received, if they show air lead levels to be lower than presumed, the presumed level of protection need no longer be provided. OSHA intends to study this issue comprehensively in a forthcoming rulemaking on a permanent final rule for lead exposures in the construction industry.

Medical Surveillance

One of the most important sets of provisions of any substance specific standard is that of medical surveillance. Medical surveillance is particularly relevant to lead exposures because, in the measurement of blood lead levels, there is a true indicator of health risk and, in the case of high blood lead levels, a course of action to address the risk. The medical surveillance provisions of the HUD Guidelines are essentially the same as in the OSHA general industry standard. The essential difference is in the conditions under which the provisions must be implemented. The medical surveillance provisions of this interim final standard are in most respects similar to those in the HUD Guidelines and the OSHA lead standard for general industry.

The Guidelines, in Chapter 8, appear to require full medical surveillance whenever any employee working in lead paint abatement is potentially exposed to any concentration of lead. This effectively places all workers covered by the Guidelines under medical surveillance. If this requirement were used in the interim final standard, it would apply to all of the more than 900,000 workers who might have some contact with lead, no matter how small the exposure. However, limited available data indicate that most exposures in many highly-populated segments of the industry are well below the 30 $\mu g/m^3$ action level of the general industry standard, and the blood lead levels of such employees are almost always below any level that, based upon the health effects analysis accompanying the OSHA general industry lead standard, would require medical action. For example, exposure data collected by NIOSH during the Demonstration Project for HUD Lead-based Paint Abatement (The HUD Lead-Based Paint Abatement Demonstration (FHA), U.S. Department of Housing and Urban Development, August 1991), revealed that, in those cases where surface concentration exceeded 1 mg/cm^2, "Over 80% of the combined numbers of all air samples, both personal and area, showed airborne lead levels below 10 $\mu g/m^3$." Therefore, in a very large number of cases, the full medical surveillance would serve no purpose and would entail very significant costs. Under these conditions, the same degree of real worker protection can be obtained without the identical requirements of the Guidelines.

The medical surveillance provisions of the OSHA general industry standard are triggered initially by air lead exposure levels. Since it is the air lead level that is relevant, not the industry in which one is exposed, specific air lead triggers in the construction industry should be the same as those in general industry. Thus, medical surveillance in the interim final standard is triggered by the same exposure levels as in the general industry standard.

There are, however, two modifications to this program. As discussed above, in the three categories of high exposure tasks, blood sampling and analysis are triggered by performance of the specified tasks when lead is involved. In addition, the employer must provide every worker who will be exposed to an air lead level greater than the 30 $\mu g/m^3$ action level, if only for a single day in any consecutive 12 month period, with blood testing. The construction-related reason for the blood testing related to the high exposure task categories has been discussed earlier. The reason for blood monitoring for workers exposed above the action level, even on one day, also arises from the peculiarities of the construction industry where jobs are frequently of short term, turnover is rapid and exposure levels vary. OSHA believes it important that exposures of duration up to 30 days not be neglected since such exposures in some applications will be very high. A worker exposed at high levels for only a few days can still incur a large lead burden in his or her blood and, if that happens, it is important to keep track of the levels.

In view of the fact that workers who need medical surveillance, based on air lead levels established in the rulemaking for the general industry standard, on high exposure tasks, and on short duration exposures above the action level receive it, the medical surveillance provisions of the interim final standard are more protective than the OSHA general industry standard and are as protective as the Guidelines.

Exposure Assessment

The HUD Guidelines do not require initial monitoring. They do, however, require that an initial determination be made "to determine whether employees are potentially exposed to lead. The goal is to establish the level of exposure expected." The Guidelines go on to say, "Indications of possible overexposure to lead, such as employee health complaints, prior abatement experience, and prolonged or intense lead-based paint removal, should lead to an initial monitoring of the workplace." The monitoring results are to be used to determine the frequency of further monitoring, and to select appropriate respiratory devices and determine the need for engineering controls. However, in using monitoring results for the foregoing purposes, the Guidelines refer to the PEL of the OSHA general industry standard and the respirator selection table that is used for selecting a respirator that will maintain exposures below the PEL. They allow consideration of objective factors before initial monitoring needs to be performed. Thus, every workplace with very low exposures need not do monitoring where it serves no purpose in identifying excessive exposures. If monitoring is done, however, the Guidelines recommend that the procedures in the general industry standard be followed.

The interim final standard is effectively very similar to the Guidelines. It requires, as a first step, an initial determination which can be an objective assessment of exposure, based on specific data or on previous

monitoring or on past experience in identical workplaces. Once again, however, the requirements for the high exposure tasks are slightly more stringent. In order for any data other than from initial monitoring to be acceptable, it must be based on specific and documented monitoring performed during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations. Also the sampling and analytical methods used to obtain the data must meet the accuracy and confidence levels specified in the standard.

The remainder of the monitoring requirements are the same as in the general industry standard and the same as the Guidelines for situations where monitoring is performed.

On balance, the exposure assessment requirements for the interim final standard are more specific and somewhat more stringent than those in the Guidelines.

Protective Clothing and Respiratory Protection

Protective clothing and respirators are required in the Guidelines whenever the potential for exposure is present. As discussed earlier in this paragraph, this provision, on its face, would place every worker in a respirator and protective clothing regardless of extent of exposure. When applied across the entire spectrum of construction operations, the overall burden of this provision would be extremely high and difficult to justify. In particular, requiring respirators and personal protective equipment in the 80% of all cases in which NIOSH found that air lead exposures were less than 10 $\mu g/m^3$ would be difficult to justify on health grounds. Such a requirement would thus entail a significant burden to employers and employees without demonstrated benefit. For these reasons, and because there is no reason to believe that the relationship between health risks in the construction industry and air lead levels is different from that in general industry, the provisions for protective clothing and respiratory protection in this interim final standard are triggered by the PEL, as in the general industry standard.

The actual provisions covering the use and selection of respirators in the Guidelines are the same as in the general industry standard. The interim final standard, however, has one important difference. The respirator selection table of the general industry standard was based on information as of 1978 and contained no specific reference to construction—particularly abrasive blasting. The selection table in the interim final standard has expanded the types of respirators permitted under the various exposure categories, including those uniquely permitted for abrasive blasting, and added another exposure level category (1250 $\mu g/m^3$) to provide greater flexibility in selection and higher probability of adequate fit. The table has been taken from the latest version of the NIOSH Respirator Decision Logic, which has been a standard reference since its publication. Therefore, in terms of respirator selection the interim final rule is more appropriate and more protective than the HUD Guidelines.

Information and Training

Regarding employee information and training, the Guidelines require comprehensive training for everyone who may be potentially exposed to lead. As discussed previously, this provision, applied to the entire construction work force, would cover a large number of workers who encounter only minimal exposure. The OSHA general industry standard requires comprehensive training only for those workers who are exposed above the action level. The interim final standard has the same provision for comprehensive training; however, other training provisions are also included. First, all employees, regardless of exposure, are required by the Hazard Communication Standard (29 CFR 1926.59) to receive training regarding any hazardous materials, including lead, they may be exposed to at their work site. The interim final standard specifically incorporates this requirement by reference. Second, all construction employees are required to undergo training relevant to all the health and safety hazards of the workplace by the Safety Training and Education Standard (29 CFR 1926.21) which the interim final standard also incorporates by reference. In addition, for those tasks listed as likely to encounter high exposure levels, training in use of respirators is required automatically, until it is shown by monitoring results that exposures will not reach the level at which respiratory protection is necessary.

In view of the foregoing, OSHA believes that the interim final standard requires training as protective as that provided for in the HUD Guidelines.

III. Summary and Explanation of the Standard

As discussed earlier, OSHA believes that the intent of Congress' mandate, to a significant degree, was the issuance of a interim final standard that provided a level of protection to workers exposed to lead in construction equivalent to that afforded other lead workers under OSHA's general industry standard. To that end, the interim final construction standard incorporates many provisions as they are set-forth in the general industry standard. Although some provisions carried from the general industry standard into the interim rule are not adopted verbatim, the regulatory intent of the provisions in the rules is consistent. Thus, the discussion and justifications set forth in the preamble and supplements to the general industry standard (43 FR 52985) are applicable to the "Summary and Explanation" in this interim final rule. Provisions derived from the general industry standard and incorporated into the interim final standard include the following paragraphs of this rule: (b) Definitions; (c)(1),(2),(3), Permissible exposure limit; (d)(1),(3),(4),(5),(6),(7),(8), Exposure assessment; (e)(2)(i)-(v),(4) Methods of compliance; (f)(1)(i)-(iv),(2),(3),(4), Respiratory protection; (g)(1),(2), Protective work clothing and equipment; (h)(1),(2),(3),(4), Housekeeping; (i)(1),(2), Hygiene facilities and practices; (j)(1)(ii)-(iv),(2)(i)(B)-(C),(ii)-(iv),(3),(4), Medical surveillance; (k)(1)(ii)-(v),(2), Medical removal protection; (l)(1)(ii)-(iii),(2),(3), Information and training; (m)(1),(2), Signs; (n)(1),(2),(3),(5),(6), Recordkeeping; and (o)(1),(2), Observation of monitoring.

A. Scope and Application Paragraph (a)

This interim final lead standard for the construction industry applies to all occupational exposure to lead in all construction work in which lead, in any amount, is present in an occupationally related context. Exposure of employees to the ambient environment which may contain small concentrations of lead unrelated to the job is not subject to this standard; however, where the source of lead is employment related, all exposure to lead is covered by the standard. The forms of lead to which this construction standard applies is defined to include metallic lead, all inorganic lead compounds, and organic lead soaps.

Construction work is defined as work involving construction, alteration and/or repair, including painting and decorating. Such work includes but is not limited to: demolition or salvage of structures where lead or materials containing lead are present; removal or encapsulation of materials containing lead; construction, alteration, repair, or renovation of structures, substrates, or portions thereof, that contain lead, or

materials containing lead; installation of products containing lead; lead contamination/emergency cleanup; transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed; and maintenance operations associated with the construction activities described above. All construction work excluded from coverage in the general industry standard, section 1910.1025(a)(2), is covered by this interim final rule. OSHA intends that there should be no gaps and no overlaps between the two standards.

It should be recognized that although this standard may apply to a particular employer or workplace, almost all of the obligations in the standard are triggered by certain minimum levels of lead exposure. For example, the employer is required to provide requirements for periodic exposure monitoring and medical surveillance only if employees are exposed to airborne lead in excess of the action level. Employers whose employees are exposed below this level are not required to comply with most provisions of the standard. This distinction is made in order to differentiate between hazardous and relatively unhazardous work operations and to impose obligations commensurate to the degree of hazard present.

B. Definitions: Paragraph (b)

The terms "*Action Level*", "*Assistant Secretary*", "*Director*" and "*Lead*" in this interim standard are defined as set forth in 29 CFR 1910.1025.

"Action level" is defined as an airborne concentration of lead of 30 µg/m³ of air calculated as an 8-hour time-weighted average. Several provisions of the standard, such as periodic exposure monitoring, biologic monitoring and initial and annual employee training are triggered whenever exposure measurements reach or exceed the action level. For employees exposed to lead at or above the action level for more than 30 days per year, employers are also required to provide an ongoing medical surveillance program. Past experience with the action level concept in other OSHA standards has demonstrated its usefulness to employers as an objective means of determining whether compliance activities are required, thus relieving them of most compliance obligations where exposures are maintained below the action level.

Action levels are important because their use permits employers to concentrate their resources on those employees and workplace conditions with the potential for high lead exposures. Thus the action level in the interim standard provides for the most cost-effective means of employee protection. The action level provides a mechanism to tailor certain requirements of the standard to a minimum level of employee exposure to lead by triggering preventive action by the employer for employees who face exposure at or above that level. The use of the action level to trigger various provisions of the lead standard is consistent with other final OSHA health standards (e.g., the Lead standard for general industry, as well as Asbestos, 51 FR 22612, June 20, 1986; Benzene, 52 FR 34460, September 11, 1987; Formaldehyde, 52 FR 4668, December 4, 1987; Ethylene Oxide decision (796 F.2d 1479 (DC Cir., 1986) and, *Public Citizen Health Research Group* v. *Tyson*, 796 F.2d 1479 (DC Cir., 1986), and Acrylonitrile, 43 FR 45809, October 3, 1978).

This substantive consistency provides administrative consistency and continuity to employers in developing and implementing compliance strategies for this and other applicable OSHA health standards at individual worksites. In addition, use of an action level has been found to encourage employers, where feasible, to lower lead exposure levels to below the action level to avoid the added costs of required compliance with provisions triggered by the action level.

A definition of "*Competent person*" is included in this paragraph. Paragraph (e)(2)(iii) of the standard broadly establishes the duties of the "competent person." The duties and definition of the "competent person" under this standard are essentially identical to those already prescribed for construction work in 29 CFR 1926.20 and 29 CFR 1926.32, respectively, and are included in this section to primarily ensure that employers are aware of these existing requirements. Thus, no new burdens are imposed by the "competent person" provisions in this section. The term "competent person" means a person who is capable of identifying hazards and has authorization to take corrective measures to eliminate them. Compliance programs required to be developed by employers under paragraph (e) of this section must provide for inspections of job sites, materials, and equipment to be made by the "competent person" to achieve the duties of the competent person set forth in the definition.

C. Permissible Exposure Limit: Paragraph (c)

The employer is required to assure that no employee is exposed to lead at concentrations in excess of the PEL of fifty micrograms of lead per cubic meter of air (50 µg/m³). The PEL adopted in this interim rule is the same as the PEL provided for in OSHA's general industry lead standard (29 CFR 1910.1025). This is in accordance with Congress' intention, as expressed in the legislative history of the 1992 Act.

The PEL is an eight-hour average of exposure for any work day. If respiratory protection is permissibly being used to comply with this limit and all of the requirements relating to selection, fitting, and maintenance of respirators are met, the employee needs to wear the respirator only for a period of time that, when averaged with periods of time the respirator is not worn, will result in a TWA exposure to or below the PEL. For this purpose, the employee's exposure level when a respirator is worn may be considered to be the airborne concentration, without regard to the respirator, divided by the protection factor of the respirator. For example, if an employee is exposed to 100 ug/m³ for 8 hours without a respirator, he would have to wear a respirator with a protection factor of 10 for about 4.4 hours or with a protection factor of 50 for about 4.1 hours, in order to comply with the PEL.

Of course, a class of respirator more protective than required by paragraph (f) may be selected, and if selected, would reduce the amount of time a respirator would need to be worn.

OSHA recognizes that workshifts can extend beyond the regular 8-hour period as the result of overtime or other alterations of the work schedule. This extension of worktime also extends the time during which the employee is exposed. The effects of this additional exposure time must be considered in arriving at a permissible level of exposure. For the purpose of calculating such a level, the relationship of concentration and length of time of exposure has been assumed to be linear. As the exposure time increases, the factor of concentration multiplied by time ($C \times T$) should remain constant. As a result, it is believed that by not exceeding the total allowable exposure of the 8-hour time-weighted average (8 hrs $\times$ 50 µg/m³=400), reasonable assurance of maintaining a safe exposure level is retained.

The interim final standard contains a formula by which adjustments to the permissible exposure limit can be made due to overtime. For example, if an

employee is exposed to lead for 10 hours, the permissible limit as a 10 hour average would be 400/10 or 40 μg/m³. This is the same formula used in the lead General Industry Standard to calculate the allowable exposure level for employees working beyond 8 hours in lead exposed jobs.

D. Exposure Assessment: Paragraph (d)

Each employer who has a workplace or work operation covered by this standard is required to determine if any employee may be exposed to lead at or above the action level of 30 μg/m³ as an 8-hour TWA. This initial determination need not be based exclusively on employee exposure monitoring. Where the employer has objective data demonstrating that under any expected conditions of use a particular product or material containing lead or a specific process, operation or activity involving lead cannot result in employee exposure to lead at or above the action level during processing, use, or handling, the employer may rely upon such data instead of implementing initial monitoring. The employer must establish and maintain a record documenting the nature and relevancy of the objective data (see paragraph (n)(4)). As is discussed elsewhere in this preamble, certain specified tasks are treated differently.

Where objective data as described above is not available to employers, employers must monitor employee exposures, except as noted below, and base initial determinations on the employee exposure monitoring results and any of the following relevant considerations: Any information, observations, or calculations which would indicate employee exposure to lead; any previous measurements of airborne lead; and any employee complaints of symptoms which may be attributable to exposure to lead.

Historical measurements of airborne lead may be used to satisfy the initial exposure assessment requirement if all the requirements of (d)(3)(iii) are met. OSHA has included this provision to allow employers who have been conducting relevant exposure monitoring on construction sites to use such data for current construction jobs that are substantially similar to previous jobs for which monitoring was conducted.

However, such monitoring data must have been obtained from projects conducted by the employer within the past 12 months under conditions which in all relevant and significant respects are essentially the same as the current project. These conditions include the following:

(1) The data upon which employee exposure assessments are based are scientifically sound and collected using methods that are sufficiently accurate and precise.

(2) The processes and work practices in use when the historical data were obtained are essentially the same as those to be used during the job for which initial monitoring will not be performed.

(3) The characteristics of the lead containing material being handled when the historical data were obtained are essentially the same as those on the job for which initial monitoring will not be performed.

(4) Environmental conditions prevailing when the historical data were obtained are essentially the same as for the job which initial monitoring will not be performed.

OSHA believes that if an employer has previous monitoring data that meet all these conditions, these data can be reasonably assumed to be representative of employee exposures that will be encountered on a new construction site. The employer must develop and maintain a record of the relevancy of previous exposure data if used for the initial exposure assessment. These provisions are set-forth in paragraph (d)(3)(iii) of this section.

The initial monitoring requirement only requires monitoring of a representative sample of the employees believed to have the highest exposure levels. If these measurements indicate exposures are all below the action level no further monitoring is required except where subsequent process or control changes would trigger a redetermination pursuant to paragraph (d)(8) due to additional employee exposure. If any employee is determined to be at or above the action level, then full-scale representative monitoring for all exposed employee is required as set-forth in paragraph (d)(4) of this section. However, under paragraph (d)(4)(ii) historical exposure monitoring data, which is permitted to be used to assess whether exposures are either above or below the action level, as discussed above, can also be used to satisfy the determination of the level of exposure that employees will be subject to above the action level.

In conducting the monitoring of employee exposures under paragraph (d)(4), the standard does not require that each individual employee's exposure level be measured. In establishments having more than one work operation involving the use of lead, in order for monitoring to be representative, it must be performed for each type of employee exposure within each operation. An employer, of course, is allowed to take individual exposure measurements of each of his employees. Representative monitoring merely establishes the minimum that the employer must meet.

All exposure monitoring performed pursuant to this section must consist of personal breathing zone samples which are representative of the monitored employee's regular, daily exposure to lead over a full shift and which must consist of at least one sample for each job classification in each work area either for each shift or for the shift with the highest exposure level. The exposure data may be collected during a single shift only if the activities in the other shifts are essentially the same as that shift.

The purposes served by air sampling for employee exposures include: Determination of the extent of exposure at the worksite; prevention of employee overexposure; identification of the sources of exposure to lead; collection of exposure data so that the employer can select the proper control methods to be used; and evaluation of the effectiveness of selected controls. Monitoring further enables employers to notify employees of their exposure levels, as required by section 8(c)(3) of the Act.

Required periodic monitoring provides the employer with assurance that employees are not experiencing higher exposures that may require the use of additional controls. In addition, periodic monitoring reminds employees and employers of the continued need to protect against the hazards associated with exposure to lead.

The collection of exposure monitoring data also enables an examining physician to be informed of the existence and extent of potential sources of occupational diseases.

The results of initial and periodic monitoring determine whether subsequent monitoring is necessary. Exposure monitoring is important not only to determine the level of lead to which employees are exposed and the frequency at which employees should be monitored, but also determine whether other protective provisions of the standard need to be implemented.

Where exposure monitoring is required under this standard samples must be taken within the employee's breathing zone (i.e., personal samples) and must reflect the employee's exposure, without regard to the use of respirators, to airborne concentrations of lead over an eight-hour period. A full description of "Breathing zone" is provided in the OSHA Instruction CPL 2-2.20B, CH-1, Nov. 13, 1990, Directory of Technical Support, Basically, it

encompasses a sampling area as close as practical to the nose and mouth of the employee.

If the initial determination or subsequent determination reveals employee exposure to be at or above the action level but at or below the PEL the employer is required to perform monitoring at least every 6 months. The employer must continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee.

If the initial determination reveals that employee exposure is above the PEL the employer must perform monitoring at least quarterly. The employer must continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are at or below the PEL but at or above the action level at which time the employer shall repeat monitoring at least every 6 months.

Within 5 working days after completion of the exposure assessment, the employer is required to notify each employee in writing of the results which represent that employee's exposure. Whenever the results indicate that the representative employee exposure, without regard to respirators, is at or above the PEL, the employer shall include in the written notice a statement that the employees exposure was at or above that level and a description of the corrective action taken or to be taken to reduce exposure to below that level. Section 8(c)(3) of the Act requires employee notification of monitoring results which reveal excess exposures to toxic substances, and requires employers to also notify affected employees of corrective actions that will be taken to reduce exposures.

Where monitoring is required under this standard the employer must use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 25 percent for airborne concentrations of lead equal to or greater than 30 $\mu g/m^3$. This accuracy requirement is consistent with the most recent criterion established under the NIOSH/OSHA Standards Completion Program with regards to monitoring and analyses of airborne lead concentrations.

As discussed earlier, OSHA is aware that in many instances in the construction industry the exposure assessment required under this standard will not be completed until after lead operations have begun or even ended (i.e. exposure monitoring usually must be conducted during actual performance of the lead activity in order to be representative). Thus, employees performing certain tasks which will generate airborne lead due to the presence of lead either in paint or in other materials being worked on, might be exposed without protection to some unknown, and potentially high concentrations of lead, pending the outcome of the exposure assessment. The Lead Workgroup of the Department of Labor's Advisory Committee on Construction Safety and Health (ACCSH), which was consulted by OSHA in development of this standard expressed concern to the Agency regarding this issue. The ACCSH Workgroup comprised of representatives from labor, industry, state government, and the public, recommended that some degree of interim protection, pending completion of the exposure assessments, should be provided to employees performing activities which are recognized as having the potential to produce exposures to lead in excess of the PEL. The Agency agrees with the ACCSH Workgroup that the need for interim employee protection should be presumed necessary for certain tasks until demonstrated otherwise. The Workgroup indicated that minimal interim protective measures, pending completion of the exposure assessment, should include provision of respirators, protective clothing and equipment, hygiene facilities, training, and biological monitoring.

The list of lead-related tasks/operations that have been developed by OSHA are based on available exposure data and recommendations of SOEH and the Workgroup, and are grouped by the presumed degree of overexposure to lead and, therefore, are differentiated by the type of respirator to be provided. One group of tasks/operations presumes employee exposures above the PEL, but not so high as to require the employer to provide the employee with more than the least protective, allowable respirator (e.g. a respirator with a protection factor of 10). The second task group presumes employee exposure above 500 $\mu g/m^3$ and requires the employer to provide the employee with a respirator with a protection factor of at least 25. The third task group presumes very high exposures to lead (in excess of 2500 $\mu g/m^3$) and, therefore, requires the employer to provide the employee with a respirator permitted by the standard for use during that exposure condition (e.g a respirator with a protection factor above 50).

The tasks identified as requiring interim worker protection are briefly described below.

Abrasive blasting: Removes scale, paint, and dirt from surfaces prior to repainting; abrasive media includes sand, steel grit, steel shot, aluminum oxide, "Black Beauty" (processed boiler slag, and others).

Welding, cutting and burning on steel structures: Involves the process of heating coated steel to its melt temperature typically by using an oxy-acetylene torch or an arc welder.

Lead burning: Involves torch melting or fusing of lead or alloyed lead to another lead object.

Manual scraping and sanding: Associated with lead paint removal and involves the application of hand-held scraping or sanding tool to the painted surface containing lead.

Manual demolition of structures: Involves removal of walls (plaster, gypsum) or building components coated with lead based paint by sledge hammer or similar tool.

Heat gun application: Involves use of a heat gun that produces a stream of hot air which is directed to surfaces to melt lead paint which is subsequently scraped off.

Using lead containing mortar: Typically used in high pressure acid tanks lined with specialized tile or lead brick held in place with specialized lead-containing mortar or grout; these tank linings periodically require repainting, repairing or relining. involving lead containing mortar.

Abrasive blasting enclosure movement and removal: Involves movement and removal of blasting enclosure or containment units as work proceeds on structures; such units are often comprised of flexible nylon, plastic or burlap tarpaulins upon which lead dust will accumulate and be reentrained when movement of the structure occurs.

Power tool cleaning: Involves the use of power tools (grinders, brushes, needle guns, sanders, etc.) to remove dirt, scale, or paint from structures where lead based paint is present.

Rivet busting: Involves removal of rivets from steel structures where lead containing paints are present; rivet busting can involve use of torches and mechanical means for rivet extraction.

Cleanup activities where dry expendable abrasives are used: Pertains to the use of non-recycled dry abrasives during abrasive blasting operations on structures where lead containing paint is found.

The requirements regarding interim employee protection during performance of these specific tasks, when lead is involved typically as in a paint or coating, are discussed below.

Paragraph (d)(2)(i) includes a listing of the following tasks which are presumed to frequently entail lead exposure levels above the PEL: Where lead containing coatings or paint are present; manual demolition of structures (e.g. dry wall), manual scraping, manual sanding, heat gun applications, and power tool cleaning with dust collection systems; and spray painting with lead based paint. With respect to these tasks, paragraph (d)(2)(i) requires that, until the employer performs an employee exposure assessment as required in paragraph (d) of this section and documents that the employee performing any of the listed tasks is not exposed above the PEL, the employer must treat the employee as if the employee were exposed above the PEL by providing the protective measures as prescribed in paragraph (d)(2)(v) of the standard (discussed below).

In addition, with regard to tasks not listed in paragraph (d)(2)(i), paragraph (d)(2)(ii) requires that where the employer has any reason to believe that an employee performing a task may be exposed in excess of the PEL, until the employer performs an employee exposure assessment as required by paragraph (d) and documents that the employee's lead exposure is not above the PEL, the employer must treat the employee as if the employee were exposed above the PEL by providing the protective measures as prescribed in paragraph (d)(2)(v) of this standard.

