URS

Before the Occupational Safety and Health Administration
United States Department of Labor

Critique of OSHA's Cost Models for the Proposed Crystalline Silica Standard and Explanation of the Modifications to Those Cost Models Made by URS Corporation

Docket No. OSHA-2010-0034, 78 Fed. Reg. 56274 (September 12, 2013)

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Introduction

At the request of the American Chemistry Council Crystalline Silica Panel and with its financial support, URS Corporation has performed a detailed critique of the cost models OSHA used to estimate the cost for general industry sectors to comply with the proposed 50 μg/m^3 permissible exposure limit (PEL) and 25 μg/m^3 action level (AL) for respirable crystalline silica, as well as with the ancillary provisions of the proposed rule. Section I below sets forth URS's critique of OSHA's engineering controls cost model; Section II provides URS's critique of the ancillary provisions cost model. URS has identified and describes in this report many invalid assumptions and calculations made by OSHA in both of the Agency's cost models. To correct those problems, URS has developed alternative cost models that more accurately reflect practical, "real world" assumptions and inputs. The URS cost models conservatively predict that the actual expected costs of compliance with the proposed Silica Standard would be dramatically higher than OSHA estimates.

- *Full* Annualized Costs: OSHA does not show its estimate of the *full* annualized costs of the proposed rule (reflecting necessary reductions in exposures from actual current exposure levels) in any formal report or table. However, the spreadsheets OSHA used for its cost model calculations (OSHA-2010-0034-1781 Workbook #7) estimate that the *full* annualized cost for general industry to achieve the proposed 50 μg/m^3 PEL and comply with the ancillary provisions of the proposed rule (given current exposure levels) would be $249 million for all general industry sectors plus maritime. URS, by contrast, projects that the *full* annualized cost to comply with the proposed rule would be about $6.1 billion per year in combined engineering control and ancillary provision costs for 19 general industry sectors (excluding maritime and those general industry sectors where data are insufficient to develop a reliable estimate).

- *Incremental* Annualized Costs: URS also has considered the hypothetical *incremental* cost to reduce exposures from the current PEL of 100 μg/m^3 to achieve and maintain compliance with the proposed PEL of 50 μg/m^3. While OSHA estimates that the total annualized *incremental* cost to general industry would be only $132.5 million for combined engineering control and ancillary costs, 78 Fed. Reg. 56,274, 56,358 (Sept. 12, 2013) (Table VIII-8), URS projects that the annualized *incremental* cost would be $4.7 billion for the 19 general industry sectors included in URS' estimate of the *full* annualized costs.

While URS believes that the *Full* Annualized Cost figure is the relevant value for evaluating economic feasibility, we also present the *Incremental* Annualized Cost figure so as to allow an

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evaluation to be made on that basis as well. Following the reasoning URS summarizes in this report, URS has compiled its results and analyses for each general industry sector in Tables 1-4 of this report as follows:

Table 1: Overall URS Annualized Costs of Proposed Silica Rule. This table compiles the results of URS's adjusted engineering and ancillary cost estimate models. The table displays the data for 19 general industry sectors[1]. It displays one set of data that are the *full* engineering control costs to achieve the proposed PEL, given actual current exposures, and a second set of data that show the *incremental* engineering control costs to achieve the proposed PEL based on the hypothetical assumption that all employers have already reduced silica exposures to a level of 100 µg/m^3 (which, of course, is not the case). It also displays the costs for complying with the ancillary provisions of the proposed rule. Finally it displays the total combined *full* costs and the total combined *incremental* costs of the proposed rule.

Table 2A: Overall URS Engineering Control Annualized Costs. This table compiles the results of URS's adjusted cost estimate model. Consistent with OSHA's approach, this table shows the annualized costs for very small,[2] small,[3] and large facilities in each sector. It further displays one set of data that are the *full* costs to comply with the proposed PEL, given actual current exposures, and a second set of data that show the *incremental* costs based on the hypothetical assumption that all employers have already reduced silica exposures to a level of 100 µg/m^3 (which, of course, is not the case).

Table 2B: Per Facility URS Engineering Control Annualized Costs. This table shows the average compliance costs for very small, small, and large facilities based on URS's adjusted cost estimate model.

Tables 3A and 3B: Overall OSHA Engineering Control Annualized Costs and Per Facility OSHA Engineering Control Annualized Costs for the same 19 general

[1] URS has evaluated the OSHA data for the remaining sectors (Captive Foundries, Dental Equipment and Supplies, Dental Laboratories, Porcelain Enameling Services, Railroads, Refractory Repair, Porcelain-enameling Iron, Porcelain-enameling Architecture, Porcelain-enameling Appliances, and Porcelain-enameling Signs), but determined that OSHA's estimates of the number of facilities were not sufficiently reliable to consider the costs of compliance for those facilities. For example, OSHA assumes there are 60,000 captive foundries, which is without basis in the record. To keep this analysis of the real costs of the proposed rule appropriately conservative, URS has excluded those sectors (and whatever their compliance costs might be) from its analysis. As a result, the URS cost estimates are understated by some undetermined amount.

[2] "Very small" facilities are defined by OSHA as those owned by an entity having less than 20 employees.

[3] "Small" facilities are defined by OSHA as those owned by an entity having less than 500 employees in total. However, these employees are sometimes distributed over more than one factory site, termed an establishment by OSHA. For the purposes of this cost analysis, URS separated out the very small facilities from this "small" category. Facilities larger than this are defined by OSHA as "large."

industry sectors. These replicate for comparison purposes the annualized engineering cost estimates prepared by OSHA.

Tables 4A and 4B: Total Ancillary Provisions Annualized Costs and Per Facility Ancillary Provisions Annual Costs. Table 4A compiles the results from the URS adjusted cost estimate model of the annualized costs for the 19 general industry sectors to comply with the ancillary provisions of the proposed rule. Table 4B shows those results on a per facility basis. Both Tables 4A and 4B display for comparison purposes OSHA's estimates of the annualized costs to implement the ancillary provisions across the 19 general industry sectors.

In modifying the assumptions and calculations contained in OSHA's cost models, URS has relied primarily on communications with veteran professionals from the various General Industry sectors and on URS's extensive engineering experience. The following sections explain the major flaws identified by URS in OSHA's cost models and then discuss the modifications that URS made to correct OSHA's cost models. The more specific details of the URS models, and the exact modifications made to OSHA's cost estimates can be found in the URS Alternative Cost Model spreadsheets, which are provided with this report.

SECTION 1: URS's Modifications to OSHA's Engineering Control Costs Model

I. Description of the basic flaws in OSHA's approach, Followed by Remedies Applied in the URS Engineering Cost Model

A. OSHA vastly underestimated the required controls and associated costs of the proposed rule for general industry because OSHA's model erroneously determined the number of controls required solely by the number of overexposed workers for a given job description.

A fundamental flaw in OSHA's analysis is its decision to determine the number of engineering controls required in any given industry based on its estimate of how many workers in a given job category are deemed to be overexposed vis-à-vis a PEL of 100 µg/m^3 and a PEL of 50 µg/m^3. By focusing exclusively on its misplaced theory of overexposed workers, OSHA failed to recognize the fact that *facilities* install engineering controls; thus the crucial factors in determining the nature and scope of engineering controls required in any given general industry sector are the number of facilities in that industry sector and the number of areas within a given facility where the employer would need to install the controls.

The simplistic process OSHA followed is this: OSHA estimated how many workers are overexposed for each industry and job description. Then, OSHA identified the engineering controls the agency believes necessary to achieve compliance with the proposed PEL and the average number of overexposed workers that will be protected by each unit of controls. In most instances, OSHA assumed its preferred controls would cover four overexposed workers – based on the assumption of two workers in the overexposed job per shift. For certain specific controls, OSHA assumed its bundle of engineering controls would cover fewer or more than four workers, ranging from two to eight workers depending on the type of control. OSHA then arrived at a count of how many controls would be required by dividing the number of overexposed workers in the industry by the number of workers it believed would be covered by a single bundle of engineering controls, which in most cases was four. Once it had the resulting count of controls, OSHA selected a unit cost per control bundle and determined the total engineering costs for the industry. The engineering control costs for each of the general industry sectors were then summed to arrive at the total cost of engineering controls in general industry as a whole.

By focusing on the number of overexposed workers instead of on the facilities and the areas within the facilities that would need controls, OSHA's approach fails to recognize the realities of how industry works in the real world. As an example, for an iron foundry sand mixer operator, OSHA's model assumes that a local exhaust ventilation (LEV) control package with 1,050 cubic feet per minute (cfm) on a single mixer would be sufficient to cover four overexposed sand-mixer operators, two for each shift.[4] However, our consultations with industry representatives

[4] OSHA model workbook #7, Docket ID OSHA-2010-0034-1781

indicated that each foundry sand-mixer operator usually operates multiple sand-mixers, not just one for every two workers as OSHA assumes. Sand mixing also was not often performed on the second shift, but each mixer would still require separate LEV controls whether or not each sand mix operator on each shift was measured as being over the 50 μg/m^3 PEL. Therefore, OSHA's assumption that a single control was sufficient for four workers (two simultaneously for each shift), and that each of those workers was among those measured as overexposed, dramatically underestimated the number of controls and the LEV required for sand mixers.