Paragraph (d)(2)(iii) includes a listing of the following tasks: Using lead containing mortar; lead burning; rivet busting; power tool cleaning without dust collection systems; cleanup activities where dry expendable abrasives are used; and abrasive blasting enclosure movement and removal. With respect to these tasks, paragraph (d)(2)(iii) requires that until the employer performs an employee exposure assessment as required in paragraph (d) of this section and documents that the employee performing any of the listed tasks is not exposed in excess of 500 $\mu g/m^3$, the employer must treat the employee as if the employer were exposed to lead in excess of 500 $\mu g/m^3$ by providing the protective measures prescribed in paragraph (d)(2)(v) of this section. Where the employer has established that employee exposure is at or below 500 $\mu g/m^3$ during these tasks, a less protective respirator, in accordance with Table 1 of this section, shall be provided as protection.

Paragraph (d)(2)(iv) includes a listing of the following tasks which are presumed to frequently entail exposures to lead above 2,500 $\mu g/m^3$: Abrasive blasting, and welding, cutting, and torch burning on steel structures where lead containing coatings or paint are present.

With respect to these tasks, paragraph (d)(2)(iv) requires that until the employer performs an employee exposure assessment as required in paragraph (d) and documents that the employee performing any of the listed tasks is not exposed to lead in excess of 2,500 $\mu g/m^3$ (50 × PEL), the employer must treat the employee as if the employee were exposed to lead in excess of 2,500 $\mu g/m^3$ by providing the protective measures prescribed under paragraph (d)(2)(v) of the standard. Where the employer has established that the employee is exposed to levels of lead below 2,500 $\mu g/m^3$ during these tasks, the employer shall provide the exposed employee with a less protective respirator in accordance with Table I of this section.

Paragraph (d)(2)(v) of the standard sets forth the interim protective measures that employers must implement during performance of the tasks discussed above at least until an exposure assessment as prescribed in paragraph (d) of the standard is completed.

These protections are required when an employee performs a specified task where lead is present. Interim protection to be provided to affected employees includes: (1) Appropriate respiratory protection in accordance with paragraph (f) of the standard; (2) appropriate personal protective clothing and equipment in accordance with paragraph (g) of the standard; (3) change areas in accordance with paragraph (i)(2) of the standard; (4) hand washing facilities in accordance with paragraph (i)(5) of the standard; (5) biological monitoring in accordance with paragraph (j)(1)(i) of the standard; and (5) training as required under paragraph (l)(1)(i) of the standard, which incorporates the relevant requirements of 29 CFR 1926.59 (Hazard Communication), as required under 29 CFR 1926.21 (Safety training and education), and as required under paragraph (l)(2)(ii)(c) of the standard regarding the purpose, selection, fitting, use and limitation of respirators.

It should be noted that the interim respiratory protection required to be provided to employees performing the tasks listed above is based on a presumed 8-hour exposure period. Where the tasks listed above are performed for lesser periods than 8-hours, the employer may be able to provide a less protective respirator if compliance with the PEL as an 8-hour TWA can be achieved.

E. Methods of Compliance: Paragraph (e)

The interim final standard requires employers to institute engineering and work practice controls to the extent feasible to reduce exposures to or below the PEL. Where all feasible engineering and work practice controls that can be instituted are not sufficient to reduce employee exposure to or below the PEL, appropriate respiratory protection is required to be provided as a supplement to such controls to reduce employee's exposures to lead to or below the PEL.

OSHA thus continues to maintain its preference for engineering and work practice controls in this standard. However, in the construction industry generally based on available data, OSHA is unable to show for purposes of this interim final rule that the PEL can be achieved by engineering and work practice controls in most operations most of the time. Consequently, as Congress anticipated, OSHA expects employers to place broader reliance on respirators than in General Industry.

The standard has a requirement for the development and implementation of a written compliance plan prior to the commencement of the job where employee exposure to lead, without respect to respiratory protection, will be in excess of the PEL. The plan should be a written strategy and schedule for protecting workers from occupational hazards, and must incorporate all relevant information that relates to those goals, so that one could determine whether the employer reasonably analyzed the problems and their solutions, including alternatives and has implemented the plan in accordance with its schedules.

These written plans must be furnished upon request for examination and copying to affected employees and their designated representatives and to representatives of the Assistant Secretary and the Director. They must be reviewed and updated periodically at least every 6 months to reflect the current status of exposure control. OSHA views the requirement for written plans as an essential part of the compliance program since it will form the basis for determining the employer's ability to achieve the controls and provide the necessary documentation to employees and their designated representatives of the compliance methods chosen, the extent to which controls have been instituted, and of the plans to institute further controls.

Where mechanical ventilation is used to control employee exposure to lead, the employer is required to evaluate the performance of the system in controlling

exposure as necessary to maintain its effectiveness.

Finally, the standard requires that when administrative controls are used to lower employee exposure, a rotation schedule is to be kept and followed and made a part of the written compliance plan. This will enable affected employees and OSHA to determine the effectiveness of the administrative control program.

F. Respiratory Protection: Paragraph (f)

This section contains specific requirements for the usage, selection, maintenance, and fitting of respirators.

The interim final standard, requires that respirators be used whenever the concentration of lead is at or above the PEL, in work situations in which engineering and work practice controls are not sufficient to reduce exposures to or below the PEL, or whenever an employee requests a respirator. This last requirement is to provide protection for those employees who wish to reduce their lead burden below what is required by the interim standard. For example, male and female workers whose blood lead levels are in the 30—50 µg/100g range may desire increased protection, especially if they intend to parent in the near future.

Because of the discomfort and hazards associated with negative pressure respirators, coupled with the possibility of routine and long-term use in some industries, OSHA has required employers to provide powered, air purifying (positive pressure) respirators (PAPR) to employees who request one, so long as it will provide adequate protection against the hazard for which a respirator is worn. Powered air positive-pressure respirators simultaneously provide greater protection to individuals, especially those who cannot obtain a good face fit on a negative pressure respirator, and greater comfort when a respirator needs to be worn for long periods of time. OSHA believes employees will have a greater incentive to wear respirators if discomfort is minimized.

The standard requires the employer to provide respirators at no cost to the employee and to select respirators from those approved by MSHA or NIOSH under the provisions of 30 CFR part 11 and in accordance with the respirator selection table (Table I) set-forth in the standard. The respirator selection table will enable the employer to provide the type of respirator which affords the proper degree of protection based on the airborne concentration of lead. While the employer must select the appropriate respirator from the table on the basis of the airborne concentration of lead, the employer may always select a respirator providing greater protection, that is, one prescribed for higher concentration of lead than present in the workplace. The respirator table is based on NIOSH recommendations.

The standard requires that the employer institute a respirator program in accordance with 29 CFR 1910.134 which contains basic requirements for proper selection, use, cleaning and maintenance of respirators. Under the respirator program the employer must change the filter elements of filter respirators whenever an employee detects an increase in breathing resistance, and must permit employees to leave work areas to wash their face and respirator facepiece when necessary to prevent skin irritation associated with respirator use.

The employer is also required to assure that the respirator facepieces fit properly and exhibit minimum facepiece leakage. Proper fit of the respirator is critical. As a negative pressure is created within the facepiece when the wearer inhales, unfiltered air may enter the facepiece between the facepiece and the employees' face. Obtaining a proper fit on each employee may require the employer to provide two or three different mask styles.

Employers are required to perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter for each employee wearing negative pressure respirators. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, and must be conducted in accordance with appendix D. The tests are to be used to select facepieces that provide the required protection as prescribed in the respirator selection table included in the standard (Table I).

G. Protective Clothing and Equipment: Paragraph (g)

This paragraph contains requirements that the employer provide, at no cost to employees, protective clothing and equipment that are appropriate for the hazard. Such clothing and equipment is necessary in order to protect employees from lead compounds which may cause skin or eye irritation (e.g., lead arsenate, lead azide) where encountered and, for employees who are exposed to lead above the PEL, to assure that clothing, shoes, and equipment on which lead dust can accumulate during the work shift are not worn home. Wearing contaminated clothing outside the work place will lengthen the duration of the employee's exposure through both inhalation and ingestion routes and potentially expose others in the family.

Clean work clothing is required to be provided at least weekly to employees whose exposure levels are above the PEL and daily to those above 200 µg/m³ as an 8-hour TWA. The employer must also repair or replace required protective clothing and equipment as needed to maintain its effectiveness. Removal of lead from protective clothing or equipment by blowing, shaking, or other means which disperses lead into the air is prohibited in order to minimize secondary exposure to lead in work areas.

The employer is required to provide for the cleaning, laundering, or disposal of protective clothing and equipment and must repair or replace required protective clothing and equipment as needed to maintain its effectiveness. The employer must assure that all protective clothing is removed at the completion of a work shift only in change areas provided for that purpose and must assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed labelled container in the change area.

The employer must also inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead. These requirements regarding personal protective equipment and clothing are commonplace in OSHA standards.

H. Housekeeping: Paragraph (h)

The interim standard requires that all surfaces be maintained as free as practicable of accumulation of lead dust. This is to be accomplished primarily by vacuuming floors, rafters, and other surfaces or by methods equally effective in preventing the dispersal of lead into the workplace. This clean-up is an exceptionally important provision because it minimizes the reentrainment of lead dust into the air which can provide an additional source of exposure that engineering controls are generally not designed to control.

OSHA's view is that as rigorous a housekeeping program as practicable is necessary in many jobs to keep airborne lead levels below permissible limits. This contemplates a regular housekeeping schedule adapted to exposure conditions at a particular site.

Vacuuming is considered to be the most reliable method of cleaning surfaces on which dust accumulates, but equally effective methods may be used, for example, a wet floor scrubber. Where vacuuming methods are selected, the

vacuums must be equipped with HEPA filters. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work.

Blowing with compressed air is generally prohibited as a cleaning method, unless the compressed air is used in conjunction with a ventilation system designed to capture the airborne dust created by the compressed air.

I. Hygiene Facilities: Paragraph (i)

This paragraph requires employers to provide hygiene facilities and to assure employee compliance with basic hygiene practices. These provisions are universally recognized industrial hygiene tools for minimizing additional sources of lead absorption from inhalation or ingestion of lead that accumulates on a worker's clothes or body. The employer must provide adequate shower facilities, if feasible, clean areas for changing clothes, and eating areas for employees who have exposure above the PEL. Hand washing facilities are to be provided for all employees occupationally exposed to lead in accordance with 29 CFR 1926.51(f). In addition, employers must assure that employees use the facilities as required by the standard as well as observe prohibitions on the use of tobacco, food, and cosmetics in contaminated areas. OSHA expects that strict compliance with these provisions will control several sources of lead exposure which substantially contribute to increased lead absorption.

The interim final standard requires employers to prohibit smoking, eating, applying cosmetics and the presence of tobacco products, food stuffs, or cosmetics in all work areas where employees are exposed to lead above the PEL. This prohibition will prevent unnecessary contamination of food or tobacco products caused by exposure to lead dust or fumes within the work area. It also decreases the likelihood of lead absorption in employees due to ingestion or inhalation of products contaminated with lead within the work environment.

The standard requires employers to provide separate storage facilities in change areas for street and work clothing to prevent cross-contamination between the two. This provision coupled with showering, where feasible, and the prohibition on wearing work clothing home will minimize employee exposure to lead after the work shift ends because it limits the period in which work clothes contaminated with lead dust may be worn.

Employers are also required to assure that employees exposed to lead during their work shift shower before leaving the workplace, where showers are provided, and do not leave wearing protective work clothing. Showering reduces the worker's period of exposure to lead and removes lead particles which accumulate on the skin and hair. Employees are not permitted to leave the worksite wearing any protective work clothes or equipment required to be provided by the employer.

The interim final standard also requires employers to provide employees working in lead areas where their airborne exposures exceed the PEL with lunchroom facilities or eating areas which are as free as practicable from lead contamination and are readily accessible to employees. Employers must also assure that employees wash their hands and face prior to eating or smoking and do not enter the lunchroom facilities or eating area wearing protective clothing, unless properly cleaned beforehand. This is to further minimize the possibility of food contamination and reduce the likelihood of additional lead absorption from contaminated food, beverages or tobacco.

J. Medical Surveillance: Paragraph (j)

The medical surveillance provisions are part of this standard's comprehensive approach to prevention of lead-related disease. Its purpose is to supplement the standard's primary mechanisms of disease prevention, the elimination or reduction of airborne concentrations of lead and sources of ingestion, by facilitating the early detection of medical effects associated with exposure to lead. These provisions in most respect are very similar to parallel provisions in the HUD Guidelines and lead standard for general industry.

All medical examinations and procedures are to be performed by or under the supervision of a licensed physician and are to be provided without cost to employees at a reasonable time and place. The standard does not make participation in the medical surveillance program mandatory for the employee. The employer's obligation is to "provide" and "make available" the medical tests and procedures as required. Where employee confidence in the medical program exists, refusal to participate should be minimal.

The medical surveillance provisions contemplate two phases of medical surveillance: one is initial medical surveillance, the other is a medical surveillance program. The employer is required to provide initial medical surveillance to employees occupationally exposed to airborne concentration of lead on any one day at or above the action level, consisting of biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels. Where this initial biological monitoring indicates that an employee's blood lead level is at or above 40 µg/dl, the employer must continue to provide biological monitoring at least every two months. The frequency is to continue until two consecutive blood samples and analyses indicate that the employee's blood lead level is below 40 µg/dl.

If an employee's airborne lead exposure is at or above the action level for more than 30 days a year, the employer shall provide a medical surveillance program to the employee consisting of routine monitoring of an employee's blood lead and ZPP levels, made available at least every 2 months for the first 6 months in the exposed job and every 6 months thereafter. If an employees PbB exceeds 40 µg/dl, the monitoring frequency must be increased to at least every 2 months and not reduced until two consecutive PbB's are below 40 µg/dl. If PbB levels exceed the removal criteria under paragraph (k)(1)(i), a second PbB must be provided within 2 weeks after the employer receives the results of the first blood test to confirm the accuracy of the results. This follow-up is intended to assure that no unnecessary removals occur. If the second test exceeds the removal criteria then the employee must be removed. Blood lead level sampling and analysis must have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 µg/dl, whichever is greater, and must be conducted by a laboratory approved by OSHA.

Within five working days after the receipt of biological monitoring results, the employer is to notify each employee in writing of his or her blood lead level. The employer must notify each employee who underwent biological monitoring whose blood lead level exceeds 40 µg/dl, that the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal.

The employer's obligation to provide a full medical surveillance program to an employee, including annual medical exams, is triggered by a determination that the employee's blood lead level exceeds 40 µg/dl if the employee's airborne exposure is or may be at or

above the action level for more than 30 days a year.

The required examination includes a work history and medical history; a physical examination; determinations of blood lead level (PbB), hematocrit, hemoglobin, peripheral smear morphology and red cell indices; levels of zinc protoporphyrin (ZPP), routine urinalysis (specific gravity, sugar, protein determinations, and microscopic examination), blood urea nitrogen (BUN), and serum creatinine (S-Creat).

Medical consultations, with examinations as appropriate, are required to be provided upon notification by an employee (1) that the employee has developed symptoms commonly associated with lead-related disease, (2) that the employee desires advice concerning the effects of lead on reproductive capacity, and (3) that the employee has demonstrated difficulty in breathing during fit testing or use of a respirator. Additional examinations must be made available when an employee is removed from exposure or otherwise limited under paragraph (k) of the regulation. The content and frequency of these examinations is to be at the discretion of the physician. Upon request of an employee, however, a pregnancy test or male fertility test (at a minimum analyzing sperm number, motility, and morphology) must be provided. These tests will facilitate the protection of reproductive capacity.

The employer must make medical examinations and consultations available to each employee exposed to lead at or above the action level for more than 30 days per year on the following schedule: at least annually for those employees for whom a blood sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 µg/dl; as soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, that the employee is pregnant, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use; and as medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.

The medical surveillance provisions of the final standard contain a multiple physician review mechanism which gives workers an opportunity to obtain a second and possibly third opinion regarding the medical determinations made pursuant to the standard. An employee may designate a second physician to review any findings, determinations or recommendations of an initial physician chosen by the employer. Efforts are to be made to resolve any disagreement which may arise between the two physicians. Should they be unable to agree, a third physician they select will resolve the disagreement.

OSHA's reasons for the provision of this review process are twofold; first, to broaden and strengthen the basis for medical determinations in situations where a worker questions the results of the initial examination or consultation provided by the employer; and second, to assure employee confidence in the soundness of medical determinations made pursuant to the standard. OSHA views the multiple physician review mechanism as an important element of the lead standard's medical surveillance program both due to the importance attached to medical surveillance by the Act, and due to the crucial role medical surveillance will play in the operation of the standard's medical removal protection program.

Medical surveillance, as under the HUD Guidelines and OSHA lead standard, must be provided by employers without cost to employees. Since the multiple physician review mechanism will be one means by which medical surveillance is provided to an employee, employers must bear the expense of this mechanism when it is used. In practice, the costs of this mechanism should not be burdensome, particularly since employers will have substantial control over the frequency of its use. Where employers carefully structure and administer medical surveillance programs which engender, merit and maintain worker confidence, workers will see no need to seek a second medical opinion.

The multiple physician review mechanism commences after an initial medical examination or consultation provided by a physician chosen by the employer. OSHA recognizes the value to employers and employees alike of having the mechanism operate in an expeditious fashion, and thus has established explicit criteria for the beginning of the process. After an initial physician conducts an examination or consultation pursuant to the standard, the employer must promptly notify the employee of his or her right to seek a second medical opinion. This notification need be no more than an oral reminder of the existence and content of this multiple physician review mechanism. After this notification has been given, an employer may condition employee participation in, and payment for, the mechanism upon the employee acting within 15 days after receipt of the foregoing notification, or receipt of the physician's written opinion, whichever is later. Before or within this 15-day period the employee must inform the employer (orally or otherwise) that the employee intends to seek a second medical opinion. The employee must also initiate steps within this time to make an appointment with a second physician. These steps would include actually making an appointment or contacting a physician with the request that a referral to a specialist be arranged.

The standard contains no more limitation upon an employee's choice of a second physician than the standard places on an employer's choice of the initial physician. The second physician, like the initial physician, need only be licensed to practice medicine. There is no subspecialty of medicine solely concerned with lead-related diseases, and since lead-related diseases affect numerous systems of the body, it would not be appropriate to limit the choice of doctors to any one specialty. It is certainly to an employee's advantage to choose a competent physician, thus OSHA relies on this self-interest to assure the value of the second opinion. For example, where an employee's difference with the initial physician revolves around a particular body system—e.g., nervous system—it is likely that the employee will choose a specialist in that body system—e.g., a neurologist. Where, however, the dispute revolves around several body systems, or the employee cannot identify one specific system, the employee will likely choose the general practitioner or internist most familiar with the employee's medical history or current health status.

The standard provides that the second physician shall review any findings, determinations or recommendations of the initial physician, and may conduct such examinations, consultations and laboratory tests as the second physician deems necessary to facilitate this review. An additional provision in the standard requires the employer to supply the same information to the second physician upon request that must be supplied to an initial physician. The second physician, therefore, is provided an opportunity to fully assess the employee's health status with access to the same background information supplied to the initial physician.

If the second physician's findings, determinations and recommendations are the same as those of the initial physician, then the multiple physician review process comes to an end. If, however, the opinions of the two physicians are in conflict, then the standard provides that the employer and the employee shall assure that efforts are made for the two physicians to communicate with each other to resolve their differences. This professional interaction among peers should in most cases resolve any differences between the two physicians. The preceding elements of the multiple physician review mechanism assure that if differences of opinion remain, these differences are likely to be genuine and substantial.

Where the first two physicians have been unable to quickly resolve any differences of opinion with respect to an employee, then it is necessary for a third qualified physician to resolve the dispute. It is important that this third physician be competent to resolve the dispute, thus the standard provides that the third physician shall be designated by the employer and the employee jointly through their respective physicians. It is the responsibility of the employer and the employee to assure that a third physician is selected, but the selection is to be made by the two prior physicians.

The standard provides the third physician with full opportunity to review the findings, determinations, and recommendations of the prior physicians by conducting such examinations, consultations, and laboratory tests as the third physician deems necessary. The standard incorporates the expectation that the third physician will consult with the two prior physician, and upon request, the employer must supply the same information to the third physician given to the initial physicians. The third physician is required to provide a written medical opinion to the employer, which will operate to resolve the disagreement between the earlier physicians. The standard finally requires the employer to act in a manner consistent with the findings, determinations, and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

The medical surveillance section of the standard includes a provision stating that the employer and employee or authorized employee representative may agree upon the use of any alternate physician determination mechanism in lieu of the multiple physician review mechanism. The only conditions are that the alternate mechanism be as expeditious and protective as the multiple physician review mechanism. For example, the parties might decide, in cases of dispute, for an employee to go directly from an initial physician chosen by the employer to an agreed upon final physician—thus dispensing with the need for a second physician. Alternately, a mutually agreed upon physician might be used in the first instance without recourse to other physicians. Or, an employee might be given the opportunity to choose this final physician. OSHA desires to encourage employers and employees to adopt medical determination procedures in which all parties have trust and confidence.

The interim final standard prohibits prophylactic chelation of any employee by any person the employer employs, retains, supervises, or controls, and requires the employer to assure that any therapeutic or diagnostic chelation, if administered, is done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. In cases where the examining physician determines that chelation is appropriate, the employee must be notified of this fact before such treatment. This is to inform the employee that chelation can be a potentially harmful treatment, and will afford the employee the opportunity to seek the review of this determination by another physician.

K. Medical Removal Protection: Paragraph (k)

The employer is required to remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test indicate that the employee's blood lead level is at or above 50 µg/dl. Although OSHA's General Industry Standard (1910.1025) requires removal based on the average of three blood tests indicating blood leads in excess of 50 µg/dl, OSHA believes that the length of time associated with taking these three tests (up to four months) would not be appropriate for activities in construction which often will not last 4 months. The provisions for blood testing under this construction standard to determine whether removal is necessary, would be accomplished within a much shorter period (e.g., a periodic test revealing blood lead above 50 µg/dl requires a follow-up test within 2-weeks). OSHA further believes that this more stringent requirement for removal based on fewer blood tests is warranted in view of the high airborne lead exposures that construction workers have been permissibly exposed to (e.g., 200 µg/m^3).

The employer must also remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead. The phrase "final medical determination" means the written medical opinion on the employee's health status by the examining physician or, where relevant, the outcome of the multiple physician review mechanism or alternate medical determination mechanism.

Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer must implement and act consistent with the recommendation.

For an employee removed from exposure to lead at or above the action level due to a blood lead level at or above 50 µg/dl the employer may return that employee to former job status when two consecutive blood sampling tests indicate that the employee's blood level is at or below 40 µg/dl. For an employee removed from exposure to lead due to a final medical determination, the employee must be returned when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

The requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

Thus, for example, where an employee's job is concluded while the employee is on medical removal, the employee is not entitled to continuing MRP benefits or to the job since, if the employee had not been removed, the employment would have ended in any case.

The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a

subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions has not yet resulted in a final medical determination with respect to an employee, the employer may either remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status. In such circumstances, the employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, unless the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or the employee has been on removal status for the preceding eighteen months due to an elevated blood lead level.

If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer must continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation may be reduced by such amount. The employer may not receive credit for workers' compensation payments received by the employee for treatment related expenses. The employer's obligation to provide medical removal protection benefits to a removed employee may be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

For employees removed from exposure to lead due to an elevated blood lead level whose blood lead level has not declined within the past eighteen (18) months of removal to allow the employee to be returned to his or her former job status, the employer must make available to the employee a medical examination to obtain a final medical determination with respect to the employee. The employer must also assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and if not, what steps would be taken to protect the employee's health. Further, where the final medical determination has not yet been obtained, or once obtained indicates that the employee may not yet be returned to his or her former job status, the employer must continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

Finally, where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again must be decided by a final medical determination. The employer, however, need not automatically remove such an employee pursuant to the blood lead level removal criteria provided in the standard.

Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employee is entitled to full medical removal protection benefits as provided for under the standard.

L. Employee Information and Training: Paragraph (l)

The final standard requires the employer to provide an information and training program for all employees exposed to lead at or above the action level. Information and training are an essential aspect of the overall protection of employees who can do much to protect themselves if they are informed of the nature of the hazards in the workplace. To be effective, an employee education system must apprise the employee of the specific hazards associated with his work environment, protective measures which can be taken, and his rights under the standard.

The provisions under this paragraph also alert employers of their existing obligation to comply with provisions under OSHA's Hazard Communication Standard (20 CFR 1926.59), which currently applies to construction activities. Under the Hazard Communication Standard (HCS) all chemical manufacturers and importers are to assess the hazards of the chemicals they produce or import and are to develop appropriate information about those hazards, which they are required to communicate in various ways to their own exposed employees and to relevant downstream employers, as specified under paragraphs (d)—(h) of the standard. Downstream employers, in turn, are required to communicate the information concerning the hazards of such chemicals in various ways to their own employees. The transmittal of hazard information to employees is to be accomplished by means of comprehensive hazard communication programs, which must include container labeling and other forms of warning, material safety data sheets and employee training.

Employers are also obligated to comply with existing training requirements set forth in 29 CFR 1926.21, Employee training and education.

In paragraph (l)(2), OSHA includes additional particular requirements that are needed to protect employees specifically exposed to lead at or above the action level. The training program required under paragraph (l)(2) must be provided prior to the time of initial job assignment or prior to the startup date for this requirement, whichever comes last, and must be repeated at least annually for covered employees unless exposure at or above the action level will no longer occur.

Paragraph (l)(2) requires that the employer assure that each employee who is exposed at or above the action level is trained in the following:

The content of the standard and its appendices: The specific nature of the operations which could result in exposure to lead above the action level; the purpose, proper selection, fitting, use, and limitations of respirators; the purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females and hazards to the fetus and additional precautions for employees who are pregnant); the engineering controls and work practices associated with the employee's job assignment including training of employees to follow relevant good work practices

described in Appendix B of this section; the contents of any compliance plan in effect; instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician; and the employee's right of access to records under 29 CFR 1910.20.

In addition, the employer is required to make available to all affected employees a copy of this standard and its appendices and must provide, upon request, all materials relating to the employee information and training program to affected employees and their designated representatives, and to the Assistant Secretary and the Director.

M. Signs: Paragraph (M)

The standard requires warning signs to be posted in each work area where employee lead exposure exceeds the PEL.

In light of the serious nature of the hazard of exposure to lead, OSHA believes that sign posting is needed, as well as periodic training, to adequately inform employees of the presence of high levels of lead and the possible need to utilize respirators and other protective equipment when entering the area. Phrases to be placed on the sign include "Warning", "Lead Work Area," "Poison," and "No Smoking or Eating." Signs are to be illuminated and cleaned as necessary so that the legend is readily visible.

N. Recordkeeping: Paragraph (n)

The HUD Guidelines and OSHA's general industry standard mandate the inclusion of provisions requiring employers to maintain accurate biological and environmental monitoring records of employee exposures to potentially toxic materials. It also provides that employees or their representatives have access to such records.

The interim final standard requires records of all exposure monitoring and other data used in conducting the employee exposure assessment to be established and maintained. The records must include the name and job classification of employees monitored, details of the sampling and analytic techniques, results, and type of respiratory protection worn. These records must be kept for 30 years in accordance with OSHA's standard 29 CFR 1910.20, Access to Exposure and Medical records. The standard also requires employers to establish and maintain records of medical surveillance (biological monitoring and medical examination results). These include names of employees, the physician's written opinion, exposure data provided to the physician, and any employee medical complaints associated with lead exposure. In addition, the employer is required to keep or must assure that the examining physician keeps a record of the results of medical examinations, a description of laboratory procedures and a copy of the results of biological monitoring. These records must be kept for at least duration of employment plus 30 years, except that medical records of employees who have worked for less than one (1) year for the employer need not be retained beyond the term of employment if they are provided to the employee upon termination of employment. These retention requirements are in accordance with § 1910.20

The interim standard contains a limited recordkeeping requirement concerning temporary medical removals effected pursuant to the medical removal protection program. The employer must establish and maintain an accurate record for each employee removed from current exposure to lead. The record is to contain four entries each time an employee is removed. First, the employee must be identified by name and social security number. Second, the date of removal and return must be stated. Third, the employer must briefly explain how each removal was or is being accomplished. This description need be no more detailed than such statements as "Employee X was transferred from position A to position B during the entire period of removal," or "Employee X was laid off for the entire period of removal," or "Employee X is currently working half shifts until a transfer opportunity becomes available." Fourth, the record must indicate whether or not the reason for the removal was an elevated blood lead level. If removal is due to a reason other than an elevated blood lead level, this precise reason should not be stated, so as to prevent disclosure of confidential medical information about the employee. Medical removal records are to be maintained for at least the duration of employment.

The purpose of the foregoing recordkeeping requirement is to enable employees and their authorized representatives, and the Secretary to assess the operation of, and an employer's compliance with the medical removal protection program. The limited but pertinent information contained in these records will, in most cases, enable these assessments to be made without interviewing large numbers of employees or placing undue burdens on employers by requiring further time consuming and burdensome examinations of payroll, production, or confidential medical records—examinations which likely would be necessary in the absence of the standard's limited recordkeeping requirement. Due to the limited purposes to be served by these records, the standard requires an employer to maintain each medical removal record only for so long as the duration of an employee's employment.

A provision for the use of objective data in lieu of initial monitoring for the purpose of assessing employee exposure is included in this standard in paragraph (d)(3)(iv). Objective data are defined in paragraph (n)(4) as information demonstrating that a particular product or material containing lead cannot release dust or fumes in concentrations at or above the action level under any expected conditions of use. Employers might use data from an industry-wide survey to estimate maximum exposure levels that could occur if that survey pertains to workplace conditions that, to the extent relevant and significant, are all very similar to those in the employer's worksite. Employers may also use laboratory product test results to demonstrate that airborne concentrations must be below the action level.

A record documenting the relevance of the objective data in assessing employee exposure is required to be established, and maintained for at least 30 years of the objective data relied on. This retention period is consistent with OSHA's Access standard (29 CFR 1910.20) that requires retention of exposure records for at least 30 years.

The interim final standard requires that records be made available to employees and their authorized representatives, physician or other person designated by an employee or former employee in accordance with 29 CFR 1910.20, and to the Director and Assistant Secretary.

The records described above are to be transferred to a successor employer whenever the employer ceases to do business. When there is no successor employer to receive and retain the records these records must be transmitted to the Director of NIOSH.

Upon expiration of the retention period for required records, the employer must notify the Director of NIOSH at least 3 months prior to disposal of such records and must transmit those records to the Director if so requested.

O. Observation of Monitoring: Paragraph (o)

The lead standard for general industry of the Act requires that employers provide employees or their representatives with the opportunity to observe monitoring of employee exposures to toxic materials or harmful physical agents. In accordance with this section and consistent with other OSHA standards, the standard contains provisions for such observation. To insure that this right is meaningful, observers are entitled to an explanation of the measurement procedure, to observe all steps related to the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of monitoring, the standard entitles the observers to receive the results of the monitoring when returned by the laboratory. The observer, whether an employee or designated representative, must be provided with, and is required to use, any personal protective devices required to be worn by employees working in the area that is being monitored, and must comply with all other applicable safety and health procedures.

P. Effective Dates: Paragraph (p)

The effective date is June 3, 1993. Congress in section 1031 of the Housing and Community Development Act directs that this interim final regulation take effect on issuance, but also expressly authorizes OSHA to reasonably delay the effective date. OSHA, therefore sets the effective date 30 days from publication in the **Federal Register**, which is the shortest time period allowed under the Administrative Procedures Act. Consequently, the regulation becomes effective 30 days after publication in the **Federal Register**. However, implementation of many provisions of the standard does not appear to be feasible so quickly. Thus, OSHA provides a minimal additional time period before the start-up dates for these provisions. OSHA believes that this is consistent with Congress' intent.

Q. Appendices: Paragraph (q)

The appendices included with the regulation are intended to be purely informational and, unless otherwise expressly stated in this section, are not intended to create any additional obligations not otherwise imposed or to detract or reduce any existing obligations. Appendix D provides mandatory procedures for fit testing of respirators.

R. Startup Dates: Paragraph (r)

All requirements of the interim final rule, except for engineering controls specified in paragraph (e)(1) of the standard, must be complied with as soon as possible, but no later than 60 days from the effective date of this section. Feasible engineering controls specified under paragraph (e)(1) shall also be implemented as soon as possible, but no later than 120 days from the effective date of this section.

OSHA believes that expeditious action by employers to achieve compliance with the provisions of this standard is warranted. Construction employees under the current standard are being exposed to lead at concentrations that present significant risk of adverse health impairment.

Employers must install feasible engineering controls as required under this standard within four (4) months from the effective date of this standard. Compliance with all other provisions of the standard must be accomplished within two (2) months of the effective date of the standard.

Employers performing lead operations in construction to some extent have already instituted protective measures voluntarily or in response to existing OSHA or other regulations, regarding training, engineering controls, compliance plans, respirators, exposure monitoring, work practices, recordkeeping, signs, protective clothing, and hygiene facilities. In addition, the Act of 1992 put the industry on notice that protective requirements like those, would be promptly imposed on employers to protect lead exposed employees in the construction industry. Thus, OSHA believes that it is a reasonable and appropriate judgment that compliance with the new burdens imposed under this interim rule in the time-frames specified is achievable.

IV. Regulatory Impact and Regulatory Flexibility Analysis

A. Executive Summary

Industry Profile

Construction projects involving lead or lead-containing materials occur throughout the entire construction industry as well as in several non-construction industries. Eighteen construction industry SICs and five non-construction industry SICs (involving construction activity) are expected to be affected by the Interim Final Standard. OSHA estimates that approximately 936,000 employees in 147,000 establishments are exposed to at least some level of lead during construction work.

Technological Feasibility

Compliance with the PEL and ancillary provisions of the Interim Final Standard is technologically feasible for all affected industries. Existing engineering control types, including mechanical ventilation, local exhaust ventilation, shrouded tools, HEPA vacuums, and wetting agents are already in use in the construction industry. Due to the nature of the activities in which high exposures to lead are generated, OSHA assumes that supplemental respirator use will be necessary for most activities in which engineering controls will be used.

Benefits

Benefits of the Interim Final Standard include decreases in the annual number of expected cases of: reduced nerve conduction velocity; reduced blood ALA-D levels; increased urinary ALA; gastrointestinal disturbances; and blood-lead levels above the medical removal trigger level. Long-term effects avoided over a ten-year period include cases of fatal/non-fatal infarction; fatal/non-fatal stroke; and renal disease.

Costs of Compliance

The annual recurring cost of the Interim Final Standard is expected to range between $365 million to $445 million. Additional start-up costs will be incurred during the first year for worker training, biological monitoring, medical examinations, and medical removal protection benefits.

Economic Impacts

The most impacted SICs, as measured by compliance costs per worker and compliance costs per establishment, are expected to include: SIC 1611, Highway and Street Construction Contractors; SIC 1622, Bridge, Tunnel and Elevated Highway Contractors; SIC 1721, Painting Contractors; SIC 1791, Structural Steel Erection Contractors; SIC 1795, Wrecking and Demolition Contractors; and SIC 3231, Glass Products Manufacturers. OSHA has concluded that it will be economically feasible to achieve compliance for all affected sectors.

B. Industry Profile

This industry profile describes the industries identified as potentially affected by the Interim Final Standard for Lead in Construction. Information is also presented on the twenty-two types of construction projects expected to be affected by the standard. Project type is often a better indicator of the likelihood

of lead exposure than the industry classification of the firm performing the work.

The definition of "construction" includes the categories of new construction (relatively little exposure to lead will be encountered in new construction); additions, alterations, and reconstruction (including remodeling and renovation); installation; demolition; repairs and maintenance. In this profile, the three major divisions of the construction industry are identified by two-digit Standard Industrial Classification (SIC) codes: SIC 15, General Building Contractors; SIC 16, Heavy Construction Contractors, Excluding Building Contractors; and SIC 17, Special Trade Contractors.

Subsectors of each industry division are identified by four-digit SIC codes. Because an establishment's SIC classification is based solely on the primary activities of the firm, contractors from different two-digit and four-digit SIC codes are often identified as working on the same project type. Construction projects involving contact with lead or lead-containing materials occur throughout the entire construction industry as well as in several non-construction SICs. Table 1 shows the eighteen construction industry SICs and five non-construction industry SICs (involving construction activity) expected to be affected by the Interim Final Standard and the affected construction project types associated with each SIC.[1] Table 2 lists the industries affected and shows the estimated total number of affected establishments and estimated total number of workers exposed by industry sector.

TABLE 1.—SICs AFFECTED BY THE INTERIM FINAL STANDARD AND ASSOCIATED PROJECT TYPES

SIC	Industry title	Project type
1521	General Contractors, Single Family Housing	In-Place Management (Private Housing). Residential Remodeling.
1522	General Contractors, Other Residential Buildings	Residential Remodeling.
1531	Operative Builders	In-Place Management (Private Housing). Residential Remodeling.
1541	General Contractors, Industrial Buildings and Warehouses	Petroleum Tank Repainting. Indoor Industrial Facility Maintenance and Renovation. Outdoor Industrial Facility Maintenance and Renovation. Commercial and Institutional Remodeling.
1542	General Contractors, Other Non-Residential Construction	Commercial and Institutional Remodeling.
1611	Highway and Street Construction Contractors	Highway and Railroad Bridge Repainting. Highway and Railroad Bridge Rehabilitation.
1622	Bridge, Tunnel and Elevated Highway Contractors	Highway and Railroad Bridge Repainting. Highway and Railroad Bridge Rehabilitation.
1711	Plumbing Contractors	Lead Joint Work on Cast Iron Soil Pipes. Repair and Removal of Water Lines.
1721	Painting Contractors	Highway and Railroad Bridge Repainting. Water Tank Repainting. Petroleum Tank Repainting. Housing Lead Abatement (Public Housing). Housing Lead Abatement (Private Housing). In-Place Management (Public Housing). In-Place Management (Private Housing). Indoor Industrial Facility Maintenance and Renovation. Outdoor Industrial Facility Maintenance and Renovation. Commercial and Institutional Remodeling. Residential Remodeling. Electric Transmission and Communication Tower Maintenance.
1731	Electrical Work Contractors	Commercial and Institutional Remodeling. Residential Remodeling. Electrical Cable Splicing.
1742	Plastering, Drywall, and Insulation Work Contractors	In-Place Management (Public Housing). In-Place Management (Private Housing). Commercial and Institutional Remodeling. Residential Remodeling. Reinsulation over Existing Mineral Wool.
1751	Carpentry Work Contractors	Commercial and Institutional Remodeling. Residential Remodeling.
1752	Floor Layers and Other Floor Work Contractors	Commercial and Institutional Remodeling. Residential Remodeling.
1761	Roofing and Siding Contractors	Commercial and Institutional Remodeling. Residential Remodeling. Installation of Terne Roofing.
1791	Structural Steel Erection Contractors	Highway and Railroad Bridge Rehabilitation. Indoor Industrial Facility Maintenance and Renovation. Outdoor Industrial Facility Maintenance and Renovation.
1795	Wrecking and Demolition Contractors	Underground Storage Tank Demolition. Commercial and Industrial Demolition.

[1] Three of the 22 basic project types were split into two sub-categories for costing purposes. These project types are Housing Lead Abatement (Public and Private Housing), In-Place Management (Public and Private Housing) and Industrial Facility Maintenance and Renovation (Indoor and Outdoor Work).

TABLE 1.—SICs AFFECTED BY THE INTERIM FINAL STANDARD AND ASSOCIATED PROJECT TYPES—Continued

SIC	Industry title	Project type
1796	Building Equipment Contractors	Elevator Cable Babbitting.
1799	Miscellaneous Special Trade Contractors, NEC	Underground Storage Tank Demolition.
		Housing Lead Abatement (Public Housing).
		Housing Lead Abatement (Private Housing).
		In-Place Management (Public Housing).
		In-Place Management (Private Housing).
		Indoor Industrial Facility Maintenance and Renovation.
		Outdoor Industrial Facility Maintenance and Renovation.
		Industrial Process Equipment Maintenance and Repair.
		Industrial Vacuuming.
		Installation of Radiation Shielding.
		Commercial and Institutional Remodeling.
		Residential Remodeling.
		Reinsulation Over Existing Mineral Wool.
3231	Glass Products Manufacturers	Stained Glass Window Removal.
4911	Electric Utilities	Electrical Cable Splicing.
6513	Operators of Apartment Buildings	In-Place Management (Private Housing).
6514	Operators of Other Dwellings	In-Place Management (Private Housing).
9999	State and Municipal Governments	Highway and Railroad Bridge Repainting.
		Water Tank Repainting.
		In-Place Management (Public Housing).

Source: OSHA, Office of Regulatory Analysis.

TABLE 2.—ESTIMATED TOTAL NUMBER OF AFFECTED ESTABLISHMENTS AND ESTIMATED TOTAL NUMBER OF WORKERS EXPOSED BY STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE

SIC	Industry title	Estimated total number of affected establishments	Estimated total number of workers exposed
1521	General Contractors, Single Family Housing	16,742	67,716
1522	General Contractors, Other Residential Buildings	2,204	8,927
1531	Operative Builders	5,285	21,360
1541	General Contractors, Ind. Buildings and Warehouses	3,674	66,242
1542	General Contractors, Other Non-Res. Construction	5,089	92,956
1611	Highway and Street Construction Contractors	481	8,178
1622	Bridge, Tunnel and Elevated Highway Contractors	744	15,900
1711	Plumbing Contractors	43,598	56,378
1721	Painting Contractors	13,874	139,473
1731	Electrical Work Contractors	6,072	46,194
1742	Plastering, Drywall, and Insulation Work Contractors	11,746	103,638
1751	Carpentry Work Contractors	10,395	127,214
1752	Floor Layers and Other Floor Work Contractors	740	7,253
1761	Roofing and Siding Contractors	5,264	64,183
1791	Structural Steel Erection Contractors	568	11,097
1795	Wrecking and Demolition Work Contractors	685	7,699
1796	Building Equipment Contractors	2,250	4,500
1799	Miscellaneous Special Trade Contractors, NEC	14,105	71,168
3231	Glass Products Manufacturers	104	208
4911	Electric Utilities	687	4,000
6513	Operators of Apartment Buildings	1,753	7,011
6514	Operators of Other Dwellings	876	3,506
9999	State and Municipal Governments	159	1,869
	Total for All SICs	147,075	936,670

Source: OSHA, Office of Regulatory Analysis.

Lead exposure is most common among project types that involve the disturbance of lead or lead-containing materials during additions, alterations, reconstruction, demolition, repairs and maintenance. Some examples of potential sources of exposure in these project types include lead-based paint (LBP) and paint dust, lead pipes, leaded solder, the leaded support rods in stained glass windows, and some mineral wool insulation.

In contrast, project types involving exposure to lead during new construction are comparatively rare. This is in part due to government regulations that have banned specific uses of once common lead-containing construction materials. An example is the Consumer Product Safety Commission's 1977 ban on "lead containing paint" prohibiting the use of such paint on products to which consumers are exposed after sale (42 FR 44199). Another example is the Environmental Protection Agency's 1986 ban on further use of lead pipes and solder in residential plumbing. In most new construction projects involving lead use, lead and lead-

containing materials are used in limited quantities for specialized applications. Examples include terne (leaded-steel) roofing and the use of lead foil sheet in the walls of hospital x-ray suites.

Table 3 shows preliminary estimates of the number of lead-exposed projects occurring each year, the estimated total number of workers exposed, and the primary sources of lead exposure by project type. The estimated number of employees differs from those originally reported in the draft CONSAD report of July, 1991; this earlier draft did not include workers involved in commercial and residential remodeling project types. For these and other reasons, the draft CONSAD report of July, 1991 is superseded by CONSAD's final report of April, 1993, which contains more complete and accurate information. The final CONSAD report is consistent with the scope and provisions of OSHA's Interim Final Rule.

TABLE 3.—ESTIMATED TOTAL NUMBER OF CONSTRUCTION PROJECTS INVOLVING LEAD PER YEAR, ESTIMATED TOTAL NUMBER OF WORKERS EXPOSED, AND PRIMARY SOURCE(S) OF LEAD EXPOSURE BY PROJECT TYPE

Project type	Estimated number of projects involving lead per year	Estimated total number of workers exposed	Primary source(s) of lead exposure
Highway and Railroad Bridge Repainting	3,721	18,419	Lead-Based Paint and Paint Debris.
Highway and Railroad Bridge Rehabilitation	2,157	29,958	Lead-Based Paint and Paint Debris.
Water Tank Repainting	1,994	5,113	Lead-Based Paint and Paint Debris.
Petroleum Tank Repainting	3,491	4,364	Lead-Based Paint and Paint Debris.
Underground Storage Tank Demolition	648	288	Lead-Based Paint and Paint Debris.
Housing Lead Abatement (Public Housing)	900	2,893	Lead-Based Paint and Paint Debris.
Housing Lead Abatement (Private Housing)	62,300	9,345	Lead-Based Paint and Paint Debris.
In-place Management (Public Housing)	3,150	188	Lead-Based Paint and Paint Debris.
In-place Management (Private Housing)	631,000	35,056	Lead-Based Paint and Paint Debris.
Commercial and Industrial Demolition	1,240	7,440	Lead-Based Paint and Metallic Lead Residues.
Indoor Industrial Facility Maint./Renovation	280	2,113	Lead-Based Paint and Paint Debris.
Outdoor Industrial Facility Maint./Renovation	1,584	2,981	Lead-Based Paint and Paint Debris.
Lead Joint Work on Cast Iron Soil Pipes	9,438	15,337	Lead-Oakum Pipe Joint Material.
Ind. Process Equipment Mfg./Maint./Repair	982	409	Lead Bricks, Lead Mortar, and Lead Sheets.
Industrial Vacuuming	784	392	Metallic Lead Dust in Metal Processing Plants.
Stained Glass Window Removal	2,500	208	Lead Support Rods.
Installation of Radiation Shielding	100	40	Lead-Containing Construction Materials.
Commercial and Institutional Remodeling	546,000	546,798	Lead-Based Paint and Paint Debris.
Residential Remodeling	2,698,000	178,544	Lead-Based Paint and Paint Debris.
Elevator Cable Babbitting	5,400	4,500	Tin-Base Babbit Containing Lead.
Electrical Cable Splicing	100,000	5,000	Lead Splicing Material.
Reinsulation Over Existing Mineral Wool	22,000	18,333	Mineral Wool Insulation With Lead Contaminants.
Repair and Removal of Water Lines	197,000	41,042	Lead Pipes and Lead Solder.
Transmission and Communication Tower Maint	880	7,333	Lead-Based Paint and Paint Debris.
Installation of Terne Roofing	40	576	Leaded Steel Roofing Materials and Lead Solder.
Total For All Project Types	4,295,589	936,670	

Source: OSHA, Office of Regulatory Analysis.

C. Technological Feasibility

Compliance with the Interim Final Standard is considered technologically feasible for each of the affected industries. OSHA has identified several categories of engineering controls that are technologically feasible and appropriate for use in the construction industry. Due to the nature of the activities in which high exposures to lead are generated, OSHA assumes that supplemental respirator use will be necessary for most activities in which engineering controls will be used. Based on the currently available evidence in the record, OSHA has not been able to conclude that the PEL is achievable in most of the operations most of the time by engineering and work practice controls alone in the construction industry. Currently available respirators are capable of providing the supplemental protection necessary to achieve the PEL all of the time in all construction activities with the exception of abrasive blasting as described below.

In order to analyze the technological feasibility of the standard, data on lead exposures were examined by the type of activity generating the potential for exposure to lead. The exposure data reviewed by OSHA were obtained from the following sources: OSHA IMIS; various NIOSH Health Hazard Evaluation reports; various Department of Housing and Urban Development (HUD) Lead Abatement Demonstration Projects; Maryland's Department of Occupational Safety and Health; site visits conducted by CONSAD Research for OSHA and other published reports and studies. The exposure data obtained from each of these sources are believed to be representative and reliable exposure estimates for the construction activities being examined.

Table 4 summarizes exposure data by construction activity. The table shows personal TWA(8) exposure levels (in micrograms per cubic meter of air), in the absence of reduction factors from engineering controls and respirators. For several of the activities presented, statistics were calculated for small groups of data. Despite the potential weaknesses of these small samples, the data were used as the best available evidence about exposure levels in these activities.

The wide variations in the exposure data for certain construction activities accurately reflect the nature of construction work. Analogous construction work sites, even where the same types of activities are performed, can produce very different exposure levels. Sources of variability in exposure

levels for the same activity include the concentration of lead in the paint or other materials being removed; the total quantity of lead-containing materials being removed; work practices used and weather conditions on outdoor projects.

Because OSHA was unable to allow the public the opportunity to comment on the data used in this analysis, OSHA is taking a very conservative approach in the use of this data. As shown in Table 4, OSHA calculated a 95 percent confidence level for the mean exposure level in each activity and used this value to assign appropriate engineering controls and respirators.[2] (Where this statistic exceeded the maximum observed level for an activity, the maximum observed level was used to specify controls.) This methodology was used in order to ensure a consistent approach to control assignment across activities. The appropriateness of control assignments was then confirmed by examination of the actual exposure level distributions for each activity. Table 5 shows the controls assigned to each activity.

TABLE 4.—REPRESENTATIVE TWA(8) EXPOSURE LEVELS IN µG/M³ ABSENT ENGINEERING CONTROLS AND RESPIRATORY PROTECTION BY CONSTRUCTION ACTIVITY

Construction activity key	Number of observations	Minimum value	Maximum value	Arithmetic mean	Standard deviation	Exposure level used to specify controls[a]
1.0 Open abrasive blasting	26	1,352	58,700	17,315	19,001	23,680
1.1 Open abrasive blasting in full containment	13	2,188	58,700	26,673	21,502	37,300
1.2 Vacuum blasting	4	2	665	169	331	558
2.1 Welding, cutting, and burning on bridges	90	1	10,320	1,230	1,897	1,564
2.2 Other welding, cutting, and burning	152	1	28,000	615	2,681	973
2.3 Lead burning	19	33	2,557	451	533	[b]663
3.0 Spray painting lead-based paint	37	1	460	74	95	101
4.0 Hand scraping	6	6	167	45	63	96
5.1 Removal and replacement of building components	113	0.4	121	7	15	9
5.2 Manual demolition of building components	15	1	168	50	59	77
6.0 Heat gun use	380	0.4	916	26	71	32
7.0 Chemical stripping	296	0.4	476	11	35	15
8.0 Encapsulation	86	0.4	26	3	4	4
9.1 Power tool use (housing abatement projects)	28	0.2	1,596	185	347	[c]296
9.2 Power tool use (other paint removal projects)	65	1	20,600	735	2,794	1,314
10.0 Use of lead pots	10	1	19	4	5	8
11.0 Soldering and brazing	1	9	9	9	—	9
12.0 Use of lead mortar	—	—	—	—	—	[d]663
13.0 Stained glass removal	3	10	79	43	35	[e]79
14.0 Handling lead shot, bricks, or sheet	132	0.1	224	12	30	16
15.0 Industrial vacuuming	9	8	2,900	404	951	994
16.0 Cutting lead foil panels	—	—	—	—	—	[f]1
17.0 Reinsulation over existing mineral wool	3	1	90	34	49	[e]90
18.1 Miscellaneous enclosure movement	6	13	2,100	504	792	1,156
18.2 Miscellaneous abrasive blasting/repainting	30	4	9,580	1,147	2,441	1,904
18.3 Miscellaneous remodeling related	8	0.4	207	27	73	76
18.4 Miscellaneous lead abatement	442	0.4	588	6	31	8
18.5 Miscellaneous steel structure rehabilitation	54	0.2	4,100	145	601	282
19.1 Spray painting non-lead-based paint	1	26	26	26	—	26
19.2 Brush painting non-lead-based paint	13	0.4	6	2	2	3
(A) Combined lead abatement activities (4, 5.1, 6, 7, 8, 18.4)	1,323	0.4	916	13	47	15
(B) Combined in-place management activities (4, 5.1, 6, 7, 18.4, 19.2)	954	0.4	916	14	51	17
(C) Combined commercial remodeling activities (4, 5.1, 18.3, 19.1)	128	0.4	207	10	27	14
(D) Combined residential remodeling activities (4, 5.1, 18.3, 19.2)	140	0.4	207	9	26	13

[a] Represents the average exposure level that, statistically, would only be exceeded five percent of the time the activity was monitored.
[b] Control specification level is based on data collected during work performed without ventilation.
[c] Data shown were collected during use of shrouded equipment. Control specification level assumes shrouds are not being used.
[d] Activity 12 exposure levels are assumed to be similar to data from Activity 2.3.
[e] Maximum observed value used as the control specification level.
[f] Activity 16 exposure levels were assumed to be minimal due to nature of activity.

Sources: OSHA IMIS; Selected NIOSH Health Hazard Evaluation Reports; Selected HUD Lead Abatement Demonstration Projects; Maryland OSH Data; CONSAD Site Visits for Lead in Construction and Construction PELS Projects; Other Miscellaneous Reports and Studies.

[2] In no way does OSHA mean to imply that to prove feasibility, it must show that a PEL is capable of being achieved 95 percent of the time by engineering and work practice controls.