This is just one example of how the OSHA model is unrealistic and miscalculates the number of controls necessary to cover the *facilities* where workers are currently exposed over the proposed 50 μg/m^3 PEL and/or the existing 100 μg/m^3 PEL. OSHA's cost model assumed essentially 100% efficiency in control installation for a given job description industry-wide—that is, for most operations, each control was assumed to cover four workers, each of whom was assumed to be among those who are overexposed. The following errors can and did occur using the OSHA engineering cost model. Most occur because **OSHA did not consider that the most important determinant as to how many controls are required is the number of facilities and the number of areas within a facility that need to install the controls, not the total number of workers overexposed within a given job category.**

(1) <u>OSHA failed to consider the effect of size differences among facilities.</u> Most very small and many small facilities do not have enough overexposed workers within a given job category to fill even one control efficiently (i.e. they have only one or two overexposed workers in a given job, not the four as estimated by OSHA's assumed 4:1 ratio). In fact, most very small facilities have at most only one overexposed worker in a given job category. Therefore there are not enough overexposed workers available at these smaller sites to meet the assumed 4:1 ratio of overexposed workers to engineering controls in OSHA's cost model.

(2) <u>OSHA made incorrect assumptions about the number of shifts.</u> OSHA assumed two shifts industry-wide, but most very small facilities rarely run second shifts, and a significant percentage of small and large facilities also perform the bulk of their production work in one shift, with more limited operations during a second shift. This practice does not fit the OSHA cost model because, in the absence of a second shift, each control bundle would protect fewer overexposed workers on average, and many more control bundles than OSHA had estimated would have to be installed to address each area in each facility where workers will be exposed above the proposed PEL.

(3) <u>OSHA failed to recognize the physical limitations of some engineering controls.</u> OSHA's nearly uniform assumption that each bundle of engineering controls could protect four workers occasionally ignored the physical limitations of certain engineering controls. In some cases, a particular design aspect of an engineering control dictates that fewer than four workers can be protected if the control is installed. For example, OSHA assumes that four overexposed workers will be protected if a facility installs an enclosed cab for vehicles such as fork lifts or front end loaders.[5] However, only one worker can

[5] OSHA model workbook #7, Docket ID: OSHA-2010-0034-1781

occupy the cab at a time. Assuming that there are two shifts, each enclosed cab would be capable of protecting only two workers, not four as OSHA suggests.

(4) OSHA failed to recognize that the variability in monitoring results would require additional controls. Much of the data obtained by OSHA and presented in the PEA demonstrate that the controls at a given facility could vary from poor to quite good, and the percentages of workers exposed over the proposed 50 $\mu g/m^3$ or current 100 $\mu g/m^3$ PEL would generally increase or decrease in accordance with the quality of the controls at a given facility. However, in nearly every instance, the range of concentrations measured for workers in the same job at the same facility varied greatly. Within each job category, OSHA's sampling data would nearly always include several samples for workers that were under 50 $\mu g/m^3$, and also a few to several worker samples that exceeded 50 and even 100 $\mu g/m^3$, all at the same industrial facility. *See, e.g.*, OSHA-2010-0034-0235 (structural clay brick making facility); OSHA-2010-0034-0232 (same); OSHA-2010-0034-0233 (concrete products facility). Further, in the case of foundries, these wide ranges of measured concentrations for a given job were found to be the rule, not the exception. *See* Robert C. Sholz, PE, Critique of the Interpretation of Foundry Silica Sampling Results Used by OSHA as Support of Feasibility of Foundries Meeting a Reduced Silica Exposure Limit (2014).[6] This paper also noted that the exposures for individual workers were often not consistent; that is, individual workers measured as overexposed during one sampling were often not measured as overexposed in subsequent samplings, and vice-versa. Because OSHA interprets the PEL as a never-to-be-exceeded standard, facilities must take a conservative approach and apply engineering controls whenever there is a risk that an employee may be exposed above the PEL. Thus, in situations where sampling results are variable, any controls installed at a facility must necessarily also cover at least some workers whose monitoring results did not exceed either the 50 or 100 $\mu g/m^3$ PEL.

(5) OSHA's simplistic approach fails to recognize that as a practical matter, a facility often cannot address just the overexposed worker. When, based on monitoring, it is found that the majority of workers in a job at a given facility are exposed above the PEL, that facility would not have the option of singling out those few employees who are not overexposed and refusing to provide to them the same controls as other overexposed workers performing the same job. For any job description, as the percentage of workers exposed above the PEL increases, it becomes increasingly likely (and obvious) that the existing controls in place are inadequate, and require either a complete overhaul or replacement. At some point, these more drastic remedies become the only practical, cost effective options. Targeting individual workers with localized control repairs or improvements is not practical for jobs where a majority of workers at the facility are overexposed because there are too many overexposed workers, and it is doubtful a patchwork approach would succeed. Overhauling or replacing the entire control system

[6] URS has verified that the American Foundries Association (AFS) intends to submit this paper as part of their comments.

clearly is an application that must apply to all workers in a given job, whether they are overexposed or not, and cannot be targeted only on the workers measured as being over the PEL. This is another situation where OSHA's assumption that raw numbers of overexposed workers can be used to determine the size and number of controls installed proves unworkable in practice. Instead, the situations at the facility level are the primary determinant (along with the associated costs).

For all of the above reasons, the OSHA cost model drastically undercounts the number of controls that would be required for a given industry sector. Again, this is because OSHA's cost model uses *only* the number of overexposed workers to determine the number of controls required, and does not take into account in any way the various conditions that arise at the facility level and render the OSHA cost model extremely inaccurate.

B. URS Cost Model Remedy: For its Cost Model, URS developed a binomial distribution to approximate real world conditions.

Ideally, a facility-specific model would be used to estimate the costs to comply with OSHA's proposed standard. However, there is not enough facility-specific information in the docket or in OSHA's cost model to convert directly to a facility-specific system for determining the costs of engineering controls. Thus, to correct the fundamental flaw in OSHA's approach, URS used available data in OSHA's record to create a statistical model that takes into account the different sizes of facilities in order to more realistically approximate the number of engineering control bundles and the resulting expected cost to general industry that would be required under the proposed rule. The data provided by OSHA do include the total number of workers in each general industry sector for each of three sized facilities—very small, small, and large facilities.[7] OSHA also supplies percentages of workers within each job category that are exposed over the 50 $\mu g/m^3$ and 100 $\mu g/m^3$ PEL.[8] From these data, average numbers of workers and overexposed workers can be calculated for each of these three facility sizes. For each job category with silica exposures within each industry, URS created three statistical binomial distributions of overexposed workers, one for each of the three facility sizes, using OSHA's estimate of the percentage of over-exposed workers for that job. The result was a binomial distribution curve indicating the percentage of overexposed workers for each job category for each size-specific "model facility."[9]

For each binomial distribution, the peak of the distribution curve centers on the average number of overexposed workers per facility for that job description according to OSHA's estimate. Facilities with lower percentages of workers exposed over the PEL are represented to the left of the peak, while those with higher percentages of overexposed workers are represented to the right. If OSHA estimated a low percentage of overexposed workers, the peak of the distribution would occur closer to (or within) the first percentage quartile (0 to 25% worker overexposure

[7] Docket ID: OSHA-2010-0034-1781

[8] Docket ID: OSHA-2010-0034-1781

[9] URS Silica PEL Engineering Cost Model.xlsm, explanation sheet

rates); for higher percentages of overexposed workers, the peak would be progressively further down the curve (2nd through 4th quartiles). In the URS model, the percentage of facilities in the first quartile of the graph would receive one engineering control for each overexposed worker, since the overexposed workers in this quartile are assumed to be sparse and spread out. Overexposed workers in the 26-50% exposure quartile (2nd quartile) were assumed to be "packed" into controls at a rate equal to 50% of the OSHA-estimated capacity of the control (typically two workers per engineering control bundle). Overexposed workers in the upper two quartiles (51-100% exposure) were placed into controls up to the OSHA estimated maximum worker capacity (typically 4 workers per engineering control bundle)[10].

For those job categories with overexposure rates greater than 50%, URS assumed that the facility would have to provide controls for each worker within that job category, not just those workers deemed to be overexposed. As described in point 1.A.(4) above, when the number of overexposed workers exceeds a certain threshold, one is led to the practical conclusion that the existing control methods for a given job category at a facility are simply inadequate, and must be totally replaced or completely overhauled for all workers. For the purposes of this cost model, URS has determined that when a majority of the workers (>50%) in a job category are exposed above the PEL, it is rational to conclude that the threshold has been exceeded and that the existing controls are totally inadequate and must be replaced. URS believes this is a conservative approach, as many industry representatives would set this threshold lower than 50%. Once this threshold is reached and a new control system is installed, the new controls would necessarily apply to all workers in that job category. Practically, an employer could not spend money to build a new control system only for those measured as being over the 50 $\mu g/m^3$ PEL because, due to the inherent variability in sampling results, it is overwhelmingly likely that additional workers would be measured as over the PEL in subsequent samplings.[11]

URS believes that all of these adjustments to OSHA's worker-based cost model more accurately simulate controls as they would be installed at actual facilities that have overexposed workers.

II. OSHA's proposal to adopt the ISO/CEN definition of respirable dust, which increases the particle size "cut point" from 3.5 to 4 microns, would result in the collection of approximately 20% more respirable crystalline silica than would be collected under OSHA's existing definition of respirable dust. This change (1) effectively lowers the PEL relative to the definition of respirable dust OSHA currently uses, and (2) increases the number of workers who would be exposed above 50 $\mu g/m^3$ and who therefore require new engineering controls in order to comply with the proposed PEL. OSHA did not include the impact of this change in its cost model.

[10] URS Silica PEL Engineering Cost Model.xlsm, Cost Calcs Sheet

[11] In addition, it is doubtful that OSHA would allow a percentage of workers performing the same job to remain covered only by the same set of controls that have been shown to be inadequate, as demonstrated by the fact that a high percentage of workers were found to be exposed above the PEL when that set of controls was used.

A. The effect of OSHA's proposal to change the definition of respirable dust.

In the PEA, OSHA describes its proposal to adopt the ISO/CEN definition of respirable dust to replace the old ACGIH definition it has been using for decades. *See* PEA pages IV-18-21. But OSHA does not address the effect that this switch to the ISO/CEN definition will have on sampling results. According to studies by Soderholm, ISO/CEN sample collection methods would cause an increase of more than 21% in the reported concentration of 6 of 31 aerosols studied as compared to the ACGIH method, with 3 of the 6 being greater than 30%. For the remaining 25 aerosols studied, sample weights increased by 0 to 20%.[12] When OSHA conducted technological feasibility studies for attaining the proposed 50 µg/m^3 PEL, the Agency based its decisions on samples collected using the current ACGIH method, not the proposed ISO/CEN method. Thus, the switch to the ISO/CEN definition will have two impacts on feasibility. First, it will add uncertainty regarding OSHA's technological feasibility determination because greater reductions in exposure will be required to achieve a 50 µg/m^3 PEL measured by the ISO/CEN definition than by the ACGIH definition that OSHA applied. Second, OSHA's use of the ACGIH definition to estimate compliance costs causes the Agency to underestimate the costs of achieving the 50 µg/m^3 PEL because OSHA did not account for the additional workers whose exposures would exceed the proposed PEL under the ISO/CEN definition but who would be exposed below the proposed PEL if measured under the ACGIH definition.

B. URS Cost Model Remedy: URS factored the shift to the ISO/CEN method into the URS cost model.

To factor in OSHA's proposal to change the definition of respirable dust, URS calculated the number of additional workers that would be expected to be exposed over the proposed PEL solely because OSHA is proposing to adopt the ISO/CEN definition.

Specifically, using the exposure data provided in the PEA, URS assumed that on average, the resulting sample concentration would increase by 20%. This means that workers previously measured as between 42 and 50 µg/m^3 would actually be exposed over the proposed 50 µg/m^3 PEL, (an 8 µg/m^3 difference). In OSHA's engineering costs spreadsheets, OSHA provided percentages of workers in a series of concentration brackets, but not the individual concentrations measured for each worker.[13] However, based on the total number of workers in each job category, the number of workers in each concentration bracket could be calculated. The concentration bracket immediately below the 50 µg/m^3 PEL for which worker percentages were available was the 25 to 50 µg/m^3 bracket. URS assumed an equal distribution of the number of workers across the 25 to 50 µg/m^3 concentration bracket, so that the percentage of workers in that bracket between 42 µg/m^3 and 50 µg/m^3 could be estimated. These workers were assumed

[12] Docket ID: OSHA-2010-0034-1661

[13] OSHA Cost Model Workbook, Docket ID: 2010-0034-1781

to be exposed above the proposed 50 μg/m^3 PEL under the ISO/CEN definition. The 8 μg/m^3 difference (42 or higher increasing up to 50) divided by the 25 μg/m^3 concentration interval equals 32% (8/25) in that concentration bracket. Thus, URS estimated that 32% of the workers in the 25-50 μg/m^3 concentration bracket would actually be exposed above the proposed 50 μg/m^3 PEL if the ISO/CEN method were used to interpret their monitoring samples.[14]

URS determined that it would be inappropriate to apply a similar adjustment to the workers measured just below the current 100 μg/m^3 PEL for purposes of determining the incremental costs between complying with the current and proposed PELs, since the ISO/CEN method is being proposed by OSHA as part of the proposed standard, and thus is not applicable to determining compliance with the current PEL. The costs associated with the engineering controls for the additional workers who would be deemed overexposed due to OSHA's proposed adoption of the ISO/CEN definition are therefore properly attributed entirely to the proposed rule.

III. The types, sizes and applicability of the engineering controls selected for use in OSHA's cost model are flawed, and likely would be insufficient to achieve the proposed PEL of 50 μg/m^3.

A. OSHA's record in the PEA and Docket does not support its assumption that the package of controls it has selected would be sufficient to achieve and maintain compliance with the proposed PEL.

For compliance purposes, OSHA interprets PELs as limits that may never be exceeded. Nevertheless, in its proposed rule, OSHA often made the preliminary decision that engineering controls were technologically feasible and capable of achieving and maintaining compliance with the proposed 50 μg/m^3 PEL in various industry sectors on the basis of very scant data. Often only a few sampling results slightly below 50 μg/m^3 were deemed sufficient evidence of technological feasibility, even if such results could not be consistently demonstrated. One example: for cut stone fabricators, when full wet controls were implemented, in one instance, a mean exposure of 60 μg/m^3 was found for several measurements, while at another facility, the results for seven samples were found to be "51 μg/m^3 or less". OSHA simply stated that the addition of other controls not used at the site "should" achieve the 50 PEL.[15] The only further controls "costed" for cut stone fabricators in OSHA's cost model (workbook #7) were housekeeping measures. This is entirely a subjective judgment, especially since it is based on OSHA's expectation of what housekeeping measures at a facility would accomplish without any actual demonstration of the effectiveness of such measures at even a single site. Moreover, there is no record in the docket or the PEA that OSHA applied any statistical tools (such as their own sampling and analytical error (SAE) field test described in OSHA Method ID-142) to determine if measurements below 50 μg/m^3 could be achieved at a 95th percentile confidence level given

[14] URS Silica PEL Engineering Cost Model.xlsm, explanation sheet

[15] PEA pages IV-109 to IV-110

the results that OSHA reported for cut stone fabricator exposures. Further, all the sample measurements for cut stone fabricators used to evaluate the ability to comply with the proposed 50 μg/m^3 PEL were based on the old ACGIH definition of respirable dust, despite the fact that the new proposed ISO/CEN definition will result in higher silica measurements of up to 20% or more for most samples.

B. In its cost model, OSHA selects inappropriate or undersized controls, resulting in greatly underestimated costs for achieving the proposed PEL of 50 μg/m^3.

Inside the OSHA cost model details, there are a number of inconsistencies that reflect OSHA's failure to account for the full magnitude of controls that will be necessary to consistently achieve the proposed 50 μg/m^3 PEL.

(1) OSHA fails to account for the non-linear costs associated with each incremental reduction in silica concentrations. In its cost estimate spreadsheets, OSHA assumes that the exact same type and size of control will have the same incremental effect in reducing silica concentrations, regardless of the level of silica exposures that need to be reduced.[16] This is fundamentally inconsistent with industry's experience over the past 40 years. While large reductions in silica exposure are possible when concentrations are high, control costs increase exponentially as facilities seek to achieve lower and lower exposure levels. This is frequently observed in current OSHA enforcement actions for the 100 μg/m^3 PEL for silica, which are often left unresolved because no suitable control has been found to meet the 100 μg/m^3 PEL in every case. In contrast to OSHA's apparently linear cost curve for reducing silica exposures, industry representatives believe that it will be at least five times more difficult (and costly) to meet the 50 μg/m^3 PEL for many industrial applications as it would be to achieve the current 100 μg/m^3 PEL. *See, e.g.*, (American Foundry Society in this proceeding, describing case histories for foundries).

(2) OSHA arbitrarily applies minimally-sized controls. Engineering controls selected by OSHA were all minimally sized, and for many, if not most, industrial applications, they were based on hypothetical work areas that are much smaller than the normal work stations used in many industries. Accounting for the larger work stations would require larger controls. For example, the capture velocities for LEV systems in OSHA's models were often based on the minimum recommended velocity (see #3 below) across a very small square foot area that in many industrial settings is and must be significantly larger. These larger areas require much more LEV cfm than the OSHA model uses to attain the required capture velocity.

(3) OSHA used LEV capture velocities and related assumptions that are not appropriate for many industry sectors, resulting in undersized (lower cost) engineering controls. Many of the LEV capture velocity and cubic feet per minute (cfm) values in OSHA's cost

[16] See, *e.g.*, OSHA Cost Model Workbook, Docket ID: 2010-0034-1781, Workbook # 7__.

model came from size ranges suggested in the ACGIH Manual of Recommended Practices for Design of Industrial Ventilation (2001). Oftentimes a value on the lower end of the possible presented ranges was chosen to be used in OSHA's model. For example, Table 6-2 in Edition 28 (2013) version of the ACGIH Manual indicates ranges for recommended capture velocities dependent on the energy of dispersion of the material. Most silica-related industrial processes involve either high (analogous to conveyor loading, crushing) or very high (analogous to grinding, abrasive blasting, tumbling,) dispersion energy. Capture velocity ranges in Table 6-2 for high energy dispersion are 200 to 500 feet per minute (fpm), and for very high energy dispersion, they range from 500 to 2000 fpm. However, in OSHA's cost model, capture velocities are typically only 100 up to 250 fpm, a velocity range typically used for areas much smaller than those in many industrial applications. These velocities are either below or at the low end of the range for high energy of dispersion processes, and all were well below the lowest velocity of 500 fpm for very high energy of dispersion processes. Further, the ACGIH capture velocity values used by OSHA were first developed and published many years ago, long before silica concentrations as low as the proposed 50 $\mu g/m^3$ PEL and 25 $\mu g/m^3$ AL were even contemplated by OSHA. As a result, the velocity values used in OSHA's cost model are most likely undersized by a factor of 2 or more and, in all events, grossly underestimate the cost of LEV engineering controls.