TABLE 5.—ANALYSIS OF ENGINEERING CONTROLS AND RESPIRATORS NEEDED TO ACHIEVE COMPLIANCE WITH THE 50 μG/M³ PEL

Project type activity	Exposure level used to specify controls (μg/m3)	Type of ventilation controls specified (by activity)	Other types of controls specified (by project)	Exposure level after control application (μg/m³)	Respirator type specified
Highway and railroad bridge repairing			HV, WA		
1.1 Abrasive blasting in full containment	37,300	MV		18,650	10
3.0 Spray painting with LBP	101	MV		51	5
19.1 Spray painting with non-LBP	26	MV		13	
18.1 Enclosure movement	1,156	—		1,156	4
18.5 Associated miscellaneous activities	1,904	—		1,904	4
Highway and railroad bridge rehabilitation			HV, WA		
2.1 Welding, cutting, burning on bridges	1,564	—		1,564	4
18.5 Associated miscellaneous activities	282	—		282	4
Water Tank Repainting			HV, WA		
1.1 Abrasive blasting in full containment	37,300	MV		18,650	10
3.0 Spray painting with LBP	101	MV		51	5
19.1 Spray painting with non-LBP	26	MV		13	—
18.1 Enclosure movement	1,156	—		1,156	4
18.5 Associated miscellaneous activities	1,904	—		1,904	4
Petroleum tank repainting			HV, WA		
1.1 Abrasive blasting in full containment	37,300	MV		18,650	10
3.0 Spray painting with LBP	101	MV		51	5
19.1 Spray painting with non-LBP	26	MV		13	—
18.1 Enclosure movement	1,156	—		1,156	4
18.5 Associated miscellaneous activities	1,904	—		1,904	4
Underground storage tank demolition			HV		
2.2 Other welding, cutting, burning	973	—		973	4
Housing lead abatement (public housing)			HV, WA		
(a) Combined lead abatement activities	15	—		15	—
9.1 Power tool use (housing)	296	ST		74	5
Housing lead abatement (private housing)			HV, WA		
(A) Combined lead abatement activities	15	—		15	—
In-place management (public housing)			HV, WA		
(B) Combined in-place mgmt. activities	17	—		17	—
In-place management (private housing)			HV, WA		
(B) Combined in-place mgmt. activities	17	—		17	—
Commercial and industrial demolition			HV		
2.2 Other welding, cutting, burning	973	—	HV	973	5
Indoor industrial facility maint./renovation			HV, WA		
1.1 Abrasive blasting	37,300	MV		18,650	10
9.2 Power tool use (other)	1,314	ST		329	5
2.2 Other welding, cutting, burning	973	LEV		243	5
19.1 Spray painting with non-LBP	26	MV		13	—
18.1 Enclosure movement	1,156	—		1,156	4
18.5 Associated miscellaneous activities	282	—		282	4
Outdoor industrial facility maint./renovation			HV, WA		
1.1 Abrasive blasting	37,300	MV		18,650	10
9.2 Power tool use (other)	1,314	ST		329	5
2.2 Other welding, cutting, burning	973	—		973	5
19.1 Spray painting with non-LBP	26	MV		13	—
18.1 Enclosure movement	1,156	—		1,156	4
18.5 Associated miscellaneous activities	282	—		282	4
Lead joint work on cast iron soil pipes			HV		
10.0 Use of lead pots	1	—		1	—
Ind. process equipment mfg./maint./repair			HV		
2.3 Lead burning	663	MV		332	5
Industrial vacuuming			HV		
15.0 Industrial vacuuming	994	—		994	4
Stained glass window removal			HV		
13.0 Removal of stained glass	79	—		79	4
Installation of radiation shielding			HV		
14.0 Handling of lead shot/bricks/sheets	16	—		16	—
16.0 Cutting of lead foil panels	1	—		1	—
Commercial and institutional remodeling			HV, WA		
(C) Combined comm./inst. remodeling activities	14	—		14	—
5.2 Manual demolition	77	—		77	4
9.2 Power tool use (other)	1,314	ST		329	5
2.2 Other welding, cutting, burning	973	LEV		243	5
Residential remodeling			HV, WA		
(D) Combined res. remodeling activities	13	—		13	—
5.2 Manual demolition	77	—		77	4
Elevator cable babbitting			HV		

TABLE 5.—ANALYSIS OF ENGINEERING CONTROLS AND RESPIRATORS NEEDED TO ACHIEVE COMPLIANCE WITH THE 50 μG/M³ PEL—Continued

Project type activity	Exposure level used to specify controls (μg/m3)	Type of ventilation controls specified (by activity)	Other types of controls specified (by project)	Exposure level after control application (μg/m³)	Respirator type specified
10.0 Use of lead pots	1	—		1	—
Electrical cable splicing			HV		
10.0 Use of lead pots	1	—		1	—
Reinsulation over existing mineral wool			HV		
17.0 Reinsulation over existing mineral wool	90	—		90	1
Repair/removal of water lines containing lead			HV		
11.0 Soldering, brazing	9	—		9	—
Transmission and communication tower maint.			HV, WA		
4.0 Hand scraping	96	—		96	4
9.2 Other power tool cleaning	1,314	ST		329	5
19.2 Brush painting with non-LBP	3	—		3	—
18.5 Associated miscellaneous activities	282	—		282	4
Installation of terne roofing			HV		
11.0 Soldering, brazing	9	—		9	—
14.0 Handling of lead shot, bricks, or sheet	16	—		16	—

Engineering control key: MV—Mechanical ventilation [50% exposure reduction factor]; LEV—Local exhaust ventilation [75% exposure reduction factor]; ST—Shrouded tools [75% exposure reduction factor]; HV—HEPA vacuums; WA—Wetting agents.

Respirator type key: Type 1: Half mask cartridge respirator; Type 2: Full facepiece cartridge respirator; Type 3: Loose fitting hood or helmet powered air purifying respirator; Type 4: Tight fitting powered air purifying respirator; Type 5: Half mask supplied air respirator; Type 6: Full facepiece supplied air respirator; Type 7: Loose-Fitting supplied air blasting helmet; Type 8: Full facepiece SCBA; Type 9: Supplied air welding helmet; Type 10: Abrasive blasting helmet with tight fitting facepiece.

Associated protection factor: Protection factor=10 x PEL; protection factor=50 x PEL; protection factor=25 x PEL; protection factor=50 x PEL; protection factor=10 x PEL, 50 x PEL, or 1,000 x PEL depending on operating mode; protection factor=50 x PEL or 2,000 x PEL depending on operating mode; protection factor=25 x PEL; protection factor=50 x or 2,000 x PEL depending on operating mode; protection factor=25 x PEL; protection factor=2,000 x PEL.

Source: OSHA, Office of Regulatory Analysis

The hierarchy of controls requires employers to first apply all feasible engineering controls. OSHA concluded that ventilation controls are an appropriate means of exposure reduction in lead-exposed construction activities. The two categories of ventilation controls considered especially appropriate were mechanical ventilation systems used in conjunction with enclosures or containments (MV) and local exhaust ventilation (LEV). Local exhaust ventilation includes both portable ventilation systems and shrouded tools with ventilation (ST).

CONSAD assigned a 30 percent reduction factor to mechanical ventilation systems and a 75 percent reduction factor for portable local exhaust ventilation and shrouded tools. Based upon OSHA's judgement and experience, the 30 percent exposure reduction factor is an underestimate and does not take into account technological advances in construction and design of containment systems. According to John Peart, Director of Research on Bridge Coatings for the Federal Highway Administration, the current state of industry use of mechanical ventilation controls is improving. Industry and establishment experience continues to develop as contractors steadily move towards more use of full containment with ventilation systems. Continuing research into proper containment and ventilation for activities involving steel structures painting is resulting in increased efficiency ratings being attained by these large mechanical ventilation systems. OSHA therefore believes that an exposure reduction factor of 50 percent will be achievable for mechanical ventilation systems.

Two other categories of engineering controls were assumed to be required, where appropriate, in accordance with the hierarchy of controls. These control categories were HEPA vacuums (HV) and wetting agents (WA). HEPA vacuums are used to prevent exposure before it occurs by reducing the amount of lead-contaminated debris in the work environment. HEPA vacuums are also used to clean personal protective equipment and work clothes to limit worker exposure to lead. Wetting agents prevent lead-based paint dust and lead-contaminated debris from becoming airborne. These controls are considered technologically feasible for all affected activities where their use is appropriate.

When all feasible engineering controls have been added and personal exposures have not been reduced below the PEL, respiratory protection, as specified in Table I of the Interim Final Standard, must be used. Currently available respirators provide sufficient levels of protection for all activities except for abrasive blasting. The loose-fitting, continuous-flow abrasive blasting helmet currently used in the construction industry has been assigned a protection factor of 25×PEL (1,250 μg/m³). Because exposures during abrasive blasting inside pollution containment setups often exceed this level, this type of respirator is no longer considered adequate. At present, no manufacturer makes a Type CE abrasive blasting respirator with both a helmet and the tight-fitting facepiece needed to achieve an acceptable protection factor. However, the technology for producing such a respirator is already known to exist and a Type CE respirator with a hood is already available on the market.

OSHA assumes that a type CE abrasive blasting helmet can be designed and be certified for use in environments of up to 2,000×PEL within one to two years following promulgation of the standard. Until such a respirator is developed, workers may have to wear a respirator type that provides an acceptable protection factor but lacks integral head protection.

OSHA has assumed for costing purposes that workers will be supplied with respirators providing at least the minimum protection sufficient to meet the requirements of the interim final standard. (These respirator selections are shown in Table 5.) For most construction activities, the supplied-air respirators were found to be more cost-effective than cartridge respirators

because cartridge replacement would produce ongoing costs outweighing the "up-front" costs of purchasing supplied air respirators.

Other regulatory provisions requiring employer action under OSHA's Interim Final Lead Standard include (depending upon the construction activity):

- Initial determination of the presence of lead.
- Competent persons.
- Exposure monitoring and associated recordkeeping.
- Written compliance programs.
- Warning signs.
- Worker training.
- Notification of other employers.
- Protective work clothing and equipment.
- Hygiene facilities (hand washing, changing and decontamination facilities)
- Eating areas and facilities.
- Biological monitoring, medical examinations, and medical removal protection (including associated recordkeeping)

All of these provisions were deemed technologically feasible for the affected construction activities. These requirements can be satisfied by work practice modifications and/or conventional, off-the-shelf items, most of which have already been implemented or introduced in well-maintained workplaces.

D. Benefits

This section presents an analysis of the potential benefits associated with the reduction of the permissible exposure limit for lead to 50 μg/m³. The avoidable adverse health effects of lead are described in detail in the Preamble and Supplements to OSHA's 1978 Lead Standard. In addition, OSHA relied upon the technical expertise of Meridian Research, Inc. in the development and formulation of the benefit model and estimates presented in this section.

Because exposure to lead causes a number of different adverse health effects, the potential benefits associated with this requirement of the Interim Final Standard are varied and include benefits that will accrue during the first year following the effective date, as well as benefits that accrue over longer time horizons (separately identified). Some of the near-term benefits that are expected to accrue include reductions in the incidence of acute lead poisoning and adverse neurologic and biochemical effects, and reductions in the incidence of blood lead levels above 50 μg/m³. Benefits that accrue over longer time horizons include reductions in the incidence of lead-induced hypertension, which may increase the risk of myocardial infarction or stroke, and renal disease. Other potential benefits that are expected to accrue, but which are not specifically discussed below, are reductions in the incidence of lead-induced male and female reproductive effects.

This analysis estimates benefits associated with reducing exposures to airborne lead. Additional benefits are likely to be realized as a result of reductions in worker blood-lead levels due to improved hygiene practices. The general approach taken to evaluate the quantitative benefits was as follows:

- For each construction project and activity, available exposure data were used to develop a profile of worker exposures to airborne lead;
- The exposure profiles were used as inputs for a compartmentalized kinetic lead model to generate a blood-lead profile for each group of workers engaged in a particular construction activity;
- The resulting blood-lead profiles were used to predict the frequency with which blood-lead values were likely to exceed the medical removal trigger of 50 μg/dl, and to calculate an average blood-lead level for each group of workers; and
- The average and peak blood-lead levels were used along with risk estimates contained in Meridian's Peer-Review Draft Risk Assessment report to estimate the number of lead-related illness cases that might potentially be avoided as a result of reducing the PEL to 50 μg/m³ for construction.

For each construction activity, airborne exposures to lead were characterized using statistics to reflect that worker exposures to lead may vary considerably from one day to the next. For all of the construction activities shown in Table 4, exposure profiles were calculated using the full set of available exposure data. However, for the benefits analysis, additional exposure profiles were created by combining data from different activities to recognize that some construction workers may typically be engaged in more than one activity. For example, the abrasive blasting exposure data were combined with painting exposure data to create an exposure profile for workers performing both tasks on a regular basis. In addition, a supplementary baseline exposure profile was created for project types involving lead abatement, in-place management and remodeling activities, in order to obtain a blood-lead level profile for workers currently using poor work practices. This profile was generated to yield a blood-lead profile consistent with blood-lead levels reported in the state of Massachusetts. (One of the few states with useful construction industry data in their blood lead registry.)

For each construction activity and operation, the exposure profile data were used to generate numerical sets that matched the parametric distributions of the exposure profiles. These figures were used to represent daily air-lead levels to which workers engaged in each activity are believed to be exposed during a one-year period. Blood-lead levels likely to result from these exposures were estimated using the compartmentalized kinetic lead distribution/excretion model contained in Meridian's Peer-Review Draft Risk Assessment Report. Table 6 presents the results of this analysis, and includes the average blood-lead levels expected to result over a year of performing each construction activity under baseline exposure conditions. These conditions are based upon the exposure levels shown in Table 4 and the wearing of respirators with the estimated protection factors specified in column one of Table 6.

A similar analysis was performed to evaluate likely blood-lead levels that would result from complying with the 50 μg/m³ PEL. For this analysis, OSHA's consultant, Meridian, assumed that air lead exposures would be reduced in accordance with the same engineering and respiratory protection assumptions used in the cost analysis. Table 7 presents the blood-lead profiles associated with compliance with the 50 μg/m³ PEL. Given the implementation of the control strategies required by the rule, blood-lead levels are not expected to exceed 25 μg/dl among construction workers.

TABLE 6.—BASELINE BLOOD-LEAD PROFILE, BY CONSTRUCTION ACTIVITY

Construction project activity	Assumed baseline factor of respiratory protection	Percent of time that blood-lead level (µg/dl) is within stated range						Average blood-lead level (µg/dl)
		<=15	>15-25	>25-30	>30-40	>40-50	>50	
Highway and Railroad Bridge Repainting:								
1.1 Abrasive Blasting	100-600	34.8	19.5	10.7	11.1	7.4	16.4	32.1
3.0 Spray Painting with LBP	1	33.4	11.8	12.3	35.3	7.1	0.0	24.2
19.1 Spray Painting with Non-LBP	1	13.4	86.6	0.0	0.0	0.0	0.0	16.9
—Combined Blasting/Painting	—	40.5	23.8	28.2	7.4	0.0	0.0	18.4
18.1 Enclosure Movement	10	51.8	12.9	17.0	18.4	0.0	0.0	17.9
18.2 Associated Miscellaneous Activities	10	35.1	17.5	8.8	16.2	6.6	15.9	28.0
Highway and Railroad Bridge Rehabilitation								
2.1 Welding, Cutting, Burning on Bridges	10	26.6	10.7	7.1	5.5	3.8	46.3	43.8
18.5 Associated Miscellaneous Activities	1	51.0	13.7	3.8	4.9	7.4	19.2	26.6
Water Tank Repainting:								
1.1 Abrasive Blasting	100-600	28.9	31.5	9.5	10.5	6.3	13.4	28.9
3.0 Spray Painting with LBP	1	29.6	31.2	25.8	13.4	0.0	0.0	20.5
19.1 Spray Painting with Non-LBP	1	80.8	19.2	0.0	0.0	0.0	0.0	11.5
—Combined Blasting/Painting	—	17.8	66.3	12.9	3.0	0.0	0.0	20.1
18.1 Enclosure Movement	10	44.4	34.2	10.7	10.7	0.0	0.0	17.6
18.2 Associated Miscellaneous Activities	10	23.8	32.6	10.4	10.1	9.9	13.2	27.6
Petroleum Tank Repainting:								
1.1 Abrasive Blasting	100-600	34.8	19.5	10.7	11.1	7.4	16.4	32.1
3.0 Spray Painting with LBP	1	33.4	11.8	12.3	35.3	7.1	0.0	24.2
19.1 Spray Painting with Non-LBP	1	13.4	86.6	0.0	0.0	0.0	0.0	16.9
—Combined Blasting/Painting	—	40.5	23.8	28.2	7.4	0.0	0.0	18.4
18.1 Enclosure Movement	10	51.8	12.9	17.0	18.4	0.0	0.0	17.9
18.2 Associated Miscellaneous Activities	10	35.1	17.5	8.8	16.2	6.6	15.9	28.0
Underground Storage Tank Demolition:								
2.2 Other Welding, Cutting, Burning	10	100.0	0.0	0.0	0.0	0.0	0.0	5.2
Housing Lead Abatement (Public):								
(A) Combined Abatement Activities-HUD Practice	1	100.0	0.0	0.0	0.0	0.0	0.0	7.9
—Combined Abatement Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
9.1 Power Tool Use (Housing)	1	31.2	35.3	15.3	16.7	1.4	0.0	21.4
Housing Lead Abatement (Private):								
(A) Combined Abatement Activities-HUD Practice	1	100.0	0.0	0.0	0.0	0.0	0.0	7.2
—Combined Abatement Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
In-Place Management (Public):								
(B) Combined In-Place Mgmt. Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	8.6
—Comb. In-Place Mgmt. Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
In-Place Management (Private):								
(B) Combined In-Place Mgmt. Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	9.2
—Comb. In-Place Mgmt. Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
Commercial and Industrial Demolition:								
2.2 Other Welding, Cutting, Burning	10	58.1	35.9	5.5	0.5	0.0	0.0	14.0
Indoor Industrial Facility Maintenance/ Renovation:								
1.1 Abrasive Blasting	100-600	77.5	11.8	2.9	2.7	2.1	3.0	15.0
9.2 Power Tool Use (Other)	10	81.1	7.9	3.8	4.7	2.5	0.0	10.8
2.2 Other Welding, Cutting, Burning	10	94.0	6.0	0.0	0.0	0.0	0.0	7.6
19.1 Spray Painting with Non-LBP	1	95.9	4.1	0.0	0.0	0.0	0.0	7.3
—Combined Blasting/Painting	—	82.2	13.2	4.7	0.0	0.0	0.0	9.3
—Combined Power Tool Use/Painting	—	84.7	14.8	0.5	0.0	0.0	0.0	8.7
18.1 Enclosure Movement	10	100.0	0.0	0.0	0.0	0.0	0.0	7.5
18.5 Associated Miscellaneous Activities	1	94.8	5.2	0.0	0.0	0.0	0.0	7.4
Outdoor Industrial Facility Maintenance/ Renovation:								
1.1 Abrasive Blasting	100-600	34.8	19.5	10.7	11.1	7.4	16.4	32.1

TABLE 6.—BASELINE BLOOD-LEAD PROFILE, BY CONSTRUCTION ACTIVITY—Continued

Construction project activity	Assumed baseline factor of respiratory protection	Percent of time that blood-lead level (μg/dl) is within stated range						Average blood-lead level (μg/dl)
		<=15	>15–25	>25–30	>30–40	>40–50	>50	
9.2 Power Tool Use (Other)	10	35.9	10.1	10.7	16.2	15.3	11.8	27.8
2.2 Other Welding, Cutting, Burning	10	55.6	44.4	0.0	0.0	0.0	0.0	13.1
19.1 Spray Painting with Non-LBP	1	13.4	86.6	0.0	0.0	0.0	0.0	16.9
—Combined Blasting/Painting	—	41.4	14.2	18.4	26.0	0.0	0.0	19.7
—Combined Power Tool Use/Painting	—	44.1	34.5	18.1	3.3	0.0	0.0	16.8
18.1 Enclosure Movement	10	51.8	12.9	17.0	18.4	0.0	0.0	17.9
18.5 Associated Miscellaneous Activities	1	51.0	13.7	3.8	4.9	7.4	19.2	26.6
Lead Joint Work on Cast Iron Soil Pipes:								
10.0 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.4
Ind. Process Equipment Mfg./Maint. Repair:								
2.3 Lead Burning	10	3.8	95.1	1.1	0.0	0.0	0.0	20.2
Industrial Vacuuming:								
15.0 Industrial Vacuuming	1	100.0	0.0	0.0	0.0	0.0	0.0	6.1
Stained Glass Window Removal:								
13.1 Removal of Stained Glass Windows	1	8.5	66.6	24.9	0.0	0.0	0.0	22.2
Installation of Radiation Shielding:								
14.0 Handling Lead Shot, Bricks, or Sheet	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
16.0 Cutting of Lead Foil Panels.								
Commercial and Institutional Remodeling:								
(C) Combined Comm./Inst. Remodeling Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	7.0
=Combined Remodeling Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
5.2 Manual Demolition	1	34.0	53.4	11.2	1.4	0.0	0.0	17.9
9.2 Power Tool Use (Other)	10	32.3	40.0	6.0	13.2	4.4	4.1	22.0
2.2 Other Welding, Cutting, Burning	10	63.6	35.9	0.5	0.0	0.0	0.0	14.2
Residential Remodeling:								
(D) Combined Res. Remodeling Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	7.6
=Combined Remodeling Activities-Poor Practice	1	20.8	42.7	14.5	14.5	4.4	3.0	33.8
5.2 Manual Demolition	1	34.0	53.4	11.2	1.4	0.0	0.0	17.9
Elevator Cable Babbitting:								
10.0 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.0
Electrical Cable Splicing:								
10.0 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
Reinsulation over Existing Mineral Wool:								
17.0 Reinsulation over Existing Mineral Wool	1	100.0	0.0	0.0	0.0	0.0	0.0	5.2
Repair/Removal of Water Lines Containing Lead:								
11.0 Soldering, Brazing	1	100.0	0.0	0.0	0.0	0.0	0.0	5.1
Transmission Communication Tower Maint.:								
4.0 Hand Scraping	1	74.2	25.8	0.0	0.0	0.0	0.0	9.7
9.2 Power Tool Use (Other)	10	73.4	8.5	6.8	7.9	3.3	0.0	12.9
19.2 Brush Painting with Non-LBP	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
=Combined Hand Scraping/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	6.4
=Combined Power Tool Use/Painting	—	86.3	12.3	1.4	0.0	0.0	0.0	9.0
18.5 Associated Miscellaneous Activities	1	71.0	13.4	2.2	3.0	4.9	5.5	15.1
Installation of Terne Roofing:								
11.0 Soldering, Brazing	1	100.0	0.0	0.0	0.0	0.0	0.0	6.3
14.0 Handling Lead Shot, Bricks, or Sheet	1	100.0	0.0	0.0	0.0	0.0	0.0	5.6

Source: OSHA, Office of Regulatory Analysis.

TABLE 7.—PROJECTED BLOOD-LEAD PROFILE ASSOCIATED WITH THE 50 µG/M³ PEL, BY CONSTRUCTION ACTIVITY

Construction project activity	Assumed factor of exposure reduction	Percent of time that blood-lead level (µg/dl) is within stated range						Average blood-lead level (µg/dl)
		<=15	>15–25	>25–30	>30–40	>40–50	>50	
Highway and Railroad Bridge Repainting:								
1.1 Abrasive Blasting	4000	100.0	0.0	0.0	0.0	0.0	0.0	6.6
3.0 Spray Painting with LBP	20	100.0	0.0	0.0	0.0	0.0	0.0	6.0
19.1 Spray Painting with Non-LBP	2	100.0	0.0	0.0	0.0	0.0	0.0	8.6
—Combined Blasting/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	7.1
18.1 Enclosure Movement	50	100.0	0.0	0.0	0.0	0.0	0.0	7.6
18.2 Associated Miscellaneous Activities	50	86.0	14.0	0.0	0.0	0.0	0.0	9.6
Highway and Railroad Bridge Rehabilitation:								
2.1 Welding, Cutting, Burning on Bridges	50	59.2	40.8	0.0	0.0	0.0	0.0	12.8
18.5 Associated Miscellaneous Activities	50	100.0	0.0	0.0	0.0	0.0	0.0	5.4
Water Tank Repainting:								
1.1 Abrasive Blasting	4000	100.0	0.0	0.0	0.0	0.0	0.0	6.6
3.0 Spray Painting with LBP	20	100.0	0.0	0.0	0.0	0.0	0.0	5.9
19.1 Spray Painting with Non-LBP	2	100.0	0.0	0.0	0.0	0.0	0.0	8.6
—Combined Blasting/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	8.5
18.1 Enclosure Movement	50	100.0	0.0	0.0	0.0	0.0	0.0	7.5
18.2 Associated Miscellaneous Activities	50	92.3	7.7	0.0	0.0	0.0	0.0	9.5
Petroleum Tank Repainting:								
1.1 Abrasive Blasting	4000	100.0	0.0	0.0	0.0	0.0	0.0	6.6
3.0 Spray Painting with LBP	20	100.0	0.0	0.0	0.0	0.0	0.0	6.0
19.1 Spray Painting with Non-LBP	2	100.0	0.0	0.0	0.0	0.0	0.0	8.6
—Combined Blasting/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	7.1
18.1 Enclosure Movement	50	100.0	0.0	0.0	0.0	0.0	0.0	7.6
18.2 Associated Miscellaneous Activities	50	86.0	14.0	0.0	0.0	0.0	0.0	9.6
Underground Storage Tank Demolition:								
2.2 Other Welding, Cutting, Burning	50	100.0	0.0	0.0	0.0	0.0	0.0	5.0
Housing Lead Abatement (Public):								
(A) Combined Abatement Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
9.1 Power Tool Use (Housing)	40	100.0	0.0	0.0	0.0	0.0	0.0	9.1
Housing Lead Abatement (Private):								
(A) Combined Abatement Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	5.1
In-Place Management (Public)								
(B) Combined In-Place Mgmt. Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	8.6
In-Place Management (Private):								
(B) Combined In-Place Mgmt. Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	9.2
Commercial and Industrial Demolition:								
2.2 Other Welding, Cutting, Burning	50	100.0	0.0	0.0	0.0	0.0	0.0	6.8
Indoor Industrial Facility Maintenance/ Renovation:								
1.1 Abrasive Blasting	4000	100.0	0.0	0.0	0.0	0.0	0.0	5.5
9.2 Power Tool Use (Other)	40	99.2	0.8	0.0	0.0	0.0	0.0	6.5
2.2 Other Welding, Cutting, Burning	50	100.0	0.0	0.0	0.0	0.0	0.0	5.5
19.1 Spray Painting with Non-LBP	2	100.0	0.0	0.0	0.0	0.0	0.0	6.1
—Combined Blasting/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	5.7
—Combined Power Tool Use/Painting	—	97.5	2.5	0.0	0.0	0.0	0.0	6.7
18.1 Enclosure Movement	50	100.0	0.0	0.0	0.0	0.0	0.0	5.7
18.5 Associated Miscellaneous Activities	50	100.0	0.0	0.0	0.0	0.0	0.0	5.1
Outdoor Industrial Facility Maintenance/ Renovation:								
1.1 Abrasive Blasting	4000	100.0	0.0	0.0	0.0	0.0	0.0	6.6
9.2 Power Tool Use (Other)	40	81.92	18.1	0.0	0.0	0.0	0.0	10.7
2.2 Other Welding, Cutting, Burning	50	100.0	0.0	0.0	0.0	0.0	0.0	6.6
19.1 Spray Painting with Non-LBP	2	100.0	0.0	0.0	0.0	0.0	0.0	8.6
—Combined Blasting/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	6.9
—Combined Power Tool Use/Painting	—	74.52	25.5	0.0	0.0	0.0	0.0	10.2
18.1 Enclosure Movement	50	100.0	0.0	0.0	0.0	0.0	0.0	7.6
18.5 Associated Miscellaneous Activities	50	100.0	0.0	0.0	0.0	0.0	0.0	5.4
Lead Joint Work on Cast Iron Soil Pipes:								
10.0 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.4

TABLE 7.—PROJECTED BLOOD-LEAD PROFILE ASSOCIATED WITH THE 50 μG/M³ PEL, BY CONSTRUCTION ACTIVITY—Continued

Construction project activity	Assumed factor of exposure reduction	Percent of time that blood-lead level (μg/dl) is within stated range						Average blood-lead level (μg/dl)
		<=15	>15–25	>25–30	>30–40	>40–50	>50	
Ind. Process Equipment Mfg./Maint./Repair:								
2.3 Lead Burning	20	98.90	1.1	0.0	0.0	0.0	0.0	12.6
Industrial Vacuuming:								
15.0 Industrial Vacuuming	50	100.0	0.0	0.0	0.0	0.0	0.0	5.0
Stained Glass Window Removal:								
13.1 Removal of Stained Glass Windows	50	100.0	0.0	0.0	0.0	0.0	0.0	5.3
Installation of Radiation Shielding:								
14.0 Handling Lead Shot, Bricks, or Sheet	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
16.0 Cutting of Lead Foil Panels	1							
Commercial and Institutional Remodeling:								
(C) Combined Comm./Inst. Remodeling Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	7.0
5.2 Manual Demolition	50	100.0	0.0	0.0	0.0	0.0	0.0	5.3
9.2 Power Tool Use (Other)	40	94.79	5.2	0.0	0.0	0.0	0.0	9.2
2.2 Other Welding, Cutting, Burning	50	100.0	0.0	0.0	0.0	0.0	0.0	6.8
Residential Remodeling:								
(D) Combined Res. Remodeling Activities	1	100.0	0.0	0.0	0.0	0.0	0.0	7.6
5.2 Manual Demolition	50	100.0	0.0	0.0	0.0	0.0	0.0	5.3
Elevator Cable Babbitting:								
10.0 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.0
Electrical Cable Splicing:								
10 Use of Lead Pots	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
Reinsulation over Existing Mineral Wool:								
17.0 Reinsulation over Existing Mineral Wool	10	100.0	0.0	0.0	0.0	0.0	0.0	5.0
Repair/Removal of Water Lines Containing Lead:								
11.0 Soldering, Brazing	1	100.0	0.0	0.0	0.0	0.0	0.0	5.1
Transmission and Communication Tower Maint.:								
4.0 Hand Scraping	50	100.0	0.0	0.0	0.0	0.0	0.0	5.0
9.2 Power Tool Use (Other)	40	99.18	0.8	0.0	0.0	0.0	0.0	7.0
19.2 Brush Painting with Non-LBP	1	100.0	0.0	0.0	0.0	0.0	0.0	5.3
=Combined Hand Scraping/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	6.4
=Combined Power Tool Use/Painting	—	100.0	0.0	0.0	0.0	0.0	0.0	5.8
18.5 Associated Miscellaneous Activities	50	100.0	0.0	0.0	0.0	0.0	0.0	5.2
Installation of Terne Roofing:								
11.0 Soldering, Brazing	1	100.0	0.0	0.0	0.0	0.0	0.0	6.3
14.0 Handling Lead Shot, Bricks, or Sheet	1	100.0	0.0	0.0	0.0	0.0	0.0	5.6

Source: OSHA, Office of Regulatory Analysis.

Table 8 presents the analysis of the number of potential medical removal protection (MRP) cases expected to occur during the first year that the Interim Final Standard is in effect. The estimates shown are based on the assumptions that initial monitoring is administered to all workers in activities with exposures at or above the 30 μg/m³ action level and that medical surveillance program monitoring is administered to all workers in activities with exposures at or above the 30 μg/m³ action level for more than 30 days per year. These estimates were prepared to support the analysis of potential costs of medical removal protection benefits and increased medical surveillance for workers with detected and confirmed blood leads over 50 μg/dl. Because measurements of blood-lead levels are to be taken at fixed intervals under the Interim Final Standard, and because a worker's blood-lead level changes in response to variations in air lead exposures, there is a determinable probability that a blood-lead level above the 50 μg/dl medical removal trigger will be detected on any particular test. To estimate the number of MRP cases that would likely be identified, two alternative assumptions were made. First, it was assumed that blood-lead levels above the MRP trigger occur irregularly during the year. Under this assumption, the probability of detecting a blood-lead level above the MRP trigger can be described using binomial statistics, and the result represents a minimum estimate of the true probability. Alternatively, it was assumed that all blood-lead levels above the MRP trigger occur on consecutive days (i.e., blood-lead levels are highly autocorrelated), and that blood-lead measurements will be taken at 60-day intervals. Under this assumption, the probability of detecting a blood-lead level above the MRP trigger can be described by the ratio of the number of days that blood-lead levels are above the

MRP trigger divided by 60. This approach was assumed to yield the maximum probability of detecting a blood-lead level above 50 µg/dl. Multiplying the minimum and maximum probabilities of detecting a blood-lead level above the MRP trigger by the estimated number of employees engaged in each construction activity yields estimates of the annual number of employees that will be detected with blood-lead levels above the MRP trigger under baseline exposure conditions.

TABLE 8.—PREVALENCE OF MEDICAL REMOVAL CASES UNDER BASELINE EXPOSURE ASSUMPTIONS BY PROJECT TYPE

Project type	Total number of workers exposed	Initial biological monitoring**	Medical surveillance program monitoring***	Number of MRP cases per year (minimum)	Number of MRP cases per year (maximum)
Highway and Railroad Bridge Repainting	18,419	X	X	2,419	4,697
Highway and Railroad Bridge Rehabilitation	29,958	X	X	11,733	15,053
Water Tank Repainting	5,113	X	X	579	1,077
Petroleum Tank Repainting	4,364	X	X	565	1,097
Underground Storage Tank Demolition	288	X		0	0
Housing Lead Abatement (Public Housing)*	2,893	X	X	0	0
Housing Lead Abatement (Private Housing)*	9,345			0	0
In-place Management (Public Housing)*	188			0	0
In-place Management (Private Housing)*	35,056			0	0
Commercial and Industrial Demolition	7,440	X	X	0	0
Indoor Industrial Facility Maint./Renovation	2,113	X	X	9	14
Outdoor Industrial Facility Maint./Renovation	2,981	X	X	393	706
Lead Joint Work on Cast Iron Soil Pipes	15,337			0	0
Ind. Process Equipment Mfg./Maint./Repair	409	X	X	0	0
Industrial Vacuuming	392	X		0	0
Stained Glass Window Removal	208	X	X	0	0
Installation of Radiation Shielding	40			0	0
Commercial and Institutional Remodeling*	546,798	X		186	301
Residential Remodeling*	178,544	X		0	0
Elevator Cable Babbitting	4,500			0	0
Electrical Cable Splicing	5,000			0	0
Reinsulation Over Existing Mineral Wool	18,333	X		0	0
Repair/Removal of Water Lines	41,042			0	0
Transmission & Comm. Tower Maint.	7,333	X	X	372	614
Installation of Terne Roofing	576			0	0
Total for all project types	936,670			16,256	23,559

* OSHA's analysis shows that in some activities in these project types, poor work practices can result in blood-lead levels that would require medical removal. However, once the standard is in effect, and good work practices are implemented, none of these workers in these activities will be exposed above the action level.

** Initial monitoring is triggered by a single day of exposure above the action level of 30 µg/m³.

*** Medical surveillance program monitoring is triggered by exposure above the action level for more than 30 days and for all workers with blood-lead levels above 40 µg/dl.

Source: OSHA, Office of Regulatory Analysis.

However, not all of these employees will be medically removed. The interim final standard mandates that employees be removed from exposure only after a follow-up blood-lead test taken two weeks after a periodic test confirms the blood-lead level to be above 50 µg/dl. Of the number of employees found to have a blood-lead level above the MRP trigger, Meridian assumed that two-thirds will require medical removal as a result of a confirming follow-up blood-lead test.

In addition, it can reasonably be expected that blood-lead levels will fall during the first year that the standard is in effect, due to the requirement to reduce employee exposures during that year. Therefore, the number of employees having blood-lead levels above 50 µg/dl will likely decline during the first year. For this analysis, it was assumed that the number of employees requiring medical removal will decline by half after the first four months following the effective date, and should approach zero at the end of the first year following the effective date of the standard. (The number of MRP cases expected to be identified during the first year was reduced, in accordance with this assumption, for purposes of the cost analysis.)

Table 9 contains estimates of the number of illness and MRP cases expected to be avoided following promulgation of the 50 µg/m³ PEL for construction. (About half of these benefits would have been achieved if there had been full compliance with the existing OSHA PEL of 200 µg/m³.) Except for cases of gastrointestinal disturbances, detected blood-leads above the 50 µg/dl medical removal trigger, and medical removal, estimates of the numbers of cases avoided were derived using average baseline blood-lead levels predicted for each group of workers (see Table 6) and corresponding risk estimates contained in Meridian's Peer-Review Draft Risk Assessment. For gastrointestinal disturbances, a minimum estimate of cases avoided was derived by assuming that all workers predicted to have blood-lead levels exceeding 90 µg/dl at least five percent of the time (i.e., about three weeks) were at risk of acute lead poisoning. The maximum estimate was derived by assuming that all workers with blood-lead levels exceeding 70 µg/dl are at risk. The number of cases of detected

blood-leads above the MRP trigger level and number of cases of medical removals comes from the analysis summarized in Table 8.

The number of illness and MRP cases avoided for near-term effects listed in Table 9 are expected to accrue during or shortly after the first year following promulgation of the Interim Final Standard. These near-term effects have generally been found to be reversible upon reduction or cessation of exposure to lead. The number of illness cases avoided for long-term effects are expected to accrue over at least a 10-year period of time.

TABLE 9.—SUMMARY OF POTENTIAL BENEFITS ASSOCIATED WITH A REDUCTION OF THE LEAD PEL TO 50 µG/M³ for Construction

Effect avoided	Number of cases	
	Minimum	Maximum
Near-Term Effects Avoided Annually:		
Reduced Nerve Conduction Velocity	16,199	22,831
Reduced Blood ALA-D Levels	130,056	164,044
Increased Urinary ALA	60,389	78,676
Gastrointestinal Disturbances	1,135	4,413
Detected Blood-Lead Levels Above MRP Trigger**	24,262	35,163
Long-Term Effects Avoided Over A Ten-Year Period:		
Fatal/Nonfatal Infarctions	2,164	2,322
Fatal/Nonfatal Stroke	698	644
Renal Disease	1,258	2,157

**Note: The minimum estimate of expected medical removal cases is 16,256. The maximum estimate of expected medical removal cases is 23,559.

Source: OSHA, Office of Regulatory Analysis.

E. Costs of Compliance

This section describes the costs of compliance expected to be incurred by the industries affected by the Interim Final Standard for Lead in Construction. The cost estimates presented in this section are based on the preliminary findings of OSHA's research into current compliance, costs and economic impact issues related to lead exposure reduction efforts in the construction industry.

As described in the technological feasibility section above, there are several general approaches for controlling exposure to airborne lead. The existing OSHA lead standard, 29 CFR 1926.55, requires engineering controls, work practices, and respirators to be used to meet a PEL of 200 µg/m³ for lead exposure in the construction industry.[3] The Interim Final Standard reduces the lead PEL to 50 µg/m³ and requires additional safeguards in the form of ancillary provisions intended to prevent overexposure to lead. These ancillary provisions include requirements for competent person supervision, exposure monitoring, protective clothing and equipment, biological monitoring, and recordkeeping. The costs of meeting these additional requirements are attributable to the Interim Final Standard. Table 10 summarizes information on the regulatory provisions of the existing standard, the Interim Final Standard, and the exposure levels at which required controls must be employed.

TABLE 10.—SUMMARY OF CONTROL PRACTICE REQUIREMENTS ASSOCIATED WITH OSHA'S EXISTING AND INTERIM FINAL LEAD STANDARDS

Control practice	Existing standard: 200 µg/m³ PEL		Interim final standard		
	Exposure below PEL	Exposure above PEL	Exposure below 30 µg/m³ AL	Exposure between AL and PEL	Exposure above 50 µg/m³ PEL
Determination of the Presence of Lead[a]			X	X	X
Competent Person					X
Exposure Monitoring and Assoc. Recordkeeping[a]			X	X	X
Mechanical Ventilation		X			X
Local exhaust Ventilation		X			X
Enclosures/Containment Systems[b]		X			X
HEPA Vacumms	X[c]	X[c]	X	X	X
Wetting Agents	X	X	X	X	X
Written Compliance Program					X
Warning Signs					X
Worker Training				X	X
Notification of Other Employers			X	X	X
Respiratory Protection		X			X

[3] Thus the capital costs of mechanical ventilation, local exhaust ventilation, HEPA vacuums, wetting agents, and respiratory protection for projects with exposures over 200 µg/m³ are already required under 29 CFR 1926.55.

TABLE 10.—SUMMARY OF CONTROL PRACTICE REQUIREMENTS ASSOCIATED WITH OSHA'S EXISTING AND INTERIM FINAL LEAD STANDARDS—Continued

Control practice	Existing standard: 200 µg/m³ PEL		Interim final standard		
	Exposure below PEL	Exposure above PEL	Exposure below 30 µg/m³ AL	Exposure between AL and PEL	Exposure above 50 µg/m³ PEL
Protective Clothing/Gloves/Shoe Covers					X
Handwashing Facilities Only[d]			X	X	X
Change Areas with Storage Facilities					X
Decontamination Facilities Including Showers					X
Eating Areas and Facilities					X
Biological Monitoring and Assoc. Recordkeeping				X	X
Medical Examinations and Assoc. Recordkeeping				X	X
Medical Removal Protection Requirements[e]			X	X	X

[a] Exemption is possible if objective data shows that exposures are below the action level or if the employer has relevant data from the past 12 months.
[b] Enclosures are only assumed to be needed in conjunction with indoor projects using mechanical ventilation. Outdoor enclosures are required by EPA regulations concerning environmental release of lead.
[c] For this standard, vacuums are only needed for worksite clean-up.
[d] Hand washing facilities for activities below the PEL are required by 29 CFR 1926.51(f).
[e] Medical removal is dependent on worker blood-lead level.
Source: OSHA, Office of Regulatory Analysis.

In order to develop the cost estimates associated with achieving full compliance with OSHA's Interim Final Standard, unit cost estimates were obtained for the control practices and ancillary measures required for each of the project types and activities covered by the rule. The appropriate control practices required to achieve compliance were identified for each project type and construction activity in accordance with the exposure data presented in the technological feasibility section above. The unit cost data used in this analysis were obtained from published price lists of equipment suppliers and from other information collected and developed by OSHA's consultant, CONSAD Research.

The control practices costed in the analysis of the Interim Final Standard included: Determination of the presence of lead; exposure monitoring; competent person labor time; written compliance programs; warning signs; worker training; respirators for activities with exposures below the old PEL of 200 µg/m³ but above the new PEL of 50 µg/m³ (including the respirator unit, accessories, fit testing, cleaning, and training); disposable and reusable protective clothing, shoe covers and gloves; handwashing facilities; decontamination facilities; clean change areas with storage facilities; eating facilities; biological monitoring (blood lead and ZPP testing); medical examinations; medical removal protection; recordkeeping; and employee notification of monitoring data, blood lead analysis, and medical exam results.[4]

Estimates of the annual need for or use of each control practice were calculated using the following bases for costing purposes: Establishments, projects,[5] crews, workers, project-days, crew-days, or worker-days. Estimates for the other parameters in the cost analyses were calculated based upon estimates of the types and frequency of construction activities performed within each project type, project and activity durations, average number of crews per construction activity, crew size, hours of exposure per day, the percentage of projects performed per year involving lead, and the number of available work-days per year. These estimates were developed by OSHA's consultant, CONSAD Research, based on data obtained from industry and labor experts, site visits conducted to support this analysis, CONSAD's PELs in Construction Study, and the 1991 Steel Structures Painting Council (SSPC) Survey of Facility Owners.

Annual compliance costs for each project type and associated activities were developed by combining the unit cost data with estimates of the number of units of each type of control practice needed per year to achieve compliance with the Interim Final Standard. Estimated costs for hygiene facilities, respirators and other capital goods were annualized based on assumptions about the expected useful life of the equipment. The resulting gross annual cost estimates were then adjusted to reflect existing use of specific control practices in order to develop net annual compliance cost estimates.

OSHA's preliminary estimates of current compliance with lead exposure control requirements were used to determine current expenditures on control practices for each project type. These compliance estimates were based upon information obtained from industry and labor experts, CONSAD site visits, CONSAD's PELs in Construction Study, and reports from various HUD Lead Abatement Demonstration Projects.

The cost estimates discussed in this section are the estimated incremental costs to the affected industries of achieving full compliance with the requirements of the Interim Final Standard. These incremental costs are those costs which must be expended to achieve full compliance with OSHA's new requirements in excess of amounts currently being spent by industry.

The annual recurring costs of achieving compliance with a 50 µg/m³ PEL and the ancillary requirements of the Interim Final Standard are estimated to range between $365 million to $445 million dollars.[6] During the first year following the standard's implementation, additional "one-time" start-up costs are expected to be incurred for worker training, biological monitoring, medical examinations, and

[4] Costs of complying with the requirement for handwashing facilities are attributed to the existing OSHA construction sanitation standard: 29 CFR 1926.51(f).

[5] Multiple pieces of equipment were costed where firms were assumed to perform more than one project at a time.

[6] Additional costs will be borne by those firms not currently in compliance with the existing 200 µg/m³ PEL.

medical removal protection benefits.[7] These costs are estimated to range between $150 million and $183 million. Start-up costs for worker training and biological monitoring are based on the need to train and monitor all current employees exposed above the trigger levels for these provisions during the first year after the standard becomes effective. Costs for medical examinations and medical removal protection benefits should not persist beyond the first year; compliance with the 50 µg/m³ PEL is expected to reduce worker blood leads below the trigger levels for these provisions.

Tables 11 and 12 present point estimates of the annual recurring cost of the Interim Final Standard to illustrate the relative magnitude of costs by project type and by provision. The figures shown in Tables 11 and 12 suggest the relative importance of each cost element.

TABLE 11.—POINT-ESTIMATE SUMMARY OF ANNUAL RECURRING COMPLIANCE COSTS FOR OSHA'S INTERIM FINAL LEAD STANDARD BY PROJECT TYPE

Project type	Total annual recurring compliance costs	Project cost as a percentage of total
Highway and railroad bridge repainting	56,742,000	13.99
Highway and railroad bridge rehabilitation	109,593,000	27.02
Water tank repainting	14,797,000	3.65
Petroleum tank repainting	16,125,000	3.98
Underground storage tank demolition	443,000	0.11
Housing lead abatement (public housing)	5,473,000	1.35
Housing lead abatement (private housing)	[1]0	0.00
In-place management (public housing)	[1]0	0.00
In-place management (private housing)	[1]0	0.00
Commercial and industrial demolition	16,445,000	4.05
Indoor industrial facility maintenance/renovation	3,739,000	0.92
Outdoor industrial facility maintenance/renovation	10,152,000	2.50
Lead joint work on cast iron soil pipes	[1]0	0.00
Industrial process equipment manufacturing/maintenance/repair	2,285,000	0.56
Industrial vacuuming	394,000	0.10
Stained glass window removal	1,046,000	0.26
Installation of radiation shielding	[1]0	0.00
Commercial and institutional remodeling	76,746,000	18.92
Residential remodeling	59,163,000	14.59
Elevator cable babbitting	[1]0	0.00
Electrical cable splicing	[1]0	0.00
Reinsulation over existing mineral wool	18,580,000	4.58
Repair/removal of water lines	[1]0	0.00
Transmission and commercial tower maintenance	13,827,000	3.41
Installation of terne roofing	[1]0	0.00
Total for all project types	405,550,000	100.000

[1] Lead exposure levels on these projects are not expected to exceed the action level of 30 µg/m.

Source: OSHA, Office of Regulatory Analysis.

TABLE 12.—POINT-ESTIMATE SUMMARY OF ANNUAL RECURRING COMPLIANCE COSTS FOR OSHA'S INTERIM FINAL LEAD STANDARD BY CONTROL PRACTICE

Control practice	Total annual recurring compliance costs	Control practice percentage of total
Determination of the presence of lead	1,413,000	0.35
Competent person labor time	18,610,000	4.59
Exposure monitoring and association recordkeeping	121,617,000	29.99
Written compliance program	15,179,000	3.74
Warning signs	7,036,000	1.73
Worker training	11,118,000	2.74
Respiratory protection	4,714,000	1.16
Protective work clothing	89,325,000	22.03
Hand washing facilities only	[1]0	0.00
Change areas with storage facilities	2,108,000	0.52
Decontamination facilities and shower time labor cost	111,510,000	27.50
Eating facilities	419,000	0.10
Biological monitoring and association recordkeeping	22,500,000	5.55
Total	405,550,000	100.00

[1] Costs of hand washing facilities were attributed to 29 CFR 1926.51(f).

Source: OSHA, Office of Regulatory Analysis.

As shown in Table 11, the project types expected to account for the largest share of annual costs are Highway and Railroad Bridge Rehabilitation (27%); Commercial and Institutional Remodeling (19%); Residential Remodeling (15%); and Highway and Railroad Bridge Repainting (14%). It should be noted that although lead exposures associated with remodeling project types are generally low, and less than 20 percent of commercial and 5 percent of residential remodeling jobs involving lead exposure are expected to be exposed over the PEL, the large number of remodeling projects estimated to occur annually results in significant total costs for these project types. As shown above in Table 3, the annual numbers of lead-exposed projects for Commercial and Institutional Remodeling and

[7] Cost estimates for medical removal benefits were based on an average removal duration of 100 work days and an average medical removal benefit per case of $74 per day. This estimate is based on OSHA's assumptions about the likelihood of removed workers: finding non-lead exposed jobs with a different employer; moving to a job with the same employer at the same wage rate; moving to a lower-paying job with the same employer; receiving worker compensation; or being removed for fewer than 100 work days.

Residential Remodeling are 546,000 and 2,698,000, respectively.

Table 12 shows the annual recurring costs by control practice in order to indicate the relative magnitude of costs associated with specific regulatory provisions. In descending order of importance, the most costly provisions are exposure monitoring and associated recordkeeping (30%); hygiene facilities, including change areas and decontamination facilities with associated showering labor time costs (28%); and protective work clothing and equipment, including both reusable and disposable protective clothing (22%).

F. Economic Impacts

This chapter examines the economic impacts associated with OSHA's Interim Final Standard for Lead in Construction. The economic impact analysis presented below is based on those costs attributable to the Interim Final Standard as described in the cost section above.

The economic impacts in this section are presented on both a "per worker" and a "per establishment" basis. The bases for estimating these impacts were derived from data on each SIC obtained from the 1987 Census of Construction Industries, the 1989 County Business Patterns, and the Dun & Bradstreet Insight Database. The following data were used to construct this analysis:

- The total number of establishments;
- The total number of employees and the total number of construction workers;
- The average number of employees and the average number of construction workers per establishment;
- The annual payroll for all employees and for construction workers;
- The net dollar value of construction work for construction SICs or sales for non-construction SICs; and
- The pre-tax profit ratio.

These data were used to derive the annual payroll and net value of construction work per establishment and per construction worker. To obtain pre-tax profits per establishment, pre-tax profit ratios derived from Dun & Bradstreet data were multiplied by the net value of construction work or sales per establishment.

Across all the affected SICs, the annual payroll per establishment ranges from $48,000 for SIC 1521, Single Family Housing to $3.4 million for SIC 4911, Electric Utilities. The net value of construction work or sales per establishment ranges from $15,300 in sales for SIC 6514, Operators of Other Dwellings to $7 million in sales for SIC 4911, Electric Utilities. Across all the affected SICs, pre-tax profits per establishment range from $1,300 for SIC 6514, Operators of Other Dwellings to $676,000 for SIC 4911, Electric Utilities.

Several different cost-related impact measures were calculated for each of the 18 construction SICs and four of the five non-construction SICs identified as affected by OSHA's Interim Final Standard.[8] These impact measures are:

- The ratio of the average annual compliance costs per affected establishment (or per exposed construction worker) to an estimate of the annual payroll for an average establishment (or per construction worker) in the specific SIC. This measure compares the projected compliance costs to labor costs normally incurred by the establishment. It can be interpreted as the cost of providing a mandated occupational safety and health "benefit" relative to existing payroll expenses.
- A comparison of the average annual compliance costs per affected establishment (or per exposed construction worker) to an estimate of the net dollar value of construction work or sales for an average establishment (or per construction worker) in the specific SIC. This ratio indicates the relationship of the compliance costs to an establishment's output.
- The average annual compliance cost per affected establishment as a percentage of pre-tax profits for an average establishment in the specific SIC. This measure is particularly meaningful when establishments face highly competitive conditions which prevent the pass through of compliance costs to customers.

The impact measures described above were calculated for the annual recurring costs of the Interim Final Standard as shown in Table 11 above. Table 13 presents estimates of the annual recurring compliance costs per exposed worker and per establishment for each affected SIC. These estimates are an average of costs across the mix of different project types assumed to be performed by each construction or non-construction industry SIC.

Table 13 shows these average costs as a percentage of construction payroll and net value of construction work or sales, on both a per worker and per establishment basis for affected industries. The last column of Table 13 presents the compliance costs per establishment as a percentage of pre-tax profits per establishment. These average percentages are shown to illustrate the relative magnitude of impacts on specific SICs; they should not be interpreted as indicative of the cost impacts on specific project types or on firms within an SIC which specialize in only one of the associated project types.