(4) OSHA has not costed the entire package of controls recommended in the PEA. When the PEA evaluates the technological feasibility of achieving the 50 $\mu g/m^3$ PEL, it typically relies on a series of controls to be used in conjunction with each other, not separately. However, the OSHA model in many instances does not fully cost all of the controls included in the PEA as being necessary to meet the proposed PEL and AL. One of many examples of this point is in the structural clay industry where professional cleaning was found to be most effective in reducing exposures of most material handlers to below the 50 $\mu g/m^3$ PEL. OSHA further suggests professional cleaning be used for the concrete products industry, since material handling in that industry is similar.[17] However, as is discussed in these comments, professional cleaning was not utilized in either the OSHA engineering cost model or the OSHA ancillary cost model. By failing to account for the costs of these necessary engineering controls, OSHA underestimates the full compliance costs of complying with the proposed PEL.

(5) OSHA applied inaccurate unit cost figures for several engineering controls. While URS generally applied the unit cost estimates provided by OSHA, it adjusted the costs for several engineering controls based on discussions with industry representatives who explained that OSHA underestimated the unit costs for several engineering controls. For example, foundry experts pointed out that the size of the abrasive blasting cabinet cited by OSHA for a variety of industries was very much smaller than those typically used in the foundry industry, so that the cost of maintenance was greatly underestimated for

[17] PEA page IV-91.

foundries. URS used the higher costs suggested by the foundry experts.[18]

C. URS Cost Model Remedy: URS's revised cost model includes a series of additional controls that URS finds would be required to achieve and maintain compliance with the proposed PEL.

All changes or additions URS has made to the original OSHA engineering controls are listed in Table 5: Changes to Engineering Controls used in URS Alternative Engineering Costs Model. These additional controls fit into one or more of the following categories discussed below.

(1) Controls suggested by representatives of affected industry sectors. The first set of additional or alternative controls used by URS were controls suggested by representatives of specific industries that would be most significantly impacted by the proposed rule, including foundries, concrete products, and structural clay. URS discussed the problems related to engineering controls and their technical feasibility in telephone conferences and meetings with numerous plant managers, environmental health and safety (EHS) professionals, and certified industrial hygienists (CIHs). Many have had recent compliance experience with engineering controls, extensive knowledge of what was required for their industry to comply with the 100 $\mu g/m^3$ PEL, and a demonstrated basis for identifying areas where additional controls would be required to meet the proposed 50 $\mu g/m^3$ PEL. URS also relied on its own first-hand experience in addressing respirable silica exposures in plants since the 1970s. Discussions with the foundries, concrete products, and structural clay industries were most helpful in determining which job categories would definitely require additional engineering controls and/or higher levels of LEV to comply with the proposed PEL. Based on their actual case histories, industry representatives estimated that, in many cases, the cfm required for LEV would need to be five times higher than what OSHA projected in its cost spreadsheets in order to ensure compliance with a PEL of 50 $\mu g/m^3$. Further, even with additional controls, there were some jobs where meeting the 50 $\mu g/m^3$ PEL would still require respirators. In particular, maintenance workers for several industries frequently perform repair work in areas where workers normally would not be stationed, and/or when the LEV equipment must be shut down to perform maintenance or repair. All of the additional controls were assumed to apply only to attaining the 50 $\mu g/m^3$ PEL, since many facilities reported being able to comply with the 100 $\mu g/m^3$ PEL in many jobs while using smaller or less expensive controls.

(2) Adjusted size (and resulting cost) for LEV based on the experience of various general industry sectors. Plant operators also explained that they would need to design and install greatly increased LEV systems, using careful planning for mass balance of air flow, in order to reduce silica concentrations below 50 $\mu g/m^3$. They also stated that compliance could rarely be achieved by bolstering existing LEV equipment with stronger motors. Instead, it is URS's experience, confirmed by industry plant operators, that old LEV

[18] URS Silica PEL Engineering Cost Model.xlsm, Table 5, "Changes to Engineering Controls used in URS Alternative Engineering Costs Model"

systems would need to be removed, and a new system of ductwork, better shaped hoods, and reconstructed conveyor access points would need to be installed. A group of twelve professionals in the foundry industry recommended increasing the annualized costs of LEV to $27 per cfm (or higher), in part as a surrogate for the additional structural design, air flow balance, allowance for make-up air, and refitting contingencies required to achieve the proposed PEL. Instead, URS conservatively increased the unit cost to $22 per cfm (from OSHA's estimate of $12.83 per cfm) for capital costs. For operating and maintenance costs, URS used OSHA's estimate that these would be 25% of the capital cost.[19]

(3) Revised controls based on general industry sector experience that certain controls identified by OSHA would not be effective. Plant operators in several highly affected industries also indicated that several engineering controls relied upon by OSHA in the PEA would not work in practice. For example, compressed air in the foundry industry is used not just for clean-up; it is part of the production process. OSHA's suggestion to use vacuum air as a replacement, would nearly double the time to accomplish the post-pouring processing of molds. URS's alternative cost model replaced OSHA's vacuum air control with a flexible hooded duct LEV located opposite the worker; this significantly increased the cfm in order to capture the sand blown by the compressed air. Likewise, the concrete industry explained that LEV was most often not practical for concrete mixing operations because the wet concrete would set up on the filters and blind them.

(4) Adjusted LEV size required to achieve the 50 μg/m^3 PEL. As described above, when specific control recommendations were made by industry representatives as to controls within their own industry, URS adopted those specific recommendations. However, in general discussions with industry representatives, there was a clear consensus that the LEV controls possibly capable of attaining a 100 μg/m^3 PEL would not be adequate to achieve a 50 μg/m^3 PEL for most industrial jobs. Also, as described in paragraph 3 on pages 11-12, *supra,* URS found that OSHA routinely underestimated the capture velocities recommended in the ACGIH Ventilation Manual Table 6-2 for the controls used in their model by a factor of two at a minimum, and frequently much more. Therefore, for any controls not specifically addressed by industry, URS increased the LEV cfm to two times the value OSHA used in its cost spreadsheets when determining the controls needed to meet the 50 μg/m^3 PEL. This change was smaller than the upper ranges of the ACGIH recommendations and also smaller than most of the specific suggestions made by industry representatives. URS therefore believes this is a conservative estimate of the cfm that would be necessary for those workers in those job categories to meet the proposed PEL.

(5) Adjusted the bundle of engineering controls to be consistent with the scope of controls considered necessary in OSHA's industry sector discussion in the PEA. If the PEA discussed several controls that were deemed necessary to achieve the proposed PEL and

[19] This approach to operation and maintenance costs is also supported in EPA documents (EPA-452/F-03-025) for LEV baghouses.

OSHA had not incorporated all of those controls in their cost model, URS added those additional controls to its cost model at a size or quantity that it determined would be necessary to achieve the 50 $\mu g/m^3$ PEL. Most often, OSHA underestimated the required conveyor length and applied conveyers only in increments of 200 feet total length. In contrast to OSHA's minimal conveyer lengths,[20] many mid-sized or larger foundries and structural clay facilities may have thousands of feet of conveyors used in their operations. OSHA frequently discounted conveyor costs by assuming that they were included in the costs for other job stations when in fact additional conveyor covering with ventilation would be required for multiple job stations throughout each facility. Further, in the foundry sector, because some conveyors are the vibrating type due to high heat, additional cfm would be required due to higher dust levels generated from the vibration.

[20] OSHA cost model workbook #7, Docket ID: OSHA-2010-0034-1781

IV. OSHA understated the cost of complying with the proposed PEL by assigning the costs of certain controls only to achieving the existing PEL of 100 µg/m³.

A. OSHA erroneously excluded significant engineering control costs from its model when estimating the cost to comply with the proposed PEL.

Despite acknowledging the fact that there is widespread noncompliance with the current PEL, OSHA's model minimizes the costs of the proposed rule by assuming that each facility has already reduced exposures below the current PEL of 100 µg/m³. Therefore, OSHA deducted from its cost analysis the entire cost for any engineering control that OSHA determined would be needed to reduce silica exposures below 100 µg/m³, apparently because OSHA believes that industry should have already installed those specific controls to meet the current 100 µg/m³ PEL. This analysis is incorrect and not supported by OSHA's PEA.

On the contrary, in many cases, the descriptions in the PEA clearly indicate that the 50 µg/m³ PEL can only be achieved by a combination of controls, *including* the controls OSHA excludes on the basis that they are needed to meet the 100 µg/m³ PEL. In many instances where OSHA has made this assumption and excluded these costs from its economic feasibility assessment, OSHA has projected that the cost per worker to reach the 100 µg/m³ PEL is significantly larger than the additional costs needed to further reduce worker exposures below the 50 µg/m³ PEL. That belies common sense, particularly given the incremental difficulty industry will face in achieving ever lower silica concentrations. Not only will it prove much more challenging to reduce silica concentration by an additional 50 µg/m³, facilities would have exhausted all of the low-cost control options to first achieve the current 100 µg/m³ PEL.