As shown in Table 13, using annual compliance costs per worker as a measure of impact, the most impacted SICs are expected to include SIC 1791, Structural Steel Erection Contractors; SIC 1795, Wrecking and Demolition Contractors; SIC 1622, Bridge, Tunnel and Elevated Highway Contractors; SIC 1611, Highway and Street Construction Contractors; SIC 1721, Painting Contractors; and SIC 3231, Glass Products Manufacturers.

[8] Impact estimates were not made for SIC 9999, State and Municipal Governments since the relevant revenue and profit data are not applicable.

TABLE 13.—SUMMARY ECONOMIC IMPACT MEASURES FOR OSHA'S INTERIM FINAL STANDARD IMPACT MEASURES CALCULATED USING ESTIMATES OF ANNUAL RECURRING COSTS

SIC	Industry title	Compliance cost per worker ($)	Compliance cost per worker as a percentage of—		Compliance cost per establishment ($)	Compliance cost per establishment as a percentage of—		
			Construction payroll per worker (percent)	Net value of construction work/sales per worker (percent)		Construction worker payroll per establishment (percent)	Net value of construction work/sales per establishment (percent)	Pre-tax profits per establishment (percent)
1521	Single family housing	297	2.1	0.3	1,202	2.5	0.4	6.9
1522	Other residential buildings	331	1.8	0.3	1,342	1.0	0.2	3.2
1531	Operative builders	277	1.5	0.1	1,119	1.6	0.1	1.6
1541	Industrial buildings and warehouses.	168	0.7	0.2	3,028	0.9	0.2	4.8
1542	Other non-resident construction.	140	0.7	0.1	2,564	1.0	0.2	5.0
1611	Highway and street contractors	3,398	15.1	2.9	57,735	11.8	2.3	44.4
1622	Bridge, tunnel and el. highway contractors.	3,625	16.0	3.5	77,482	9.9	2.1	47.7
1711	Plumbing contractors	0	0.0	0.0	0	0.0	0.0	0.0
1721	Painting contractors	775	4.7	1.5	7,792	9.8	3.1	42.2
1731	Electrical work contractors	211	0.9	0.2	1,606	0.8	0.2	3.6
1742	Plastering, drywall, and ins. contractors.	229	1.1	0.3	2,023	0.8	0.2	4.8
1751	Carpentry work contractors	167	1.1	0.3	2,046	2.8	0.7	10.8
1752	Floor work contractors	187	1.0	0.2	1,836	2.3	0.4	6.7
1761	Roofing and siding contractors	166	1.0	0.2	2,020	1.7	0.4	7.0
1791	Structural steel erection contractors.	3,607	16.0	4.4	70,485	23.0	6.3	99.6
1795	Wrecking and demolition work contractors.	2,188	13.1	3.0	24,596	15.6	3.6	62.3
1796	Building equipment contractors	0	0.0	0.0	0	0.0	0.0	0.0
1799	Miscellaneous special trade contractors, NEC.	402	2.5	0.6	2,027	2.1	0.5	7.2
3231	Glass products manufacturers	5,019	29.7	1.8	10,038	14.0	0.9	14.6
4911	Electric utilities	0	0.0	0.0	0	0.0	0.0	0.0
6513	Operators of apartment buildings.	0	0.0	0.0	0	0.0	0.0	0.0
6514	Operators of other dwellings	0	0.0	0.0	0	0.0	0.0	0.0

Source: OSHA, Office of Regulatory Analysis.

If compliance costs per establishment are used as a measure of impact, the most impacted SICs during subsequent years are expected to include: SIC 1791, Structural Steel Erection Contractors; SIC 1795, Wrecking and Demolition Contractors; SIC 1622, Bridge, Tunnel and Elevated Highway Contractors; SIC 1611, Highway and Street Construction Contractors; SIC 1721, Painting Contractors; and SIC 3231, Glass Products Manufacturers.

Impact measures calculated on the basis of percent of net value of construction work and sales suggest the magnitude of cost increases that may potentially be passed through to consumers of construction. (The very high impact on pre-tax profits found in SICs 1791 and 1795 would only be realized if no costs were passed through to buyers of construction. Since cost pass through of most costs is likely, the impact shown in Table 13 represents a hypothetical extreme.)

Existing federal, state and local regulations have already established some obligations for owners and contractors concerning abatement practices on construction projects that supplement and reinforce the requirements of OSHA's Interim Final Lead Standard. These regulations, in conjunction with forthcoming lead regulations from the Federal Highway Administration, the Environmental Protection Agency and the Department of Housing and Urban Development, are expected to ensure a level playing field for contractors bidding on work involving lead exposure.

For many project types involving high exposures to lead, and especially those involving abrasive blasting, small contractors have traditionally made up most of the industry. In recent years, construction industry compliance with environmental regulations has resulted in large capital expenditures and additional worker skill training requirements. These requirements are bringing about some restructuring in this industry with a progressively larger share of work involving lead exposure being performed by larger, better capitalized contractors. OSHA does not anticipate that these changes will result in massive dislocations, undue concentration or any threat to the competitive structure of the industry.

Where OSHA compliance costs significantly increase costs to the buyers of construction, some projects may be delayed in order to compensate for the increased cost of existing work. This may occur in the case of infrastructure projects such as bridge repainting and bridge rehabilitation. However, OSHA cannot state with certainty whether or not this will actually occur or whether new levels of infrastructure spending will more than compensate for new costs of the interim final rule.

G. Regulatory Flexibility Analysis

Pursuant to the Regulatory Flexibility Act of 1980 (Pub.L. 96-353, 94 Stat. 1164 (5 U.S.C. et seq.)), OSHA has assessed the impact of the Interim Final Standard on small businesses, defined as establishments with fewer than 20

employees. The impacts were evaluated for potential adverse impacts on small firms and their relative consequences compared with large firms. Of the estimated 147,000 affected establishments, approximately 132,000 (90%), are small businesses. Thus, the impacts shown above for all establishments are also illustrative of the expected impacts on small businesses.

In general, the costs of compliance for any firm will depend on the extent of worker exposures, the extent of current engineering control, work practice and respirator use, and the amount of lead-exposed work being done. For any given lead-exposed activity, work is likely to be done in a similar manner by both large and small firms, with costs proportional to the scale of the project. As noted above, in response to environmental regulations regarding lead removal, larger capital requirements are bringing about some industry rationalization and concentration. However, this development is not threatening the overall competitive structure of the industry. Estimated compliance costs are feasible for both large and small establishments in each affected industry sector.

V. Environmental Impact Analysis

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 at seq.), as implemented by the regulations (40 CFR part 1500) of the Council on Environmental Quality (CEQ), requires that federal agencies assess their regulatory actions to determine if there is a potential for a significant impact on the quality of the human environment and, if necessary, to prepare an environmental impact statement.

In accordance with these requirements and DOL NEPA Compliance Procedures (29 CFR part 11, subpart B, § 11.10(a)(4)), OSHA has determined that this standard will not have any appreciable negative environmental impact. In any event, OSHA also believes that due to the compressed rulemaking schedule imposed by the Congress in issuing the interim regulation, no environmental impact statement will be prepared for this interim rule.

In similar situations, for example, when an emergency temporary standard (ETS) has been issued, the courts have held that NEPA does not require advance preparation of an environmental statement for an ETS (*Dry Color Manufacturing Association* v. *U.S. Department of Labor*; 486 F. 2d 98, 107 [3rd Cir. 1973]). This interim final standard is similar in nature to an ETS, which is issued on an abbreviated schedule and for a relatively brief period. The DOL NEPA regulations set forth in 29 CFR part 11, subpart B, section 11, 10(s)(4), provide that in these situations the regulations set forth in 40 CFR parts 1500 et seq may not be strictly observable.

VI. Federalism and State Plan Applicability

This standard has been reviewed in accordance with Executive Order 12612, 52 FR 41685 (October 30, 1987), regarding Federalism. This Order requires that agencies, to the extent possible, refrain from limiting state policy options, consult with States prior to taking any actions that would restrict State policy options, and take such actions only when there is clear constitutional authority and the presence of a problem of national scope. The Order provides for preemption of State law only if there is a clear Congressional intent for the agency to do so. Any such preemption is to be limited to the extent possible.

Section 18 of the Occupational Safety and Health Act (OSH Act), expresses Congress' clear intent to preempt State laws with respect to which Federal OSHA has promulgated occupational safety or health standards. Under the OSH Act a State can avoid preemption only if it submits, and obtains Federal approval of, a plan for the development of such standards and their enforcement. Occupational safety and health standards developed by such Plan-States must, among other things, be at least as effective as the Federal standards in providing safe and healthful employment and places of employment.

In short, there is a clear national problem related to occupational safety and health for employees exposed to lead in the construction industry. Those States which have elected to participate under section 18 of the OSH Act would not be preempted by this regulation and would be able to deal with special, local conditions within the framework provided by this performance-oriented standard while ensuring that their standards are at least as effective as the Federal standard.

The 25 States with their own OSHA-approved occupational safety and health plans must adopt a comparable standard within six months of publication of a final rule. The States are: Alaska, Arizona, California, Connecticut, Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, Wyoming. For New York and Connecticut, plans cover only state and local government employees. Until such time as a State standard is promulgated, Federal OSHA will provide interim enforcement assistance, as appropriate, in these States.

VII. Date of Effectiveness and Absence of Notice and Comment

Section 1031 of the Housing and Community Development Act specifically provides that the "not later than 180 days after enactment of this Act, the Secretary of Labor shall issue an interim final regulation regulating occupational exposure to lead."

The express use of the phrase "interim final regulation," which in the rulemaking context commonly describes a rule issued without notice and comment, in connection with the extremely limited time frame provided by this section, makes clear that Congress intended this rule to be issued without the time-consuming process of notice and comment. The Agency, therefore, concludes that neither the notice and comment rulemaking provisions of the OSH Act nor those of the Administrative Procedures Act are applicable to the issuance of this interim final rule. This view is further supported in the Act's Legislative Committee report which states that "* * * the procedural requirements of section 6 of the OSH Act do not apply to the promulgation of the interim final regulation," [n]or * * * do the notice and comment provisions of the Administrative procedures Act apply."

VIII. Clearance of Information Collection Requirements

5 CFR part 1320 sets forth procedures for agencies to follow in obtaining OMB clearances for information collection requirements under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 et seq. The lead in construction interim rule requires the employer to allow OSHA access to various records including the employers' compliance and training plans; and the employees' exposure monitoring, medical and training records. In accordance with the provisions of the Paperwork Reduction Act and the regulations issued pursuant thereto, OSHA certifies that it has submitted the information collection requirements of this standard to OMB for review under section 3504(h) of that Act.

Public reporting burden for this collection of information is estimated to average 5 minutes to allow OSHA compliance officers access to the employer's records. Send comments

regarding this burden estimate, or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Information Management, Department of Labor, room N–1301, 200 Constitution Avenue NW., Washington DC, 20210: and to the Office of Management and Budget, Paperwork Reduction Project (Lead Interim Final Rule), Washington, DC, 20503.

IX. Signature

Signed at Washington, DC, this 26 day of April, 1993.

David C. Zeigler,

Acting Assistant Secretary of Labor for Occupational Safety and Health.

Accordingly, 29 CFR part 1926 is amended as follows:

PART 1926—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1. The authority citation for subpart D of 29 CFR part 1926 is amended by adding the following:

Authority: * * * Section 1926.62 issued under sec. 1031 of the Housing and Community Development Act of 1992 (sec. 1031, title X, 106 Stat. 3924 (42 U.S.C. 4853)).

2. By adding a new § 1926.62, with Appendices A, B, C, and D to subpart D to read as follows:

§ 1926.62 Lead

(a) *Scope.* This section applies to all construction work where an employee may be occupationally exposed to lead. All construction work excluded from coverage in the general industry standard for lead by 29 CFR 1910.1025(a)(2) is covered by this standard. Construction work is defined as work for construction, alteration and/or repair, including painting and decorating. It includes but is not limited to the following:

(1) Demolition or salvage of structures where lead or materials containing lead are present;
(2) Removal or encapsulation of materials containing lead;
(3) New construction, alteration, repair, or renovation of structures, substrates, or portions thereof, that contain lead, or materials containing lead;
(4) Installation of products containing lead;
(5) Lead contamination/emergency cleanup;
(6) Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed, and
(7) Maintenance operations associated with the construction activities described in this paragraph.

(b) *Definitions.*

Action level means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 μg/m³) calculated as an 8-hour time-weighted average (TWA).

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Competent person means one who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate them.

Director means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health and Human Services, or designee.

Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

This section means this standard.

(c) *Permissible exposure limit.* (1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 μg/m³) averaged over an 8-hour period.

(2) If an employee is exposed to lead for more than 8 hours in any work day the employees' allowable exposure, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

Allowable employee exposure (in μg/m³)=400 divided by hours worked in the day.

(3) When respirators are used to limit employee exposure as required under paragraph (c) of this section and all the requirements of paragraphs (e)(1) and (f) of this section have been met, employee exposure may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

(d) *Exposure assessment—(1) General.* (i) Each employer who has a workplace or operation covered by this standard shall initially determine if any employee may be exposed to lead at or above the action level.

(ii) For the purposes of paragraph (d) of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(iii) With the exception of monitoring under paragraph (d)(3), where monitoring is required under this section, the employer shall collect personal samples representative of a full shift including at least one sample for each job classification in each work area either for each shift or for the shift with the highest exposure level.

(iv) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

(2) *Protection of employees during assessment of exposure.*

(i) With respect to the lead related tasks listed in paragraph (d)(2)(i) of this section, where lead is present, until the employer performs an employee exposure assessment as required in paragraph (d) of this section and documents that the employee performing any of the listed tasks is not exposed above the PEL, the employer shall treat the employee as if the employee were exposed above the PEL, and not in excess of ten (10) times the PEL, and shall implement employee protective measures prescribed in paragraph (d)(2)(v) of this section. The tasks covered by this requirement are:

(A) Where lead containing coatings or paint are present: Manual demolition of structures (e.g, dry wall), manual scraping, manual sanding, heat gun applications, and power tool cleaning with dust collection systems;

(B) Spray painting with lead paint

(ii) In addition, with regard to tasks not listed in paragraph (d)(2)(i), where the employee has any reason to believe that an employee performing the task may be exposed to lead in excess of the PEL, until the employer performs an employee exposure assessment as required by paragraph (d) of this section and documents that the employee's lead exposure is not above the PEL the employer shall treat the employee as if the employee were exposed above the PEL and shall implememt employee protective measures as prescribed in paragraph (d)(2)(v) of this section.

(iii) With respect to the tasks listed in paragraph (d)(2)(iii) of this section, where lead is present, until the employer performs an employee exposure assessment as required in paragraph (d) of this section, and documents that the employee performing any of the listed tasks is not exposed in excess of 500 μg/m³, the employer shall treat the employee as if the employee were exposed to lead in excess of 500 μg/m³ and shall implement employee protective measures as prescribed in paragraph (d)(2)(v) of this section. Where the employer does establish that the employee is exposed to levels of lead below 500 μg/m³, the employer may

provide the exposed employee with the appropriate respirator prescribed for such use at such lower exposures, in accordance with Table 1 of this section. The tasks covered by this requirement are:

(A) Using lead containing mortar; lead burning

(B) Where lead containing coatings or paint are present: rivet busting; power tool cleaning without dust collection systems; cleanup activities where dry expendable abrasives are used; and abrasive blasting enclosure movement and removal.

(iv) With respect to the tasks listed in paragraph (d)(2)(iv) of this section, where lead is present, until the employer performs an employee exposure assessment as required in paragraph (d) of this section and documents that the employee performing any of the listed tasks is not exposed to lead in excess of 2,500 µg/m^3 (50×PEL), the employer shall treat the employee as if the employee were exposed to lead in excess of 2,500 µg/m^3 and shall implement employee protective measures as prescribed in paragraph (d)(2)(v) of this section. Where the employer does establish that the employee is exposed to levels of lead below 2,500 µg/m3, the employer may provide the exposed employee with the appropriate respirator prescribed for use at such lower exposures, in accordance with Table I of this section. Interim protection as described in this paragaraph is required where lead containing coatings or paint are present on structures when performing:

(A) Abrasive blasting,

(B) Welding,

(C) Cutting, and

(D) Torch burning.

(v) Until the employer performs an employee exposure assessment as required under paragraph (d) of this section and determines actual employee exposure, the employer shall provide to employees performing the tasks described in paragraphs (d)(2)(i), (d)(2)(ii), (d)(2)(iii), and (d)(2)(iv) of this section with interim protection as follows:

(A) Appropriate respiratory protection in accordance with paragraph (f) of this section.

(B) Appropriate personal protective clothing and equipment in accordance with paragraph (g) of this section.

(C) Change areas in accordance with paragraph (i)(2) of this section.

(D) Hand washing facilities in accordance with paragraph (i)(5) of this section.

(E) Biological monitoring in accordance with paragraph (j)(1)(i) of this section, to consist of blood sampling and analysis for lead and zinc protoporphyrin levels, and

(F) Training as required under paragraph (l)(1)(i) of this section regarding 29 CFR 1926.59, Hazard Communication; training as required under paragraph (l)(2)(ii)(C) of this section, regarding use of respirators; and training in accordance with 29 CFR 1926.21, Safety training and education.

(3) *Basis of initial determination.* (i) Except as provided under paragraphs (d)(3)(iii) and (d)(3)(iv) of this section the employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

(A) Any information, observations, or calculations which would indicate employee exposure to lead;

(B) Any previous measurements of airborne lead; and

(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

(ii) Monitoring for the initial determination where performed may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

(iii) Where the employer has previously monitored for lead exposures, and the data were obtained within the past 12 months during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraphs (d)(3)(i) and (d)(6) of this section if the sampling and analytical methods meet the accuracy and confidence levels of paragraph (d)(10) of this section.

(iv) Where the employer has objective data, demonstrating that a particular product or material containing lead or a specific process, operation or activity involving lead cannot result in employee exposure to lead at or above the action level during processing, use, or handling, the employer may rely upon such data instead of implementing initial monitoring.

(A) The employer shall establish and maintain an accurate record documenting the nature and relevancy of objective data as specified in paragraph (n)(4) of this section, where used in assessing employee exposure in lieu of exposure monitoring.

(B) Objective data, as described in paragraph (d)(3)(iv) of this section, is not permitted to be used for exposure assessment in connection with paragraph (d)(2) of this section.

(4) *Positive initial determination and initial monitoring.*

(i) Where a determination conducted under paragraphs (d) (1), (2) and (3) of this section shows the possibility of any employee exposure at or above the action level the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

(ii) Where the employer has previously monitored for lead exposure, and the data were obtained within the past 12 months during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraph (d)(4)(i) of this section if the sampling and analytical methods meet the accuracy and confidence levels of paragraph (d)(10) of this section.

(5) *Negative initial determination.* Where a determination, conducted under paragraphs (d) (1), (2), and (3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3)(i) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

(6) *Frequency.* (i) If the initial determination reveals employee exposure to be below the action level further exposure determination need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

(ii) If the initial determination or subsequent determination reveals employee exposure to be at or above the action level but at or below the PEL the employer shall perform monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(iii) If the initial determination reveals that employee exposure is above the PEL the employer shall perform

monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are at or below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii) of this section, except as otherwise provided in paragraph (d)(7) of this section. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

(7) *Additional exposure assessments.* Whenever there has been a change of equipment, process, control, personnel or a new task has been initiated that may result in additional employees being exposed to lead at or above the action level or may result in employees already exposed at or above the action level being exposed above the PEL, the employer shall conduct additional monitoring in accordance with this paragraph.

(8) *Employee notification.* (i) Within 5 working days after completion of the exposure assessment the employer shall notify each employee in writing of the results which represent that employee's exposure.

(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, is at or above the PEL the employer shall include in the written notice a statement that the employees exposure was at or above that level and a description of the corrective action taken or to be taken to reduce exposure to below that level.

(9) *Accuracy of measurement.* The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 25 percent for airborne concentrations of lead equal to or greater than 30μg/m³.

(e) *Methods of compliance* (1) *Engineering and work practice controls.* The employer shall implement engineering and work practice controls, including administrative controls, to reduce and maintain employee exposure to lead to or below the permissible exposure limit to the extent that such controls are feasible. Wherever all feasible engineering and work practices controls that can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit prescribed in paragraph (c) of this section, the employer shall nonetheless use them to reduce employee exposure to the lowest feasible level and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (f) of this section.

(2) *Compliance program.* (i) Prior to commencement of the job each employer shall establish and implement a written compliance program to achieve compliance with paragraph (c) of this section.

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each activity in which lead is emitted; e.g. equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;

(B) A description of the specific means that will be employed to achieve compliance and, where engineering controls are required engineering plans and studies used to determine methods selected for controlling exposure to lead;

(C) A report of the technology considered in meeting the PEL;

(D) Air monitoring data which documents the source of lead emissions;

(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this section and incorporates other relevant work practices such as those specified in paragraph (e)(5) of this section;

(G) An administrative control schedule required by paragraph (e)(4) of this section, if applicable;

(H) A description of arrangements made among contractors on multi-contractor sites with respect to informing affected employees of potential exposure to lead and with respect to responsibility for compliance with this section as set-forth in § 1926.16.

(I) Other relevant information.

(iii) The compliance program shall provide for frequent and regular inspections of job sites, materials, and equipment to be made by a competent person.

(iv) Written programs shall be submitted upon request to any affected employee or authorized employee representatives, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary and the Director.

(v) Written programs shall be revised and updated at least every 6 months to reflect the current status of the program.

(3) *Mechanical ventilation.* When ventilation is used to control lead exposure, the employer shall evaluate the mechanical performance of the system in controlling exposure as necessary to maintain its effectiveness.

(4) *Administrative controls.* If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

(i) Name or identification number of each affected employee;

(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

(5) The employer shall ensure that, to the extent relevant, employees follow good work practices such as described in Appendix B of this section.

(f) *Respiratory protection*—(1) *General.* Where the use of respirators is required under this section the employer shall provide, at no cost to the employee, and assure the use of respirators which comply with the requirements of this paragraph. Respirators shall be used in the following circumstances:

(i) Whenever an employee's exposure to lead exceeds the PEL;

(ii) In work situations in which engineering controls and work practices are not sufficient to reduce exposures to or below the PEL;

(iii) Whenever an employee requests a respirator; and

(iv) An interim protection for employees performing tasks as specified in paragraph (d)(2) of this section.

(2) *Respirator selection.* (i) Where respirators are used under this section the employer shall select the appropriate respirator or combination of respirators from Table I below.

(ii) The employer shall provide a powered, air-purifying respirator in lieu of the respirator specified in Table I whenever:

(A) An employee chooses to use this type of respirator; and (B) This respirator will provide adequate protection to the employee.

(iii) The employer shall select respirators from among those approved for protection against lead dust, fume, and mist by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR part 11.

TABLE I.—RESPIRATORY PROTECTION FOR LEAD AEROSOLS

Airborne concentration of lead or condition of use	Required respirator [1]
Not in excess of 500 µg/m³.	• ½ mask air purifying respirator with high efficiency filters.[2, 3] • ½ mask supplied air respirator operated in demand (negative pressure) mode.
Not in excess of 1,250 µg/m³.	• Loose fitting hood or helmet powered air purifying respirator with high efficiency filters.[3] • Hood or helmet supplied air respirator operated in a continuous-flow mode—e.g., type CE abrasive blasting respirators operated in a continuous-flow mode.
Not in excess of 2,500 µg/m³.	• Full facepiece air purifying respirator with high efficiency filters.[3] • Tight fitting powered air purifying respirator with high efficiency filters.[3] • Full facepiece supplied air respirator operated in demand mode. • ½ mask or full facepiece supplied air respirator operated in a continuous-flow mode. • Full facepiece self-contained breathing apparatus (SCBA) operated in demand mode.
Not in excess of 50,000 µg/m³.	• ½ mask supplied air respirator operated in pressure demand or other positive-pressure mode.
Not in excess of 100,000 µg/m³.	• Full facepiece supplied air respirator operated in pressure demand or other positive-pressure mode—e.g., type CE abrasive blasting respirators operated in a positive-pressure mode.
Greater than 100,000 µg/m³ unknown concentration, or fire fighting.	• Full facepiece SCBA operated in pressure demand or other positive-pressure mode.

[1] Respirators specified for higher concentrations can be used at lower concentrations of lead.

[2] Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

[3] A high efficiency particulate filter (HEPA) means a filter that is 99.97 percent efficient against particles of 0.3 micron size or larger.

(3) *Respirator usage.* (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) Employers shall perform either quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter for each employee wearing negative pressure respirators. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, and shall be conducted in accordance with appendix D of this section. The tests shall be used to select facepieces that provide the required protection as prescribed in Table I.

(iii) If an employee exhibits difficulty in breathing during the fitting test or during use, the employer shall make available to the employee an examination in accordance with paragraph (j)(3)(i)(B) of this section to determine whether the employee can wear a respirator while performing the required duty.

(4) *Respirator program.* (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e) and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator facepiece whenever necessary to prevent skin irritation associated with respirator use.

(g) *Protective work clothing and equipment*—(1) *Provision and use.* Where an employee is exposed to lead above the PEL without regard to the use of respirators, where employees are exposed to lead compounds which may cause skin or eye irritation (e.g. lead arsenate, lead azide), and as interim protection for employees performing tasks as specified in paragraph (d)(2) of this section, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment that prevents contamination of the employee and the employee's garments such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

(ii) Gloves, hats, and shoes or disposable shoe coverlets; and

(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with § 1910.133 of this chapter.

(2) *Cleaning and replacement.* (i) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 µg/m³ of lead as an 8-hour TWA.

(ii) The employer shall provide for the cleaning, laundering, and disposal of protective clothing and equipment required by paragraph (g)(1) of this section.

(iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change areas provided for that purpose as prescribed in paragraph (i)(2) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change area which prevents dispersion of lead outside the container.

(vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.

(vii) The employer shall assure that the containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) of this section are labelled as follows:

Caution: Clothing contaminated with lead. Do not remove dust by blowing or shaking. Dispose of lead contaminated wash water in accordance with applicable local, state, or federal regulations.

(viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or

any other means which disperses lead into the air.

(h) *Housekeeping*—(1) All surfaces shall be maintained as free as practicable of accumulations of lead.

(2) Clean-up of floors and other surfaces where lead accumulates shall wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of lead becoming airborne.

(3) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

(4) Where vacuuming methods are selected, the vacuums shall be equipped with HEPA filters and used and emptied in a manner which minimizes the reentry of lead into the workplace.

(5) Compressed air shall not be used to remove lead from any surface unless the compressed air is used in conjunction with a ventilation system designed to capture the airborne dust created by the compressed air.

(i) *Hygiene facilities and practices.* (1) The employer shall assure that in areas where employees are exposed to lead above the PEL without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied.