(1) <u>The current rule, which has a PEL of 100 µg/m³, does not specify the controls that must be used to reduce exposures below 100 µg/m³.</u> Therefore, there is no designation stating that specific controls are required by the current rule and must therefore already be in place at a facility. In some instances OSHA has designated *the most expensive control* as the one that is necessary to meet the 100 µg/m³ PEL.[21] This is contrary to good practical engineering judgment, and commonsense economic decision making, where the more cost-effective controls are examined and implemented first, to determine what will meet a given limit, particularly if the existing limit is not as stringent as the proposed PEL. More expensive controls would be added only after more cost-effective options have been exhausted. Thus, to the extent that OSHA can focus solely on the incremental costs of achieving the proposed PEL, low-cost controls should be attributed to meeting the existing standard, while additional high-cost controls should be attributed to meeting the proposed standard. By adopting the opposite approach, OSHA has used a sleight of hand maneuver to shift control costs to achieving the current PEL and distort the economic feasibility analysis for the proposed rule.

(2) <u>OSHA's cost model further underestimates the costs of the proposed rule by subtracting from the estimated cost of the rule every engineering control applied to a worker</u>

[21] This is the procedure applied to the additional plumbing requirements for cut stone sawyers in the OSHA engineering cost model, Docket ID: OSHA-2010-0034-0781

currently exposed over the 100 µg/m^3 PEL, even if that specific control is only necessary to achieve the proposed 50 µg/m^3 PEL. This is done by calculating the number of employees in a given job that are currently estimated by OSHA to be exposed over the 100 µg/m^3 PEL and **subtracting the entire cost of all controls applied to those employees,** even though many of those controls would not likely be necessary if the PEL were maintained at 100 µg/m^3, but are necessary to meet the proposed 50 PEL.[22] As a result, in estimating costs to achieve the proposed PEL of 50 µg/m^3, OSHA effectively removes all costs associated with reducing the exposures of workers who are currently exposed above the 100 µg/m^3 PEL to below the 50 PEL, and instead estimates only the costs for the cohort of workers currently exposed between 50 and 100 µg/m^3.

(3) By assigning certain controls *exclusively* to achieving the current 100 µg/m^3 PEL, OSHA implicitly assumes that these controls are somehow irrelevant for achieving the proposed 50 µg/m^3 PEL. This is contrary to OSHA's assertions in the PEA where it repeatedly explains that a full suite of controls are required **in conjunction with each other to achieve the 50 µg/m^3 PEL.** As just one example, OSHA's cost analysis assigns the cost of cab enclosures for front end loaders in the asphalt paving sector solely to achieving the 100 µg/m^3 PEL.[23] Cab enclosures are often the only control cost for material handlers, so in the OSHA cost model, the entire cost of the 50 µg/m^3 PEL for material handlers has been deducted from the rule. URS agrees that a HEPA ventilated cab enclosure would most likely be a control required to meet the proposed 50 µg/m^3 PEL for material handlers. It does not follow, however, that the same engineering control would be needed to achieve the current PEL of 100 µg/m^3. Depending on the types of materials being moved and the locations in which the material is being handled, more cost effective controls might be sufficient to reduce exposures below 100 µg/m^3.

(4) Another example of the PEA stating that multiple controls are required in conjunction with each other can be found on page IV-106, which discusses the need to use pressurized water outlets, re-plumbing, floor grading, and drains in the cut stone industry. In its cost model, however, OSHA assigned all costs associated with these controls to achieving the 100 µg/m^3 PEL for sawyers and splitter/chippers in the cut stone industry. These were by far the most expensive controls for stone cutting, and the cost for these controls was consequently subtracted entirely from the cost of achieving the proposed PEL of 50 µg/m^3. According to the OSHA model, additional LEV and local wetting were the only incremental costs required to reach the 50 µg/m^3 PEL, and these controls cost many times less than retrofitting drains and plumbing. However, on page IV-106 of the PEA, OSHA makes clear that the 50 µg/m^3 PEL could only be achieved by using all controls in conjunction with each other. In contrast to OSHA, URS, consistent with its experience and understanding of industry practice, assumes the less expensive controls

[22] OSHA cost model, Docket ID: OSHA-2010-0034-0781

[23] OSHA cost model workbook #7, Docket ID: OSHA-2010-0034-1781

would have been used to meet 100 µg/m^3, while leaving the most expensive controls to achieving the proposed 50 µg/m^3 PEL.

(5) While OSHA assumes that many controls are applicable only to achieving the 100 µg/m^3 PEL, OSHA has no corresponding category of controls for workers exposed above 100 µg/m^3 that are necessary only to achieve the 50 µg/m^3 PEL (as URS has added in its alternative cost model). For these overexposed workers, there are no controls in the OSHA cost model that are 100% attributed to the costs of achieving the 50 µg/m^3 PEL, while at the same time being 0% attributable to achieving the 100 µg/m^3 PEL. Put another way, OSHA assumes **it will take fewer engineering controls to meet the 50 µg/m^3 PEL than it will take to meet the 100 µg/m^3 PEL, since its cost model assigns the costs of some controls only to meeting the 100 µg/m^3 PEL, but no controls are assigned specifically to meeting the 50 µg/m^3 PEL.** This defies common sense and industry experience. On average, most industry professionals believe it will be at least *five times* more expensive to achieve the proposed 50 µg/m^3 PEL than to achieve a PEL of 100 µg/m^3.

B. URS Cost Model Remedy: The URS cost model assumes that engineering costs necessary to reach 100 µg/m^3 will also be needed to achieve compliance with the proposed PEL.

URS changed the status of every control used exclusively by OSHA to attain only the 100 µg/m^3 PEL. In all but one instance, consistent with its experience and available information, including the PEA, URS assumed that the controls assigned to the 100 µg/m^3 PEL would also aid facilities in achieving the proposed 50 µg/m^3 PEL in conjunction with other controls and, on that basis, considered them to be applicable costs for achieving the 50 µg/m^3 PEL (i.e. the controls would be 100% applicable to both the 50 PEL and the 100 PEL, as are most controls in the OSHA model, but we did not double-count the cost of such controls in estimating the cost of achieving the proposed 50 µg/m^3 PEL). In the instance of retrofitting the sawyer room with drains, plumbing, and pressurized water in the stone cutting industry, URS assumed that this control was so expensive, it would be used only as a last resort to achieve the 50 µg/m^3 PEL, and did not cost that control for meeting the 100 µg/m^3 PEL.

V. URS's cost models are conservative and likely underestimate the costs of complying with the proposed 50 µg/m^3 PEL.

As described above, even as URS critiqued OSHA's cost analysis, it maintained several conservative assumptions that make it likely that the true costs of complying with the proposed standard will exceed URS's estimates. To further ensure the conservative nature of its analysis, URS intentionally ignored a number of sources of uncertainty that will increase compliance costs beyond those included in URS's cost estimates. For example, URS does not account for the costs that would be associated with the trial-and-error process of achieving the proposed 50 µg/m^3 PEL. While OSHA presents the suite of necessary engineering controls in a formulaic manner and simply assumes that each would be installed in a single successful effort to attain the proposed PEL, this is not the case. Instead, facilities will engage in a trial and error process, adding increasingly more costly controls and optimizing existing controls in an effort to reduce exposure below 50 µg/m^3. This trial and error process can add significant costs related to design, labor and materials, and the interim use of respirators until full compliance with the PEL can be assured. While these costs are difficult to predict with certainty, they are real costs and, by choosing not to include them in its cost model, URS intentionally ensured that its cost model would be conservative and would not inadvertently overestimate the true costs to comply with the 50 $\mu g/m^3$ PEL. Further, URS's cost model does **not** address the lack of precision in measuring low-level silica exposures. This lack of precision means that facilities will have to set average exposure targets substantially below the proposed 50 $\mu g/m^3$ PEL in order to achieve the accepted 95% statistical confidence that silica exposures will almost never exceed the proposed PEL.

VI. Discussion of the breakdown of costs to a per facility basis

After calculating total costs for each industry and facility size, URS also calculated the average cost per facility based on facility size. This is strictly an average based on all facilities in each industry in each size category; there likely are facilities in every industry and every size category that would have very little cost, and others that will have costs that are much higher. These additional cost tables will serve as inputs for the economic feasibility analysis conducted by Environomics.

SECTION 2: URS Methods and Justifications Used To Revise OSHA's Estimate of the Ancillary Costs Associated with the Proposed Silica Rule

OSHA's cost model significantly underestimates the likely costs for each industry sector to comply with the ancillary provisions of the proposed rule. To prepare a reasonable estimate, URS has developed new, more "real world" estimates of the costs of certain ancillary program requirements that industry must implement under the proposed rule. The details of the changes made by URS can be found in the "Cost Basis" sheet of the URS Revised Ancillary Costs spreadsheet. In general, URS relied on most of the unit costs used by OSHA, except as identified below. However, URS has changed most of OSHA's assumptions as to how many workers would need to be covered by each ancillary requirement to include a greater number of overexposed workers. The changes to these assumptions are outlined in the following paragraphs. Also, since the ancillary costs are due to new requirements that would be imposed for the first time by the proposed rule, the full ancillary costs are included. There is no need for a separate incremental cost calculation.

Initial Exposure Monitoring Costs

URS increased costs for initial exposure monitoring over what OSHA estimated, based on surveys and discussions with industry representatives indicating that various of OSHA's assumptions were incorrect. The surveys and discussions showed that OSHA had underestimated the costs of a certified industrial hygienist (CIH) and the CIH's assistants because OSHA understated the amount of time a CIH would spend at the facility, and because OSHA made no allowance for the CIH to draw conclusions based on the sampling and to write reports. URS estimated one day of additional time for the CIH to create a report and submit his findings.