(2) *Change areas.* (i) The employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL, and as interim protection for employees performing tasks as specified in paragraph (d)(2) of this section, without regard to the use of respirators.

(ii) The employer shall assure that change areas are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

(iii) The employer shall assure that employees do not leave the workplace wearing any protective clothing or equipment that is required to be worn during the work shift.

(3) *Showers.* (i) The employer shall provide shower facilities, where feasible, for use by employees whose airborne exposure to lead is above the PEL.

(ii) The employer shall assure, where shower facilities are available, that employees shower at the end of the work shift and shall provide an adequate supply of cleansing agents and towels for use by affected employees.

(4) *Eating facilities.* (i) The employer shall provide lunchroom facilities or eating areas for employees whose airborne exposure to lead is above the PEL, without regard to the use of respirators.

(ii) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination and are readily accessible to employees.

(iii) The employer shall assure that employees whose airborne exposure to lead is above the PEL, without regard to the use of a respirator, wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

(iv) The employer shall assure that employees do not enter lunchroom facilities or eating areas with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth, or other cleaning method that limits dispersion of lead dust.

(5) *Hand washing facilities.* (i) The employer shall provide adequate handwashing facilities for use by employees exposed to lead in accordance with 29 CFR 1926.51(f).

(ii) Where showers are not provided the employer shall assure that employees wash their hands and face at the end of the work-shift.

(j) *Medical surveillance*—(1) *General.* (i) The employer shall make available initial medical surveillance to employees occupationally exposed on any day to lead at or above the action level. Initial medical surveillance consists of biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels.

(ii) The employer shall institute a medical surveillance program in accordance with paragraphs (j)(2) and (j)(3) of this section for all employees who are or may be exposed by the employer at or above the action level for more than 30 days in any consecutive 12 months;

(iii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

(iv) The employer shall make available the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.

(2) *Biological monitoring*—(i) *Blood lead and ZPP level sampling and analysis.* The employer shall make available biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels to each employee covered under paragraphs (j)(1)(i) and (ii) of this section on the following schedule:

(A) For each employee covered under paragraph (j)(1)(ii) of this section, at least every 2 months for the first 6 months and every 6 months thereafter;

(B) For each employee covered under paragraphs (j)(1) (i) or (ii) of this section whose last blood sampling and analysis indicated a blood lead level at or above 40 µg/dl, at least every two months. This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead level below 40 µg/dl; and

(C) For each employee who is removed from exposure to lead due to an elevated blood lead level at least monthly during the removal period.

(ii) *Follow-up blood sampling tests.* Whenever the results of a blood lead level test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i) of this section, the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

(iii) *Accuracy of blood lead level sampling and analysis.* Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 µg/dl, whichever is greater, and shall be conducted by a laboratory approved by OSHA.

(iv) *Employee notification.* (A) Within five working days after the receipt of biological monitoring results, the employer shall notify each employee in writing of his or her blood lead level; and

(B) the employer shall notify each employee whose blood lead level exceeds 40 µg/dl that the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i) of this section.

(3) *Medical examinations and consultations*—(i) *Frequency.* The employer shall make available medical examinations and consultations to each employee covered under paragraph (j)(1)(ii) of this section on the following schedule:

(A) At least annually for each employee for whom a blood sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 µg/dl;

(B) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to

lead on the employee's ability to procreate a healthy child, that the employee is pregnant, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use; and

(C) As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.

(ii) *Content.* The content of medical examinations made available pursuant to paragraph (j)(3)(i)(B)–(C) of this section shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility. Medical examinations made available pursuant to paragraph (j)(3)(i)(A) of this section shall include the following elements:

(A) A detailed work history and a medical history, with particular attention to past lead exposure (occupational and non-occupational), personal habits (smoking, hygiene), and past gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems;

(B) A thorough physical examination, with particular attention to teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems. Pulmonary status should be evaluated if respiratory protection will be used;

(C) A blood pressure measurement;

(D) A blood sample and analysis which determines:

(*1*) Blood lead level;

(*2*) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral smear morphology;

(*3*) Zinc protoporphyrin;

(*4*) Blood urea nitrogen; and,

(*5*) Serum creatinine;

(E) A routine urinalysis with microscopic examination; and

(F) Any laboratory or other test relevant to lead exposure which the examining physician deems necessary by sound medical practice.

(iii) *Multiple physician review mechanism.* (A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

(*1*) To review any findings, determinations or recommendations of the initial physician; and

(*2*) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

(*1*) The employee informing the employer that he or she intends to seek a second medical opinion, and

(*2*) The employee initiating steps to make an appointment with a second physician.

(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.

(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

(*1*) To review any findings, determinations or recommendations of the prior physicians; and

(*2*) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

(E) The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

(iv) *Information provided to examining and consulting physicians.* (A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

(*1*) A copy of this regulation for lead including all Appendices;

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

(*3*) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);

(*4*) A description of any personal protective equipment used or to be used;

(*5*) Prior blood lead determinations; and

(*6*) All prior written medical opinions concerning the employee in the employer's possession or control.

(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

(v) *Written medical opinions.* (A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician which contains only the following information:

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

(*2*) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

(*3*) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator; and

(*4*) The results of the blood lead determinations.

(B) The employer shall instruct each examining and consulting physician to:

(*1*) Not reveal either in the written opinion or orally, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

(*2*) Advise the employee of any medical condition, occupational or nonoccupational, which dictates further medical examination or treatment.

(vi) *Alternate physician determination mechanisms.* The employer and an employee or authorized employee representative may agree upon the use of any alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by paragraph (j)(3)(iii) of this section so long as the alternate mechanism is as expeditious and protective as the requirements contained in this paragraph.

(4) *Chelation.* (i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.

(ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i) of this section, the employer shall assure that

it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing prior to its occurrence.

(k) *Medical removal protection*—(1) *Temporary medical removal and return of an employee*—(i) *Temporary removal due to elevated blood lead level.* The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 50 μg/dl; and,

(ii) *Temporary removal due to a final medical determination.* (A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the phrase "final medical determination" means the written medical opinion on the employees' health status by the examining physician or, where relevant, the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section.

(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

(iii) *Return of the employee to former job status.* (A) The employer shall return an employee to his or her former job status:

(*1*) For an employee removed due to a blood lead level at or above 50 μg/dl when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40 μg/dl;

(*2*) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(B) For the purposes of this section, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

(iv) *Removal of other employee special protective measure or limitations.* The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

(v) *Employer options pending a final medical determination.* Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

(A) *Removal.* The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.

(B) *Return.* The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions.

If (*1*) the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or;

(*2*) If the employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

(2) *Medical removal protection benefits*—(i) *Provision of medical removal protection benefits.* The employer shall provide an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.

(ii) *Definition of medical removal protection benefits.* For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that, as long as the job the employee was removed from continues, the employer shall maintain the total normal earnings, seniority and other employment rights and benefits of an employee, including the employee's right to his or her former job status as though the employee had not been medically removed from the employee's job or otherwise medically limited.

(iii) *Follow-up medical surveillance during the period of employee removal or limitation.* During the period of time that an employee is medically removed from his or her job or otherwise medically limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.

(iv) *Workers' compensation claims.* If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment-related expenses.

(v) *Other credits.* The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

(vi) *Voluntary removal or restriction of an employee.* Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee

equal to that required by paragraph (k)(2) (i) and (ii) of this section.

(l) *Employee information and training*—(1) *General* (i) The employer shall communicate information concerning lead hazards according to the requirements of OSHA's Hazard Communication Standard for the construction industry, 29 CFR 1926.59, including but not limited to the requirements concerning warning signs and labels, material safety data sheets (MSDS), and employee information and training. In addition, employers shall comply with the following requirements:

(ii) For all employees who are subject to exposure to lead at or above the action level on any day or who are subject to exposure to lead compounds which may cause skin or eye irritation (e.g. lead arsenate, lead azide), the employer shall provide a training program in accordance with paragraph (l)(2) of this section and assure employee participation.

(iii) The employer shall provide the training program as initial training prior to the time of job assignment or prior to the start up date for this requirement, whichever comes last.

(iv) The employer shall also provide the training program at least annually for each employee who is subject to lead exposure at or above the action level on any day.

(2) *Training program.* The employer shall assure that each employee is trained in the following:

(i) The content of this standard and its appendices;

(ii) The specific nature of the operations which could result in exposure to lead above the action level;

(iii) The purpose, proper selection, fitting, use, and limitations of respirators;

(iv) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females and hazards to the fetus and additional precautions for employees who are pregnant);

(v) The engineering controls and work practices associated with the employee's job assignment including training of employees to follow relevant good work practices described in Appendix B of this section;

(vi) The contents of any compliance plan in effect;

(vii) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician; and

(viii) The employee's right of access to records under 29 CFR 1910.20.

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

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

(m) *Signs—(1) General.* (i) The employer may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign required by this paragraph which contradicts or detracts from the meaning of the required sign.

(2) *Signs.* (i) The employer shall post the following warning signs in each work area where an employees exposure to lead is above the PEL.

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(n) *Recordkeeping*—(1) *Exposure assessment.* (i) The employer shall establish and maintain an accurate record of all monitoring and other data used in conducting employee exposure assessments as required in paragraph (d) of this section.

(ii) Exposure monitoring records shall include:

(A) The date(s), number, duration, location and results of each of the samples taken if any, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of employee exposure.

(iii) The employer shall maintain monitoring and other exposure assessment records in accordance with the provisions of 29 CFR 1910.20.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

(ii) This record shall include:

(A) The name, social security number, and description of the duties of the employee;

(B) A copy of the physician's written opinions;

(C) Results of any airborne exposure monitoring done on or for that employee and provided to the physician; and

(D) Any employee medical complaints related to exposure to lead.

(iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

(A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;

(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

(C) A copy of the results of biological monitoring.

(iv) The employer shall maintain or assure that the physician maintains medical records in accordance with the provisions of 29 CFR 1910.20.

(3) *Medical removals.* (i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.

(ii) Each record shall include:

(A) The name and social security number of the employee;

(B) The date of each occasion that the employee was removed from current exposure to lead as well as the corresponding date on which the employee was returned to his or her former job status;

(C) A brief explanation of how each removal was or is being accomplished; and

(D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.

(iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

(4) *Objective data for exemption from requirement for initial monitoring.* (i) For purposes of this section, objective data are information demonstrating that a particular product or material containing lead or a specific process, operation, or activity involving lead cannot release dust or fumes in concentrations at or above the action level under any expected conditions of

use. Objective data can be obtained from an industry-wide study or from laboratory product test results from manufacturers of lead containing products or materials. The data the employer uses from an industry-wide survey must be obtained under workplace conditions closely resembling the processes, types of material, control methods, work practices and environmental conditions in the employer's current operations.

(ii) The employer shall maintain the record of the objective data relied upon for at least 30 years.

(5) *Availability.* The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to affected employees, former employees, and their designated representatives, and to the Assistant Secretary and the Director for examination and copying.

(6) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if requested within the period.

(iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).

(o) *Observation of monitoring.* (1) Employee observation. The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing and equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to:

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(p) *Effective date.* This standard (§ 1926.62) shall become effective June 3, 1993.

(q) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(r) *Startup dates.* (1) The requirements of paragraphs (c) through (o) of this section, including administrative controls and feasible work practice controls, but not including engineering controls specified in paragraph (e)(1) of this section, shall be complied with as soon as possible, but no later than 60 days from the effective date of this section.

(2) Feasible engineering controls specified by paragraph (e)(1) of this section shall be implemented as soon as possible, but no later than 120 days from the effective date of this section.

Appendix A to § 1926.62—Substance Data Sheet for Occupational Exposure to Lead

I. Substance Identification

A. *Substance*: Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds covered by the standard*: The word "lead" when used in this interim final standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses*: Exposure to lead occurs in several different occupations in the construction industry, including demolition or salvage of structures where lead or lead-containing materials are present; removal or encapsulation of lead-containing materials, new construction, alteration, repair, or renovation of structures that contain lead or materials containing lead; installation of products containing lead. In addition, there are construction related activities where exposure to lead may occur, including transportation, disposal, storage, or containment of lead or materials containing lead on construction sites, and maintenance operations associated with construction activities.

D. *Permissible exposure*: The permissible exposure limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 $\mu g/m^3$), averaged over an 8-hour workday.

E. *Action level*: The interim final standard establishes an action level of 30 micrograms of lead per cubic meter of air (30 $\mu g/m^3$), averaged over an 8-hour workday. The action level triggers several ancillary provisions of the standard such as exposure monitoring, medical surveillance, and training.

II. Health Hazard Data

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses, lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed. Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion. A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. *Effects of overexposure to lead*—(1) *Short term (acute) overexposure.* Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) *Long-term (chronic) overexposure.* Chronic overexposure to lead may result in severe damage to your blood-forming,

nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain. Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy. Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible. Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood. Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) *Health protection goals of the standard.* Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that a worker's blood lead level (BLL, also expressed as PbB) be maintained at or below forty micrograms per deciliter of whole blood (40 µg/dl). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 µg/dl to minimize adverse reproductive health effects to the parents and to the developing fetus. The measurement of your blood lead level (BLL) is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels are most often reported in units of milligrams (mg) or micrograms (µg) of lead (1 mg=1000 µg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime BLLs are expressed in the form of mg% or µg%. This is a shorthand notation for 100g, 100 ml, or dl. (References to BLL measurements in this standard are expressed in the form of µg/dl.)

BLL measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. BLL measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between BLLs and various diseases. As a result, your BLL is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 µg/dl, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular BLL in a given person will cause a particular effect. Studies have associated fatal encephalopathy with BLLs as low as 150 µg/dl. Other studies have shown other forms of diseases in some workers with BLLs well below 80 µg/dl. Your BLL is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated BLLs. The longer you have an elevated BLL, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage. The best way to prevent all forms of lead-related impairments and diseases—both short term and long term—is to maintain your BLL below 40 µg/dl. The provisions of the standard are designed with this end in mind.

Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You, as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his or her actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead or your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases, your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place. The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if your employer selected the initial physician.

Appendix B to § 1926.62—Employee Standard Summary

This appendix summarizes key provisions of the interim final standard for lead in construction that you as a worker should become familiar with.

I. Permissible Exposure Limit (PEL)—Paragraph (C)

The standard sets a permissible exposure limit (PEL) of 50 micrograms of lead per cubic meter of air (50 µg/m^3), averaged over an 8-hour workday which is referred to as a time-weighted average (TWA). This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. However, since this is an 8-hour average, short exposures above the PEL are permitted so long as for each 8-hour work day your average exposure does not exceed this level. This interim final standard, however, takes into account the fact that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this situation, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 µg/m^3.

II. Exposure Assessment—Paragraph (D)

If lead is present in your workplace in any quantity, your employer is required to make an initial determination of whether any employee's exposure to lead exceeds the action level (30 µg/m^3 averaged over an 8-hour day). Employee exposure is that exposure which would occur if the employee were not using a respirator. This initial determination requires your employer to monitor workers' exposures unless he or she has objective data which can demonstrate conclusively that no employee will be exposed to lead in excess of the action level. Where objective data is used in lieu of actual monitoring the employer must establish and maintain an accurate record, documenting its relevancy in assessing exposure levels for current job conditions. If such objective data is available, the employer need proceed no further on employee exposure assessment until such time that conditions have changed and the determination is no longer valid.

Objective data may be compiled from various sources, e.g., insurance companies and trade associations and information from suppliers or exposure data collected from similar operations. Objective data may also comprise previously-collected sampling data including area monitoring. If it cannot be determined through using objective data that worker exposure is less than the action level, your employer must conduct monitoring or must rely on relevant previous personal sampling, if available. Where monitoring is

required for the initial determination, it may be limited to a representative number of employees who are reasonably expected to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past 12 months, he or she may use these results, provided they are applicable to the same employee tasks and exposure conditions and meet the requirements for accuracy as specified in the standard. As with objective data, if such results are relied upon for the initial determination, your employer must establish and maintain a record as to the relevancy of such data to current job conditions.

If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination.

If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level, your employer must set up an air monitoring program to determine the exposure level representative of each employee exposed to lead at your workplace. In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he or she must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represent full shift exposure. In addition, these air samples must be taken under conditions which represent each employee's regular, daily exposure to lead. Sampling performed in the past 12 months may be used to determine exposures above the action level if such sampling was conducted during work activities essentially similar to present work conditions.

The standard lists certain tasks which may likely result in exposures to lead in excess of the PEL and, in some cases, exposures in excess of 50 times the PEL. If you are performing any of these tasks, your employer must provide you with appropriate respiratory protection, protective clothing and equipment, change areas, hand washing facilities, biological monitoring, and training until such time that an exposure assessment is conducted which demonstrates that your exposure level is below the PEL.

If you are exposed to lead and air sampling is performed, your employer is required to notify you in writing within 5 working days of the air monitoring results which represent your exposure. If the results indicate that your exposure exceeds the PEL (without regard to your use of a respirator), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that has been taken or will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring, at least every six months if your exposure is at or over the action level but below the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least 7 days apart, are at or below the action level. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer must continue monitoring for you at this frequency until 2 consecutive measurements, taken at least 7 days apart, are below the PEL but above the action level, at which time your employer must repeat monitoring of your exposure every six months and may discontinue monitoring only after your exposure drops to or below the action level. However, whenever there is a change of equipment, process, control, or personnel or a new type of job is added at your workplace which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. Methods of Compliance—Paragraph (E)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL as an 8-hour TWA. The interim final standard for lead in construction requires employers to institute engineering and work practice controls including administrative controls to the extent feasible to reduce employee exposure to lead. Where such controls are feasible but not adequate to reduce exposures below the PEL they must be used nonetheless to reduce exposures to the lowest level that can be accomplished by these means and then supplemented with appropriate respiratory protection.

Your employer is required to develop and implement a written compliance program prior to the commencement of any job where employee exposures may reach the PEL as an 8-hour TWA. The interim final standard identifies the various elements that must be included in the plan. For example, employers are required to include a description of operations in which lead is emitted, detailing other relevant information about the operation such as the type of equipment used, the type of material involved, employee job responsibilities, operating procedures and maintenance practices. In addition, your employer's compliance plan must specify the means that will be used to achieve compliance and, where engineering controls are required, include any engineering plans or studies that have been used to select the control methods. If administrative controls involving job rotation are used to reduce employee exposure to lead, the job rotation schedule must be included in the compliance plan. The plan must also detail the type of protective clothing and equipment, including respirators, housekeeping and hygiene practices that will be used to protect you from the adverse effects of exposure to lead.

The written compliance program must be made available, upon request, to affected employees and their designated representatives, the Assistant Secretary and the Director.

Finally, the plan must be reviewed and updated at least every 6 months to assure it reflects the current status in exposure control.

IV. Respiratory Protection—Paragraph (F)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level is not above the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the types listed in Table I of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, your employer must give you either a qualitative fit test or a quantitative fit test (if you use a negative pressure respirator) in accordance with appendix D. Any respirator which has a filter, cartridge or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air through the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the amount, if any, of test material that leaks into the facepiece of your respirator.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

Your employer must test the effectiveness of your negative pressure respirator initially

and at least every six months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you can, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. Protective Work Clothing and Equipment—Paragraph (G)

If you are exposed to lead above the PEL as an 8-hour TWA, without regard to your use of a respirator, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu g/m^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. In addition, your employer is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment.

The interim final standard requires that your employer assure that you follow good work practices when you are working in areas where your exposure to lead may exceed the PEL. With respect to protective clothing and equipment, where appropriate, the following procedures should be observed prior to beginning work:

1. Change into work clothing and shoe covers in the clean section of the designated changing areas;
2. Use work garments of appropriate protective gear, including respirators before entering the work area; and
3. Store any clothing not worn under protective clothing in the designated changing area.

Workers should follow these procedures upon leaving the work area:

1. HEPA vacuum heavily contaminated protective work clothing while it is still being worn. At no time may lead be removed from protective clothing by any means which result in uncontrolled dispersal of lead into the air;
2. Remove shoe covers and leave them in the work area;
3. Remove protective clothing and gear in the dirty area of the designated changing area. Remove protective coveralls by carefully rolling down the garment to reduce exposure to dust.
4. Remove respirators last; and
5. Wash hands and face.

Workers should follow these procedures upon finishing work for the day (in addition to procedures described above):

1. Where applicable, place disposal coveralls and shoe covers with the abatement waste;
2. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room.
3. Clean protective gear, including respirators, according to standard procedures;
4. Wash hands and face again. If showers are available, take a shower and wash hair. If shower facilities are not available at the work site, shower immediately at home and wash hair.

VI. Housekeeping—Paragraph (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is generally prohibited unless removal with compressed air is done in conjunction with ventilation systems designed to contain dispersal of the lead dust. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used equipped with a special filter called a high-efficiency particulate air (HEPA) filter and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. Hygiene Facilities and Practices—Paragraph (I)

The standard requires that hand washing facilities be provided where occupational exposure to lead occurs. In addition, change areas, showers (where feasible), and lunchrooms or eating areas are to be made available to workers exposed to lead above the PEL. Your employer must assure that except in these facilities, food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, where airborne exposures are above the PEL. Change rooms provided by your employer must be equipped with separate storage facilities for your protective clothing and equipment and street clothes to avoid cross-contamination. After showering, no required protective clothing or equipment worn during the shift may be worn home. It is important that contaminated clothing or equipment be removed in change areas and not be worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc.

Lunchrooms or eating areas may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. Medical Surveillance—Paragraph (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability-regardless of whether you are a man or woman.

All medical surveillance required by the interim final standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—periodic biological monitoring and medical examinations. Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Full medical surveillance must be made available to all employees who are or may be exposed to lead in excess of the action level for more than 30 days a year and whose blood lead level exceeds 40 µg/dl. Initial medical surveillance consisting of blood sampling and analysis for lead and zinc protoporphyrin must be provided to all employees exposed at any time (1 day) above the action level.

Biological monitoring under the standard must be provided at least every 2 months for the first 6 months and every 6 months thereafter until your blood lead level is below 40 µg/dl. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an adverse metabolic effect of lead on your body and is therefore an indicator of lead toxicity.

If your BLL exceeds 40 µg/dl the monitoring frequency must be increased from

every 6 months to at least every 2 months and not reduced until two consecutive BLLs indicate a blood lead level below 40 µg/dl. Each time your BLL is determined to be over 40 µg/dl, your employer must notify you of this in writing within five working days of his or her receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your BLL exceeds 50 µg/dl. (See Discussion of Medical Removal Protection-Paragraph (k).) Anytime your BLL exceeds 50 µg/dl your employer must make available to you within two weeks of receipt of these test results a second follow-up BLL test to confirm your BLL. If the two tests both exceed 50 µg/dl, and you are temporarily removed, then your employer must make successive BLL tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 µg/dl at any time during the preceding year and you are being exposed above the airborne action level of 30 µg/m³ for 30 or more days per year. The initial examination will provide information to establish a baseline to which subsequent data can be compared.

An initial medical examination to consist of blood sampling and analysis for lead and zinc protoporphyrin must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level at any time. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history; (2) a thorough physical examination, including an evaluation of your pulmonary status if you will be required to use a respirator; (3) a blood pressure measurement; and (4) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism which will give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you are dissatisfied with an examination by a physician chosen by your employer, you can select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard-unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to occupational lead exposure, (3) your exposure level or anticipated exposure level, (4) a description of any personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the interim lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca Na2 EDTA), Calcium Disodium Versenate (Versenate), and d-penicillamine (pencillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be "safe". It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. Medical Removal Protection—Paragraph (K)

Excessive lead absorption subjects you to increased risk of disease. Medical removal

protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. For up to 18 months, or for as long as the job the employee was removed from lasts, protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires.

You may also be removed from exposure even if your blood lead level is below 50 µg/dl if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

X. Employee Information and Training—Paragraph (L)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead compounds such as lead arsenate or lead azide. The program must train these employees regarding the specific hazards associated with their work environment, protective measures which can be taken, including the contents of any compliance plan in effect, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. All employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter unless further exposure above the action level will not occur.

XI. Signs—Paragraph (M)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

These signs are to be posted and maintained in a manner which assures that the legend is readily visible.

XII. Recordkeeping—Paragraph (N)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytical techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Such records are to be retained for at least 30 years. Your employer is also required to keep all records of biological monitoring and medical examination results. These records must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. Medical records must be preserved and maintained for the duration of employment plus 30 years. However, if the employee's duration of employment is less than one year, the employer need not retain that employee's medical records beyond the period of employment if they are provided to the employee upon termination of employment.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than BLL's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

XIII. Observation of Monitoring—Paragraph (O)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. Effective Date—Paragraph (P)

The standard's effective date is June 3, 1993. Employer obligations under the standard begin as of that date with full implementation of engineering controls as soon as possible but no later than within 4

months, and all other provisions completed as soon as possible, but no later than within 2 months from the effective date.

XV. For Additional Information

A. A copy of the interim standard for lead in construction can be obtained free of charge by calling or writing the OSHA Office of Publications, room N-3101, United States Department of Labor, Washington, DC 20210: Telephone (202) 219-4667.

B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

Appendix C to § 1926.62—Medical Surveillance Guidelines

Introduction

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The interim final occupational health standard for lead in construction is designed to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this interim final standard occupational exposure to inorganic lead is to be limited to 50 $\mu g/m^3$ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This permissible exposure limit (PEL) must be achieved through a combination of engineering, work practice and administrative controls to the extent feasible. Where these controls are in place but are found not to reduce employee exposures to or below the PEL, they must be used nonetheless, and supplemented with respirators to meet the 50 $\mu g/m^3$ exposure limit.

The standard also provides for a program of biological monitoring for employees exposed to lead above the action level at any time, and additional medical surveillance for all employees exposed to levels of inorganic lead above 30 $\mu g/m^3$ (TWA) for more than 30 days per year and whose BLL exceeds 40 $\mu g/dl$.

The purpose of this document is to outline the medical surveillance provisions of the interim standard for inorganic lead in construction, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead, including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

I. Medical Surveillance and Monitoring Requirements for Workers Exposed to Inorganic Lead

Under the interim final standard for inorganic lead in the construction industry, initial medical surveillance consisting of biological monitoring to include blood lead and ZPP level determination shall be provided to employees exposed to lead at or above the action level on any one day. In addition, a program of biological monitoring is to be made available to all employees exposed above the action level at any time and additional medical surveillance is to be made available to all employees exposed to lead above 30 $\mu g/m^3$ TWA for more than 30 days each year and whose BLL exceeds 40 $\mu g/dl$. This program consists of periodic blood sampling and medical evaluation to be performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead level (BLL) of all employees who are exposed to lead above 30 $\mu g/m^3$ for more than 30 days per year or whose blood lead is above 40 $\mu g/dl$ but exposed for no more than 30 days per year is to be determined at least every two months for the first six months of exposure and every six months thereafter. The frequency is increased to every two months for employees whose last blood lead level was 40 $\mu g/dl$ or above. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee exposed above 30 $\mu g/m^3$ for more than 30 days per year for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 $\mu g/dl$. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the 30 $\mu g/m^3$ for more than 30 days per year. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead.

Under the standard's ultimate worker removal criteria, a worker is to be removed from any work having an eight hour TWA exposure to lead of 30 $\mu g/m^3$ when his or her blood lead level reaches 50 $\mu g/dl$ and is confirmed by a second follow-up blood lead level performed within two weeks after the employer receives the results of the first blood sampling test. Return of the employee to his or her job status depends on a worker's blood lead level declining to 40 $\mu g/dl$.

As part of the interim standard, the employer is required to notify in writing each employee whose blood lead level exceeds 40 $\mu g/dl$. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead level exceeds the above defined limit.

In addition to the above blood lead level criterion, temporary worker removal may also take place as a result of medical determinations and recommendations. Written medical opinions must be prepared after each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above 30 $\mu g/m^3$. Alternatively, if the examining physician recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations.

Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk. The return of the

employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months or for as long as the job the employee was removed from lasts if less than 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: A copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level or anticipated level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physicians's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls are not effective. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the facepiece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its interim final standard on occupational exposure to inorganic lead in the construction industry, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, ZPP levels, and other laboratory tests as appropriate. EDTA and penicillamine which are the primary chelating agents used in the therapy of occupational lead poisoning have significant potential side effects and their use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended, given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA–EDTA has limited applicability. According to some investigators, the test can differentiate between lead-induced and other nephropathies. The test may also provide an estimation of the mobile fraction of the total body lead burden.

Employers are required to assure that accurate records are maintained on exposure assessment, including environmental monitoring, medical surveillance, and medical removal for each employee. Exposure assessment records must be kept for at least 30 years. Medical surveillance records must be kept for the duration of employment plus 30 years except in cases where the employment was less than one year. If duration of employment is less than one year, the employer need not retain this record beyond the term of employment if the record is provided to the employee upon termination of employment. Medical removal records also must be maintained for the duration of employment. All records required under the standard must be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above 30 $\mu g/m^3$ of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical removal protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

II. Adverse Health Effects of Inorganic Lead

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: First, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires that worker blood lead levels be maintained at or below 40 µg/dl and second, the blood lead levels of workers, male or female, who intend to parent in the near future should be maintained below 30 µg/dl to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction are being actively researched and OSHA encourages the physician to remain abreast of recent developments in the area to best advise pregnant workers or workers planning to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: Normal, physiological changes of uncertain significance, pathophysiological changes, overt symptoms (morbidity), and mortality. Within this process there are no sharp distinctions, but rather a continuum of effects. Boundaries between categories overlap due to the wide variation of individual responses and exposures in the working population. OSHA's development of the lead standard focused on pathophysiological changes as well as later stages of disease.

1. Heme Synthesis Inhibition. The earliest demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA–D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 µg/dl. At a blood lead level of 40 µg/dl, more than 20% of the population would have 70% inhibition of

ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 µg/dl.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin. At a blood lead level of 50 µg/dl or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 µg/dl and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

While the significance of these effects is subject to debate, it is OSHA's position that these enzyme disturbances are early stages of a disease process which may eventually result in the clinical symptoms of lead poisoning. Whether or not the effects do progress to the later stages of clinical disease, disruption of these enzyme processes over a working lifetime is considered to be a material impairment of health.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 µg/dl can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 µg/dl. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

2. Neurological Effects. Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delirium, convulsions and coma.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

While there is disagreement about what exposure levels are needed to produce the earliest symptoms, most experts agree that symptoms definitely can occur at blood lead levels of 60 µg/dl whole blood and therefore recommend a 40 µg/dl maximum. The central nervous system effects frequently are not reversible following discontinued exposure or chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degrees of severity. The earliest and mildest form which can be detected in workers with blood lead levels as low as 50 µg/dl is manifested by slowing of motor nerve conduction velocity often without clinical symptoms. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in the most active upper extremity, followed in severe cases by wrist drop or, much less commonly, foot drop.

In addition to slowing of nerve conduction, electromyographical studies in patients with blood lead levels greater than 50 µg/dl have demonstrated a decrease in the number of acting motor unit potentials, an increase in the duration of motor unit potentials, and spontaneous pathological activity including fibrillations and fasciculations. Whether these effects occur at levels of 40 µg/dl is undetermined.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

3. Gastrointestinal. Lead may also affect the gastrointestinal system producing abdominal colic or diffuse abdominal pain, constipation, obstipation, diarrhea, anorexia, nausea and vomiting. Lead colic rarely develops at blood lead levels below 80 µg/dl.

4. Renal. Renal toxicity represents one of the most serious health effects of lead poisoning. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal tubular cells. Renal function remains normal and the changes in this stage are probably reversible. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atrophied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate. An abnormal Ca-EDTA mobilization test has been used to differentiate between lead-induced and other nephropathies, but this procedure is not widely accepted. A form of Fanconi syndrome with aminoaciduria, glycosuria, and hyperphosphaturia indicating severe injury to the proximal renal tubules is occasionally seen in children.

5. Reproductive effects. Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Teratospermia has been noted at mean blood lead levels of 53 µg/dl and hypospermia and asthenospermia at 41 µg/dl. Furthermore, there appears to be a dose-response relationship for teratospermia in lead exposed workers.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a higher frequency of sterility, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lowered birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12–14 weeks of gestation and increases until birth.

There is little direct data on damage to the fetus from exposure to lead but it is generally assumed that the fetus and newborn would be at least as susceptible to neurological damage as young children. Blood lead levels of 50–60 µg/dl in children can cause significant neurobehavioral impairments and there is evidence of hyperactivity at blood levels as low as 25 µg/dl. Given the overall body of literature concerning the adverse health effects of lead in children, OSHA feels that the blood lead level in children should be maintained below 30 µg/dl with a population mean of 15 µg/dl. Blood lead levels in the fetus and newborn likewise should not exceed 30 µg/dl.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, OSHA recommends a 30 µg/dl maximum permissible blood lead level in both males and females who wish to bear children.

6. Other toxic effects. Debate and research continue on the effects of lead on the human body. Hypertension has frequently been noted in occupationally exposed individuals although it is difficult to assess whether this is due to lead's adverse effects on the kidney or if some other mechanism is involved. Vascular and electrocardiographic changes have been detected but have not been well characterized. Lead is thought to impair thyroid function and interfere with the pituitary-adrenal axis, but again these effects have not been well defined.

III. Medical Evaluation

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker. Potential occupational exposure to lead and its compounds occur in many occupations in the construction industry, including demolition and salvaging operations, removal or encapsulation of materials containing lead, construction, alteration, repair or renovation of structures containing lead, transportation, disposal, storage or containment of lead or lead-containing materials on construction sites, and maintenance operations associated with construction activities.

Once the possibility for lead exposure is raised, the focus can then be directed toward eliciting information from the medical history, physical exam, and finally from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work history is important in the initial evaluation. A listing of all previous employment with information on job description, exposure to fumes or dust, known exposures to lead or other toxic substances, a description of any personal protective equipment used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity and nephrotoxicity are considered.

The medical history is also of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, and also non-occupational lead exposures such as hobbies (hunting, riflery). Also known childhood exposures should be elicited. Any previous history of hematological, neurological, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of symptoms should include the following:

1. General—weight loss, fatigue, decreased appetite.

2. Head, Eyes, Ears, Nose, Throat (HEENT)—headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth.

3. Cardio-pulmonary—shortness of breath, cough, chest pains, palpitations, or orthopnea.

4. Gastrointestinal—nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea.

5. Neurologic—irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures.

6. Hematologic—pallor, easy fatigability, abnormal blood loss, melena.

7. Reproductive (male and female and spouse where relevant)—history of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects.

8. Musculo-skeletal—muscle and joint pains.

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded and the oral mucosa checked for pigmentation characteristic of a possible Burtonian or lead line on the gingiva. It should be noted, however, that the lead line may not be present even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia which, if severe, might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the interim lead standard requires the following laboratory studies:

1. Blood lead level

2. Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology

3. Blood urea nitrogen

4. Serum creatinine

5. Routine urinalysis with microscopic examination.

6. A zinc protoporphyrin level.

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee. Additional tests which are probably not warranted on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in the urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

IV. Laboratory Evaluation

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively recent development and the lack of extensive data concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. Other blood tests currently available to evaluate lead exposure will also be reviewed.

The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the worker has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not adequate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is

deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, and brain). This fraction of the lead body burden, the biologically active lead, is not entirely reflected by blood lead levels since it is a function of the dynamics of lead absorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is only slowly mobilized from bone and other relatively stable body stores and excreted. Consequently, a high blood lead level may only represent recent heavy exposure to lead without a significant total body excess and likewise a low blood lead level does not exclude an elevated total body burden of lead.

Also due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by OSHA. Analysis is to be made using atomic absorption spectrophotometry, anodic stripping voltammetry or any method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24 hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels should not be used as a routine test.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead and as such is a better indicator of lead toxicity than the level of blood lead itself. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore is a better indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive to perform and no contamination is possible. Many investigators believe it is the most reliable means of monitoring chronic lead absorption.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a greater affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20–30 µg/dl in some workers. Once the blood lead level has reached 40 µg/dl there is more marked rise in the ZPP value from its normal range of less than 100 µg/dl100 ml. Increases in blood lead levels beyond 40 µg/100 g are associated with exponential increases in ZPP.

Whereas blood lead levels fluctuate over short time spans, ZPP levels remain relatively stable. ZPP is measured directly in red blood cells and is present for the cell's entire 120 day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3–4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP of 50 µg/100 ml whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 µg/100 ml and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by an OSHA approved laboratory which is experienced in lead level determinations. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead-ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex. Nevertheless, the ZPP promises to be an important diagnostic test for the early detection of lead toxicity and its value will increase as more data is collected regarding its relationship to other manifestations of lead poisoning.

Levels of delta-aminolevulinic acid (ALA) in the urine are also used as a measure of lead exposure. Increasing concentrations of ALA are believed to result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24 hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

The pattern of porphyrin excretion in the urine can also be helpful in identifying lead intoxication. With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin III; levels may exceed 5,000 µg/l in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

Summary. The Occupational Safety and Health Administration's interim standard for inorganic lead in the construction industry places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above 30 µg/m³ TWA. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the OSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

Appendix D to § 1926.62— Qualitative and Quantitative Fit Test Protocols

I. Fit Test Protocols

A. General: The employer shall include the following provisions in the fit test procedures. These provisions apply to both qualitative fit testing (QLFT) and quantitative fit testing (QNFT) permissible for compliance with paragraph (f)(3)(ii) of § 1926.62. All testing is to be conducted annually.

1. The test subject shall be allowed to pick the most comfortable respirator from a selection including respirators of various sizes from different manufacturers. The selection shall include at least three sizes of elastomeric facepieces of the type of respirator that is to be tested, i.e., three sizes of half mask; or three sizes of full facepiece. Respirators of each size must be provided from at least two manufacturers.

2. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to determine a comfortable fit. A mirror shall be available to assist the subject in evaluating the fit and positioning the respirator. This instruction may not constitute the subject's formal training on respirator use, as it is only a review.

3. The test subject shall be informed that he/she is being asked to select the respirator

which provides the most comfortable fit. Each respirator represents a different size and shape, and if fitted, maintained and used properly, will provide adequate protection.

4. The test subject shall be instructed to hold each facepiece up to the face and eliminate those which obviously do not give a comfortable fit.

5. The more comfortable facepieces are noted; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in item 6 below. If the test subject is not familiar with using a particular respirator, the test subject shall be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(a) position of the mask on the nose;
(b) room for eye protection;
(c) room to talk; and
(d) position of mask on face and cheeks.

7. The following criteria shall be used to help determine the adequacy of the respirator fit:

(a) chin properly placed;
(b) adequate strap tension, not overly tightened;
(c) fit across nose bridge;
(d) respirator of proper size to span distance from nose to chin;
(e) tendency of respirator to slip; and
(f) self-observation in mirror to evaluate fit and respirator position.

8. The test subject shall conduct the negative and positive pressure fit checks as described below or in ANSI Z88.2–1980. Before conducting the negative or positive pressure test, the subject shall be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths. Another facepiece shall be selected and retested if the test subject fails the fit check tests.

(a) *Positive pressure check.* Close off the exhalation valve and exhale gently into the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

(b) *Negative pressure check.* Close off the inlet opening of the canister or cartridge(s) by covering with the palm of the hand(s) or by replacing the filter seal(s), inhale gently so that the facepiece collapses slightly, and hold the breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

9. The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, or long sideburns which cross the respirator sealing surface. Any type of apparel which interferes with a satisfactory fit shall be altered or removed.

10. If a test subject exhibits difficulty in breathing during the tests, she or he shall be referred to a physician to determine whether the test subject can wear a respirator while performing her or his duties.

11. If at any time within the first two week of use the respirator becomes uncomfortable, the test subject shall be given the opportunity to select a different facepiece and to be retested.

12. The employer shall maintain a record of the fit test administered to an employee. The record shall contain at least the following information:

(a) name of employee;
(b) type of respirator;
(c) brand, size of respirator;
(d) date of test;
(e) where QNFT is used: the fit factor, strip chart recording or other recording of the results of the test. The record shall be maintained until the next fit test is administered.

13. Exercise regimen. Prior to the commencement of the fit test, the test subject shall be given a description of the fit test and the test subject's responsibilities during the test procedure. The description of the process shall include a description of the test exercises that the subject will be performing. The respirator to be tested shall be worn for at least 5 minutes before the start of the fit test.

14. Test Exercises. The test subject shall perform exercises, in the test environment, in the manner described below:

(a) Normal breathing. In a normal standing position, without talking, the subject shall breathe normally.

(b) Deep breathing. In a normal standing position, the subject shall breathe slowly and deeply, taking caution so as to not hyperventilate.

(c) Turning head side to side. Standing in place, the subject shall slowly turn his/her head from side to side between the extreme positions on each side. The head shall be held at each extreme momentarily so the subject can inhale at each side.

(d) Moving head up and down. Standing in place, the subject shall slowly move his/her head up and down. The subject shall be instructed to inhale in the up position (i.e., when looking toward the ceiling).

(e) Talking. The subject shall talk out loud slowly and loud enough so as to be heard clearly by the test conductor. The subject can read from a prepared text such as the Rainbow Passage (see below), count backward from 100, or recite a memorized poem or song.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

(f) Grimace. The test subject shall grimace by smiling or frowning.

(g) Bending over. The test subject shall bend at the waist as if he/she were to touch his/her toes. Jogging in place shall be substituted for this exercise in those test environments such as shroud type QNFT units which prohibit bending at the waist.

(h) Normal breathing. Same as exercise 1.

Each test exercise shall be performed for one minute except for the grimace exercise which shall be performed for 15 seconds. The test subject shall be questioned by the test conductor regarding the comfort of the respirator upon completion of the protocol. If it has become uncomfortable, another model of respirator shall be tried.

B. Qualitative Fit Test (QLFT) Protocols. 1. *General* (a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator qualitative fit test program.

(b) The employer shall ensure that persons administering QLFT are able to prepare test solutions, calibrate equipment and perform tests properly, recognize invalid tests, and assure that test equipment is in proper working order.

(c) The employer shall assure that QLFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. *Isoamyl Acetate Protocol.* (a) Odor threshold screening. The odor threshold screening test, performed without wearing a respirator, is intended to determine if the individual tested can detect the odor of isoamyl acetate.

(1) Three 1 liter glass jars with metal lids are required.

(2) Odor free water (e.g. distilled or spring water) at approximately 25 degrees C shall be used for the solutions.

(3) The isoamyl acetate (IAA) (also known at isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1 liter jar and shaking for 30 seconds. A new solution shall be prepared at least weekly.

(4) The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but shall not be connected to the same recirculating ventilation system.

(5) The odor test solution is prepared in a second jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. The solution shall be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution shall be used for only one day.

(6) A test blank shall be prepared in a third jar by adding 500 cc of odor free water.

(7) The odor test and test blank jars shall be labeled 1 and 2 for jar identification. Labels shall be placed on the lids so they can be periodically peeled, dried off and switched to maintain the integrity of the test.

(8) The following instruction shall be typed on a card and placed on the table in front of the two test jars (i.e., 1 and 2): "The purpose of this test is to determine if you can smell

banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil.'"

(9) The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

(10) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test shall not be performed.

(11) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(b) Isoamyl acetate fit test.

(1) The fit test chamber shall be similar to a clear 55-gallon drum liner suspended inverted over a 2-foot diameter frame so that the top of the chamber is about 6 inches above the test subject's head. The inside top center of the chamber shall have a small hook attached.

(2) Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. The cartridges or masks shall be changed at least weekly.

(3) After selecting, donning, and properly adjusting a respirator, the test subject shall wear it to the fit testing room. This room shall be separate from the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

(4) A copy of the test exercises and any prepared text from which the subject is to read shall be taped to the inside of the test chamber.

(5) Upon entering the test chamber, the test subject shall be given a 6-inch by 5-inch piece of paper towel, or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

(6) Allow two minutes for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject; to explain the fit test, the importance of his/her cooperation, and the purpose for the head exercises; or to demonstrate some of the exercises.

(7) If at any time during the test, the subject detects the banana like odor of IAA, the test has failed. The subject shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

(8) If the test has failed, the subject shall return to the selection room and remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber and again begin the procedure described in (I)(B)(2)(b) (1) through (7) of this appendix. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

(9) When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having the subject break the face seal and take a breath before exiting the chamber.

(10) When the test subject leaves the chamber, the subject shall remove the saturated towel and return it to the person conducting the test. To keep the test area from becoming contaminated, the used towels shall be kept in a self sealing bag so there is no significant IAA concentration build-up in the test chamber during subsequent tests.

3. *Saccharin Solution Aerosol Protocol.* The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

(a) Taste threshold screening. The saccharin taste threshold screening, performed without wearing a respirator, is intended to determine whether the individual being tested can detect the taste of saccharin.

(1) During threshold screening as well as during fit testing, subjects shall wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movements of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly, parts # FT 14 and # FT 15 combined, is adequate.

(2) The test enclosure shall have a ¾ inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(3) The test subject shall don the test enclosure. Throughout the threshold screening test, the test subject shall breathe through his/her wide open mouth with tongue extended.

(4) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

(5) The threshold check solution consists of 0.83 grams of sodium saccharin USP in 1 cc of warm water. It can be prepared by putting 1 cc of the fit test solution (see (b)(5) below) in 100 cc of distilled water.

(6) To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely, then released and allowed to fully expand.

(7) Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

(8) If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(9) If the second response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

(10) The test conductor will take note of the number of squeezes required to solicit a taste response.

(11) If the saccharin is not tasted after 30 squeezes (step 10), the test subject may not perform the saccharin fit test.

(12) If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

(13) Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

(14) The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

(b) Saccharin solution aerosol fit test procedure

(1) The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

(2) The fit test uses the same enclosure described in I. B. 3. (a) of this appendix.

(3) The test subject shall don the enclosure while wearing the respirator selected in section I. B. 3. (a) of this appendix. The respirator shall be properly adjusted and equipped with a particulate filter(s).

(4) A second DeVilbiss Model 40 Inhalation Medication Nebulizer is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

(5) The fit test solution is prepared by adding-83 grams of sodium saccharin to 100 cc of warm water.

(6) As before, the test subject shall breathe through the wide open mouth with tongue extended.

(7) The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same number of squeezes required to elicit a taste response in the screening test.

(8) After generating the aerosol the test subject shall be instructed to perform the exercises in section I. A. 14 above.

(9) Every 30 seconds the aerosol concentration shall be replenished using one half the number of squeezes as initially.

(10) The test subject shall indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

(11) If the taste of saccharin is detected, the fit is deemed unsatisfactory and a different respirator shall be tried.

(12) Successful completion of the test protocol shall allow the use of the tested respirator in contaminated atmospheres up to 10 times the PEL. In other words, this protocol may be used for assigned protection factors no higher than 10.

4. *Irritant Fume Protocol.* (a) The respirator to be tested shall be equipped with high-efficiency particulate air (HEPA) filters.

(b) The test subject shall be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with its characteristic odor.

(c) Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach one end of the smoke tube to a low flow air pump set to deliver 200 milliliters per minute.

(d) Advise the test subject that the smoke can be irritating to the eyes and instruct the subject to keep his/her eyes closed while the test is performed.

(e) The test conductor shall direct the stream of irritant smoke from the smoke tube towards the face seal area of the test subject. He/She shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

(f) The exercises identified in section I. A. 14 above shall be performed by the test subject while the respirator seal is being challenged by the smoke.

(g) Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube once the respirator has been removed to determine whether he/she reacts to the smoke. Failure to evoke a response shall void the fit test.

(h) The fit test shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the test agent.

C. Quantitative Fit Test (QNFT) Protocol. 1. General. (a) The employer shall assign specific individuals who shall assume full responsibility for implementing the respirator quantitative fit test program.

(b) The employer shall ensure that persons administering QNFT are able to calibrate equipment and perform tests properly, recognize invalid tests, calculate fit factors properly and assure that test equipment is in proper working order.

(c) The employer shall assure that QNFT equipment is kept clean and well maintained so as to operate at the parameters for which it was designed.

2. Definitions. (a) Quantitative fit test. The test is performed in a test chamber. The normal air-purifying element of the respirator is replaced by a high-efficiency particulate air (HEPA) filter in the case of particulate QNFT aerosols or a sorbent offering contaminant penetration protection equivalent to high-efficiency filters where the QNFT test agent is a gas or vapor.

(b) Challenge agent means the aerosol, gas or vapor introduced into a test chamber so that its concentration inside and outside the respirator may be measured.

(c) Test subject means the person wearing the respirator for quantitative fit testing.

(d) Normal standing position means standing erect and straight with arms down along the sides and looking straight ahead.

(e) Maximum peak penetration method means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(f) Average peak penetration method means the method of determining test agent penetration into the respirator utilizing a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph or by computer integration, for each exercise except the grimace exercise. Integrators or computers which calculate the actual test agent penetration into the respirator for each exercise will also be considered to meet the requirements of the average peak penetration method.

(g) "Fit Factor" means the ration of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

3. Apparatus. (a) Instrumentation. Aerosol generation, dilution, and measurement systems using corn oil or sodium chloride as test aerosols shall be used for quantitative fit testing.

(b) Test chamber. The test chamber shall be large enough to permit all test subjects to perform freely all required exercises without disturbing the challenge agent concentration or the measurement apparatus. The test chamber shall be equipped and constructed so that the challenge agent is effectively isolated from the ambient air, yet uniform in concentration throughout the chamber.

(c) When testing air-purifying respirators, the normal filter or cartridge element shall be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

(d) The sampling instrument shall be selected so that a strip chart record may be made of the test showing the rise and fall of the challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers which integrate the amount of test agent penetration leakage into the respirator for each exercise may be used provided a record of the readings is made.

(e) The combination of substitute air-purifying elements, challenge agent and challenge agent concentration in the test chamber shall be such that the test subject is not exposed in excess of an established exposure limit for the challenge agent at any time during the testing process.

(f) The sampling port on the test specimen respirator shall be placed and constructed so that no leakage occurs around the port (e.g. where the respirator is probed), a free air flow is allowed into the sampling line at all times and so that there is no interference with the fit or performance of the respirator.

(g) The test chamber and test set up shall permit the person administering the test to observe the test subject inside the chamber during the test.

(h) The equipment generating the challenge atmosphere shall maintain the concentration of challenge agent inside the test chamber constant to within a 10 percent variation for the duration of the test.

(i) The time lag (interval between an event and the recording of the event on the strip chart or computer or integrator) shall be kept to a minimum. There shall be a clear association between the occurrence of an event inside the test chamber and its being recorded.

(j) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port shall be of equal diameter and of the same material. The length of the two lines shall be equal.

(k) The exhaust flow from the test chamber shall pass through a high-efficiency filter before release.

(l) When sodium chloride aerosol is used, the relative humidity inside the test chamber shall not exceed 50 percent.

(m) The limitations of instrument detection shall be taken into account when determining the fit factor.

(n) Test respirators shall be maintained in proper working order and inspected for deficiencies such as cracks, missing valves and gaskets, etc.

4. Procedural Requirements. (a) When performing the initial positive or negative pressure test the sampling line shall be crimped closed in order to avoid air pressure leakage during either of these tests.

(b) An abbreviated screening isoamyl acetate test or irritant fume test may be utilized in order to quickly identify poor fitting respirators which passed the positive and/or negative pressure test and thus reduce the amount of QNFT time. When performing a screening isoamyl acetate test, combination high-efficiency organic vapor cartridges/canisters shall be used.

(c) A reasonably stable challenge agent concentration shall be measured in the test chamber prior to testing. For canopy or shower curtain type of test units the determination of the challenge agent stability may be established after the test subject has entered the test environment.

(d) Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator shall be measured to ensure that the peak penetration does not exceed 5 percent for a half mask or 1 percent for a full facepiece respirator.

(e) A stable challenge concentration shall be obtained prior to the actual start of testing.

(f) Respirator restraining straps shall not be overtightened for testing. The straps shall be adjusted by the wearer without assistance from other persons to give a reasonable comfortable fit typical of normal use.

(g) The test shall be terminated whenever any single peak penetration exceeds 5 percent for half masks and 1 percent for full facepiece respirators. The test subject shall be refitted and retested. If two of the three required tests are terminated, the fit shall be deemed inadequate.

(h) In order to successfully complete a QNFT, three successful fit tests are required. The results of each of the three independent fit tests must exceed the minimum fit factor needed for the class of respirator (e.g. half mask respirator, full facepiece respirator).

(i) Calculation of fit factors.

(1) The fit factor shall be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration inside the respirator.

(2) The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

(3) The concentration of the challenge agent inside the respirator shall be determined by one of the following methods:

(i) Average peak concentration

(ii) Maximum peak concentration

(iii) Integration by calculation of the area under the individual peak for each exercise. This includes computerized integration.

(j) Interpretation of test results. The fit factor established by the quantitative fit testing shall be the lowest of the three fit factor values calculated from the three required fit tests.

(k) The test subject shall not be permitted to wear a half mask, or full facepiece

respirator unless a minimum fit factor equivalent to at least 10 times the hazardous exposure level is obtained.

(l) Filters used for quantitative fit testing shall be replaced at least weekly, or whenever increased breathing resistance is encountered, or when the test agent has altered the integrity of the filter media. Organic vapor cartridges/canisters shall be replaced daily (when used) or sooner if there is any indication of breakthrough by a test agent.

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