OSHA's estimate as to the number of workers requiring initial monitoring also was too low. OSHA simply assumed that one-fourth of all workers who are at risk of potential overexposure in each job category would be monitored initially after controls had been put in place PEA V-41. This method of estimation, however, does not fully comply with the program requirements of the new rule. OSHA is requiring that every at-risk job should have at least one employee tested per facility, per shift. Many small and very small facilities do not have a total of four workers in any at-risk job category, so that the proportion of workers in at-risk jobs who will have to be monitored will be greater than one in four. Similarly, many large facilities often have two shifts. Since monitoring will be required on each shift, the proportion of at-risk employees requiring monitoring is very likely to exceed one in four at large facilities as well. In the URS cost estimates, the percentage of workers varied depending on facility size as discussed below. (For the URS alternative engineering controls cost estimate, URS had previously calculated the average number of workers from each job description at each of the three facility sizes described by OSHA.)

- **Very small facilities: URS assumed all workers in at-risk jobs will require initial monitoring**. The reason for this is that most very small facilities have on average many fewer than 10 employees in at-risk production jobs. In a very small operation, nearly all employees (if not all) actually perform several at-risk jobs. Indeed, at very small facilities, the number of at-risk jobs often exceeds the total number of at-risk production employees.

- **Small facilities: URS assumed one-half of all workers in at-risk jobs will require initial monitoring.** On average, most of these facilities also have low numbers of at-risk workers for each job, and most typically would run two shifts, requiring that at least two workers for each job description be tested.
- **Large facilities: URS assumed that at least one worker per shift for each at-risk job would be monitored**. URS based its estimate for this category on the number of at-risk jobs identified by OSHA for that industry and an average of two shifts at each facility.

In addition to the above changes to OSHA's initial monitoring cost estimates, URS also changed the amortization of the costs for initial monitoring from 10 years (used by OSHA) to 5 years. This was because initial monitoring is required to be repeated under the proposal any time there is a major change in production or control equipment for a process. These changes occur more frequently than once every 10 years; therefore it was deemed likely that additional rounds of initial monitoring would be required more frequently than once every 10 years.

Continued (Periodic) Exposure Monitoring Costs

Based on industry assessments of the effectiveness of various controls being used today, and the identification of additional controls that would likely be required in an effort to meet the new 50 $\mu g/m^3$ PEL in certain focus industries (foundries, cement products, and structural clay), it was clear to URS that OSHA's estimates for continued monitoring were unrealistically low. This is especially the case following the first round of initial monitoring, where the recently installed controls often require significant trial-and-error adjustments and modifications before becoming fully effective. Two types of ongoing monitoring were required for the proposed rule: (1) For workers found to be exposed above the proposed 50 $\mu g/m^3$ PEL based on initial monitoring, additional quarterly monitoring is required; (2) For workers exposed above the proposed 25 $\mu g/m^3$ action level, semi-annual monitoring is required. The URS model conservatively estimates that more workers will require ongoing monitoring as follows:

- The percentage of workers exceeding the proposed 50 $\mu g/m^3$ PEL and requiring quarterly monitoring after installation of controls is estimated to be one-half the percentage of workers who exceeded the 100 $\mu g/m^3$ PEL prior to the installation of controls. The exact number of workers per job is calculated on a per industry basis to reflect the variability of exposure levels across different industrial and job categories.

- The percentage of workers exceeding the proposed 25 $\mu g/m^3$ action level and requiring semi-annual monitoring after installation of controls is estimated to be one-half the percentage of workers whose exposures are currently between 50 and 100 $\mu g/m^3$ prior to the installation of controls. The exact number of workers per job is calculated on a per industry basis to reflect the variability of exposure levels across different industrial and job categories.

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Respirator Costs

URS increased OSHA's estimate of the number of workers requiring respirators after controls are installed. As noted above, URS estimates that the percentage of silica-exposed workers likely to be exposed above the proposed 50 µg/m³ PEL following the installation of controls will be one-half the percentage of silica-exposed workers that OSHA estimates are now exposed above the current 100 µg/m³ PEL. For example in the Iron Foundries industrial category, 44% of all workers in the cleaning/finishing operator job are estimated to be exposed above the current 100 µg/m³ PEL. PEA at III-51 (Table III-5). URS assumed half of these workers in this job category or 22% would remain exposed above the proposed 50 µg/m³ PEL following the installation of controls and thus require respirators. Given the fact that 44% of these workers are currently exposed above the 100 µg/m³ PEL despite the fact that employers have had over four decades to achieve compliance with that limit, it seemed quite conservative to assume that the percentage of workers exposed above a new PEL of just 50 µg/m³ would be at least half as high as the current overexposure rate, *i.e.,* 22% versus 44%. By contrast, for the entire iron foundries industrial category, OSHA estimates that 56.3% of workers are currently exposed over 50 µg/m³. OSHA assumed that just 1 in 10 of these overexposed workers or 5.6% of all silica-exposed workers in the industry will remain exposed over the proposed 50 µg/m³ PEL following the installation of controls and thus require respirators. OSHA provides no rationale for that arbitrary – and we believe totally unrealistic – assumption. OSHA also used the average exposure rate for the industrial category to obscure the variability in exposure rates across different job descriptions. As a result, OSHA estimates that a significantly smaller number of workers will have to wear respirators than URS does.

Medical Surveillance

URS significantly increased the number of workers estimated to require initial medical screening. URS believes the proposed rule, as currently worded, forces employers to provide medical screening for every worker employed in one of the jobs that have been designated as being at-risk by OSHA in the proposed rule. There are two reasons for this:

- The following passage from the PEA indicates the requirements for initial medical screening: "Paragraph (h) of the proposed standard requires an initial health screening and then triennial periodic screenings for workers exposed above the proposed PEL of 50 µg/m³ for 30 days or more per year." PEA, V-49. The problem with this requirement is that for the initial medical screening, industry is responsible for determining which workers might be exposed over the 50 µg/m³ PEL "for more than 30 days per year" after only one initial round of monitoring for silica exposure. The initial round of monitoring would not include all workers, and since 30 days is only 10% of the work year, even the workers who are tested might not have been exposed on the day of testing, but could still be exposed for more than 30 days out of the year.

- OSHA's designation of certain jobs as being at-risk for silica exposure also places employers in what appears to be an untenable legal position. If initial medical screening is not provided for all employees in an OSHA-designated at-risk job, the employer could face liabilities later if some of those workers develop pulmonary health problems.

URS believes the combination of these two factors will force industry to provide initial medical screening to all employees in designated at-risk jobs, even though the rule does not explicitly require it.

For the ongoing triennial medical surveillance, URS believes that far more workers will remain exposed above the 50 μg/m^3 PEL and require triennial medical surveillance after controls are installed than OSHA does. As in the case of respirator use, URS estimates that half of the workers who are exposed above the 100 μg/m^3 PEL prior to the installation of controls would continue to be exposed above the proposed 50 μg/m^3 PEL, with the exact percentage of workers requiring triennial medical exams being calculated on the basis of job category for each industry. In addition, URS shortened the time for annualizing the costs of medical surveillance from the ten years used by OSHA to three years. This makes sense for something that will recur every three years, and it results in a considerable increase in the annualized cost. URS did not change OSHA's estimates of the costs associated with pulmonary specialist consultations or requirements for new employee medical surveillance.

Training

URS's estimates as to which workers will require training remained the same as OSHA's estimate. OSHA, however, used an average of the worker wage rates across all affected industries, despite the fact that wages vary significantly across industry sectors, and wages in industries most affected by the training requirements are generally higher than the average wages relied on by OSHA. Accordingly, in its estimates, URS has used industry-specific wages for workers subject to training requirements, resulting in a higher final cost for the training that would be required by the proposed rule. This caused an increase in training costs due to higher wages for the workers most exposed than the average wages used by OSHA.

Regulated Areas

URS increased the number of regulated areas, again based on estimates that the exposures of far more workers would exceed the proposed PEL of 50 μg/m^3 than OSHA assumed. Details of these changes can be found on the Cost Basis sheet in the URS Ancillary Costs calculation worksheets. The major change was that if more than 25% of the workers in any job in any industrial sector initially are found to be exposed above the proposed 50 μg/m^3 PEL, then that job would require a regulated area for all facilities in that industrial sector. Also, URS increased the number of daily visitors to or passing through a regulated area, and therefore the number of disposable respirators that would be required. OSHA had assumed two visitors each day to each regulated area. URS assumed very small facilities would have one visitor, small facilities would have five visitors, and large facilities would have 20 visitors each day to each regulated area. The increased number of visitors was based on additional visits from office supervisors and administrators located elsewhere in the plant, internal and external maintenance personnel, and also outside visitors from corporate or visiting venders, deliveries, subcontract workers, or regulators. All of these categories would greatly increase as the size of the facility gets larger. URS actually decreased the number of visitors to regulated areas for very small facilities from the OSHA estimate.

Professional Cleaning

A blanket cost for annual professional cleaning apparently was removed by OSHA from the ancillary cost estimates for the proposed rule. Annual professional cleaning is identified as being a likely necessity for some industries to achieve the proposed PEL and Action Level in the PEA. E.g., PEA at IV-80, 83, 91, 92 (concrete products), IV-166, 168, 173 (foundries), IV-232 (mineral processing), IV-245, 246, 247 (porcelain enameling), IV-262, 267, 270, 271 (pottery), and IV-357, 365, 366, 367, 368, 369 (structural clay). Moreover, in OSHA's Engineering Controls spreadsheets (Workbook#7), a line item was included for annual professional cleaning costs for several industries: mineral processing, pottery, and all of the foundry categories. In this Workbook, OSHA states that these costs would be included in the (ancillary) program costs. Additional line item costs for professional cleaning occur in Tables in Appendix A of Chapter V of the PEA. E.g., PEA V-A-78, 102 (mineral processing), V-A-44, 85 (structural clay), V-A-55 (foundries). Clearly, at least some people within OSHA believed that for those industries, meeting the 50 $\mu g/m^3$ PEL was unlikely unless some form of outside professional cleaning was performed periodically. E.g., PEA V-A-8 (for structural clay, "Thorough, semi-annual professional cleaning – Commercial Cleaning Service. Addressed in program costs"); PEA-V-A-14, 16 (for Iron Foundries "Professional-level cleaning – "Covered by program requirements."). But there evidently was a miscommunication within OSHA, because costs for professional cleaning were not included in OSHA's estimates of ancillary costs.

To correct this, the URS cost model includes annual professional cleaning costs for several industry categories with higher percentages of overexposed workers. In particular, the URS ancillary cost model includes professional cleaning costs for the industrial categories identified by OSHA in its engineering controls worksheets (mineral processing, pottery, and foundries) and also for two other industrial sectors (*viz.*, Concrete Products and Structural Clay) for which professional cleaning was discussed in the PEA and that URS believes would require these services in order to comply with the proposed PEL.

Based on communications with several industries, URS estimates that a thorough annual professional cleaning will cost about $1.00 per square foot of the facility process operations area. URS used this unit cost in its ancillary costs model. A professional cleaning can take several days to accomplish and requires the facility to be shut down. URS assumes that the professional cleaning is done during a normal shut-down period; therefore the URS model does not include any costs for lost production. For square footage, URS assumed 20,000 square feet for very small facilities, 50,000 square feet for small facilities, and 200,000 square feet for large facilities.

Table 1: Overall URS Annualized Costs of Proposed Silica Rule						
Sector	Engineering Control Costs to achieve 50 PEL	Engineering Control Costs to achieve 100 PEL	Incremental Engineering Control Costs	Ancillary Provisions Costs	Total Incremental Cost of the Proposed Rule	Total Full Cost of the Proposed Rule
Asphalt Paving Products	$ 249,092	$ -	$ 249,092	$ 3,759,335	$ 4,008,427	$ 4,008,427
Asphalt Roofing Materials	$ 173,242,982	$ 57,121,739	$ 116,121,243	$ 7,387,549	$ 123,508,792	$ 180,630,531
Concrete Products	$ 582,483,088	$ 119,103,486	$ 463,379,602	$ 338,124,735	$ 801,504,337	$ 920,607,823
Costume Jewelry	$ 444,779	$ 290,162	$ 154,617	$ 1,812,338	$ 1,966,954	$ 2,257,117
Cut Stone	$ 138,143,788	$ 26,699,995	$ 111,443,793	$ 25,678,846	$ 137,122,639	$ 163,822,634
Fine Jewelry	$ 3,833,837	$ 2,577,703	$ 1,256,134	$ 16,096,315	$ 17,352,449	$ 19,930,151
Flat Glass	$ 20,468,330	$ 4,754,663	$ 15,713,667	$ 558,563	$ 16,272,230	$ 21,026,893
Iron Foundries	$ 1,247,072,468	$ 387,797,545	$ 859,274,923	$ 75,748,170	$ 935,023,093	$ 1,322,820,638
Mineral Processing	$ 97,156,919	$ 12,975,898	$ 84,181,021	$ 31,436,913	$ 115,617,934	$ 128,593,832
Mineral Wool	$ 84,442,533	$ 14,144,318	$ 70,298,215	$ 2,200,619	$ 72,498,833	$ 86,643,151
Nonferrous Sand Casting Foundries	$ 480,986,894	$ 135,680,310	$ 345,306,584	$ 34,633,883	$ 379,940,467	$ 515,620,776
Non-Sand Casting Foundries	$ 749,434,725	$ 223,184,360	$ 526,250,364	$ 50,359,945	$ 576,610,310	$ 799,794,670
Other Ferrous Sand Casting Foundries	$ 391,950,752	$ 119,543,463	$ 272,407,289	$ 24,162,351	$ 296,569,640	$ 416,113,102
Other Glass Products	$ 54,157,225	$ 15,304,377	$ 38,852,848	$ 3,427,254	$ 42,280,102	$ 57,584,479
Paint and Coatings	$ 25,363,549	$ 4,812,984	$ 20,550,565	$ 2,288,395	$ 22,838,960	$ 27,651,944
Pottery	$ 472,812,457	$ 128,479,876	$ 344,332,581	$ 50,167,685	$ 394,500,267	$ 522,980,143
Ready-Mix Concrete	$ 356,455,022	$ 11,493,697	$ 344,961,325	$ 56,589,793	$ 401,551,118	$ 413,044,815
Refractories	$ 72,260,763	$ 6,379,008	$ 65,881,755	$ 2,853,238	$ 68,734,993	$ 75,114,000
Structural Clay	$ 402,643,865	$ 138,288,396	$ 264,355,469	$ 50,191,820	$ 314,547,289	$ 452,835,685
Grand Total	**$ 5,353,603,064**	**$ 1,408,631,979**	**$ 3,944,971,085**	**$ 777,477,747**	**$ 4,722,448,832**	**$ 6,131,080,811**

Table 2A: Overall URS Engineering Control Annualized Costs

	Full Cost to reach 50 µg/m³ PEL from existing conditions				Cost to reach 100 µg/m³ PEL from existing conditions				
Row Labels	Very Small (URS 50)	Small (URS 50)	Large (URS 50)	Full Cost Total (URS 50)	Very Small (URS 100)	Small (URS 100)	Large (URS 100)	Total (URS 100)	Incremental Cost of New Rule*
Asphalt Paving Products	$ 26,629	$ 112,643	$ 109,820	$ 249,092	$ -	$ -	$ -	$ -	$ 249,092
Asphalt Roofing Materials	$ 3,927,425	$ 44,413,419	$ 124,902,138	$ 173,242,982	$ 1,295,753	$ 14,251,342	$ 41,574,644	$ 57,121,739	$ 116,121,243
Concrete Products	$ 75,764,741	$ 287,931,349	$ 218,786,998	$ 582,483,088	$ 14,649,905	$ 59,008,123	$ 45,445,458	$ 119,103,486	$ 463,379,602
Costume Jewelry	$ 143,492	$ 272,656	$ 28,631	$ 444,779	$ 95,661	$ 175,622	$ 18,879	$ 290,162	$ 154,617
Cut Stone	$ 52,810,063	$ 73,705,119	$ 11,628,606	$ 138,143,788	$ 8,429,872	$ 15,724,285	$ 2,545,838	$ 26,699,995	$ 111,443,793
Fine Jewelry	$ 953,546	$ 2,086,977	$ 793,314	$ 3,833,837	$ 660,400	$ 1,395,924	$ 521,379	$ 2,577,703	$ 1,256,134
Flat Glass	$ 466,380	$ 1,244,509	$ 18,757,440	$ 20,468,330	$ 79,361	$ 347,324	$ 4,327,978	$ 4,754,663	$ 15,713,667
Iron Foundries	$ 43,754,145	$ 414,273,828	$ 789,044,494	$ 1,247,072,468	$ 8,954,158	$ 124,069,054	$ 254,774,333	$ 387,797,545	$ 859,274,923
Mineral Processing	$ 9,182,897	$ 36,353,996	$ 51,620,027	$ 97,156,919	$ 992,562	$ 4,746,919	$ 7,236,417	$ 12,975,898	$ 84,181,021
Mineral Wool	$ 5,355,575	$ 22,693,746	$ 56,393,212	$ 84,442,533	$ 638,461	$ 3,004,621	$ 10,501,236	$ 14,144,318	$ 70,298,215
Nonferrous Sand Casting Foundries	$ 79,909,936	$ 267,858,536	$ 133,218,422	$ 480,986,894	$ 16,344,474	$ 78,180,843	$ 41,154,993	$ 135,680,310	$ 345,306,584
Non-Sand Casting Foundries	$ 64,014,366	$ 334,836,737	$ 350,583,621	$ 749,434,725	$ 13,093,254	$ 97,445,950	$ 112,645,156	$ 223,184,360	$ 526,250,364
Other Ferrous Sand Casting Foundries	$ 21,560,902	$ 193,707,887	$ 176,681,963	$ 391,950,752	$ 4,407,348	$ 61,504,788	$ 53,631,327	$ 119,543,463	$ 272,407,289
Other Glass Products	$ 4,641,849	$ 7,217,269	$ 42,298,107	$ 54,157,225	$ 778,307	$ 1,708,192	$ 12,817,878	$ 15,304,377	$ 38,852,848
Paint and Coatings	$ 2,766,166	$ 9,276,243	$ 13,321,140	$ 25,363,549	$ 523,151	$ 1,554,406	$ 2,735,427	$ 4,812,984	$ 20,550,565
Pottery	$ 89,529,300	$ 174,121,545	$ 209,161,612	$ 472,812,457	$ 17,878,162	$ 45,505,648	$ 65,096,066	$ 128,479,876	$ 344,332,581
Ready-Mix Concrete	$ 32,586,419	$ 174,418,474	$ 149,450,129	$ 356,455,022	$ 1,110,446	$ 5,672,647	$ 4,710,604	$ 11,493,697	$ 344,961,325
Refractories	$ 4,298,160	$ 23,882,176	$ 44,080,426	$ 72,260,763	$ 334,242	$ 2,204,301	$ 3,840,465	$ 6,379,008	$ 65,881,755
Structural Clay	$ 26,845,057	$ 169,363,919	$ 206,434,889	$ 402,643,865	$ 6,645,938	$ 54,865,380	$ 76,777,077	$ 138,288,396	$ 264,355,469
Grand Total	**$ 518,537,050**	**$ 2,237,771,028**	**$ 2,597,294,986**	**$ 5,353,603,064**	**$ 96,911,455**	**$ 571,365,371**	**$ 740,355,153**	**$ 1,408,631,979**	**$ 3,944,971,085**

Notes:

The calculations for reaching the proposed 50 µg/m³ PEL simulate the increased number of overexposed workers caused by OSHA's proposal to change the measurement technique from the old ACGIH method to the ISO/CEN standard. This assumes a 20% higher exposure rate for all workers.

*Uses OSHA's method of calculating final (incremental) cost (matches method used in PEA). This final (incremental) cost is calculated by subtracting the cost to reach the 100 µg/m³ PEL from the cost to reach the 50 µg/m³ PEL.

Changes from OSHA cost report:

1 The number of Engineering control packages required to achieve the proposed PEL has been adjusted up to account for a real world distribution of overexposed workers in a given job at individual facilities. Also the model adjusts for the impossibility of installing fractional controls at establishments with fewer overexposed workers than the number of workers established by OSHA as being covered by a control. To do this, a binomial distribution of overexposed workers per facility was calculated with divisions for three levels of overexposed workers per facility used to determine coverage rates of the applied controls. This calculation was performed for each at-risk job in each industry, based on the OSHA estimate of worker exposure rates for each job category.

2 The per unit cost of individual controls has been adjusted to reflect industry sector estimates of the true cost of these controls.

3 The average cost of LEV has been increased to reflect the added costs of providing makeup air, contracting engineered designs, and general renovation work required to install new more powerful LEV units. This increased the capital cost from OSHA's estimate of $12.83 to $22.00 per cfm. The operating and maintenance cost is based on OSHA's estimated 25% of capital cost. URS considers this to be a conservative cost estimate based on reports from industry representatives that the actual costs could be much higher. This conservative cost is further supported by reports from EPA (EPA-452/F-03-025) on the average costs of bag house filtration systems which would be part of a LEV control.

4 After consulting with experts in the affected industries, some job descriptions have been assigned additional controls in order to reach the required PEL.

5 The cfm requirement for most LEV controls has been upgraded to a higher amount for reaching the 50 µg/m³ PEL as a reflection of the increased air capture velocity and filtration necessary to achieve this stricter control level. Many cfm values were doubled for the 50 µg/m³ PEL, unless alternative information was provided by industry. OSHA incorrectly assumed that textbook air velocities of 100 to 250 ft./min. would be sufficient to meet both the 100 µg/m³ PEL and the proposed 50 µg/m³ PEL. Industry experience in lowerin exposure levels has typically shown that an increasingly higher capture velocity and cfm is required for each incremental change in exposure value.

6 OSHA assumed certain controls would be used to reduce worker exposures to achieve a PEL of 100 µg/m³, and thus assigned all of those costs solely to achieving compliance with the current 100 µg/m³ PEL. Contrary to this approach in its cost model, the PEA often stated that a combination of the listed controls would be necessary to reach the proposed 50 µg/m³ PEL; therefore, URS applied these controls to achieve both limits. In other instances, extremely expensive controls were applied to the 100 µg/m³ PEL only, when other less costly controls would likely be sufficient to reach a 100 µg/m³ PEL. URS adjusted for these instances.

7 The controls necessary to reach a PEL of 50 µg/m³ have been adjusted to better reflect the increased control necessary for reaching this stricter limit. Some controls discussed in the PEA as necessary to achieve the 50 µg/m³ PEL were not included in OSHA's cost estimates and have been included by URS.

8 The maximum number of workers covered by a single control has been adjusted to reflect the actual usage of controls. For example: the maximum capacity of employees covered by an enclosed vehicle cab was reduced from four to two employees, based on one employee being in the cab per shift, with two shifts assumed.

9 These cost estimates do **not** include the trial-and-error that likely will be necessary to comply with the 50 µg/m³ PEL and 25 µg/m³ AL. That could easily increase these costs by 25% or more.

10 These cost estimates do not reflect the additional cost expected from the lack of precision in measuring low-level silica exposures. The lack of precision at low levels means that facilities will have to set average exposure targets far below the proposed 50 µg/m³ PEL in order to achieve 95% statistical confidence that silica exposures will never exceed the proposed PEL

Table 2B: Per Facility URS Engineering Control Annualized Costs

	Facilities			Full Cost per facility to reach 50 µg/m³ PEL			Cost per facility to reach 100 µg/m³ PEL			Incremental cost per facility for new rule		
Sector	Very Small	Small	Large	Very Small	Small	Large	Very Small	Small	Large	Very Small	Small	Large
Asphalt Paving Products	265	448	718	$ 100	$ 251	$ 153	$ -	$ -	$ -	$ 100	$ 251	$ 153
Asphalt Roofing Materials	57	74	93	$ 68,902	$ 600,181	$ 1,343,034	$ 22,733	$ 192,586	$ 447,039	$ 46,170	$ 407,596	$ 895,995
Concrete Products	1,973	1,277	832	$ 38,401	$ 225,475	$ 262,965	$ 7,425	$ 46,208	$ 54,622	$ 30,976	$ 179,266	$ 208,343
Costume Jewelry	514	74	2	$ 279	$ 3,685	$ 14,316	$ 186	$ 2,373	$ 9,440	$ 93	$ 1,311	$ 4,876
Cut Stone	1,473	429	41	$ 35,852	$ 171,807	$ 283,625	$ 5,723	$ 36,653	$ 62,094	$ 30,129	$ 135,153	$ 221,531
Fine Jewelry	1,751	268	22	$ 545	$ 7,787	$ 36,060	$ 377	$ 5,209	$ 23,699	$ 167	$ 2,579	$ 12,361
Flat Glass	37	10	36	$ 12,605	$ 124,451	$ 521,040	$ 2,145	$ 34,732	$ 120,222	$ 10,460	$ 89,719	$ 400,818
Iron Foundries	201	221	105	$ 217,682	$ 1,874,542	$ 7,514,709	$ 44,548	$ 561,398	$ 2,426,422	$ 173,134	$ 1,313,144	$ 5,088,287
Mineral Processing	78	86	107	$ 117,729	$ 422,721	$ 482,430	$ 12,725	$ 55,197	$ 67,630	$ 105,004	$ 367,524	$ 414,800
Mineral Wool	118	75	128	$ 45,386	$ 302,583	$ 440,572	$ 5,411	$ 40,062	$ 82,041	$ 39,976	$ 262,522	$ 358,531
Nonferrous Sand Casting Foundries	274	178	31	$ 292,048	$ 1,507,671	$ 4,355,210	$ 59,734	$ 440,049	$ 1,345,449	$ 232,313	$ 1,067,622	$ 3,009,761
Non-Sand Casting Foundries	229	205	61	$ 279,075	$ 1,630,675	$ 5,708,742	$ 57,081	$ 474,568	$ 1,834,262	$ 221,994	$ 1,156,108	$ 3,874,480
Other Ferrous Sand Casting Foundries	102	93	27	$ 211,381	$ 2,082,881	$ 6,543,776	$ 43,209	$ 661,342	$ 1,986,345	$ 168,172	$ 1,421,539	$ 4,557,431
Other Glass Products	392	72	107	$ 11,841	$ 100,240	$ 395,309	$ 1,985	$ 23,725	$ 119,793	$ 9,856	$ 76,515	$ 275,516
Paint and Coatings	248	126	74	$ 11,169	$ 73,621	$ 179,208	$ 2,112	$ 12,337	$ 36,799	$ 9,057	$ 61,284	$ 142,409
Pottery	722	128	47	$ 124,002	$ 1,360,325	$ 4,450,247	$ 24,762	$ 355,513	$ 1,385,023	$ 99,240	$ 1,004,812	$ 3,065,224
Ready-Mix Concrete	1,454	2,337	2,273	$ 22,412	$ 74,633	$ 65,750	$ 764	$ 2,427	$ 2,072	$ 21,648	$ 72,206	$ 63,678
Refractories	95	79	60	$ 45,244	$ 302,306	$ 734,674	$ 3,518	$ 27,903	$ 64,008	$ 41,725	$ 274,403	$ 670,666
Structural Clay	192	138	116	$ 139,818	$ 1,227,275	$ 1,779,611	$ 34,614	$ 397,575	$ 661,871	$ 105,204	$ 829,700	$ 1,117,740
Grand Total	**10,175**	**6,318**	**4,880**									

Notes:

The calculations for reaching the proposed 50 µg/m³ PEL simulate the increased number of overexposed workers caused by OSHA's proposal to change the measurement technique from the old ACGIH method to the ISO/CEN standard. This assumes a 20% higher exposure rate for all workers.

*Uses OSHA's method of calculating final (incremental) cost (matches method used in PEA). This final (incremental) cost is calculated by subtracting the cost to reach the 100 µg/m³ PEL from the cost to reach the 50 µg/m³ PEL.

Changes from OSHA cost report:

1 The number of Engineering control packages required to achieve the proposed PEL has been adjusted up to account for a real world distribution of overexposed workers in a given job at individual facilities. Also the model adjusts for the impossibility of installing fractional controls at establishments with fewer overexposed workers than the number of workers established by OSHA as being covered by a control. To do this, a binomial distribution of overexposed workers per facility was calculated with divisions for three levels of overexposed workers per facility used to determine coverage rates of the applied controls. This calculation was performed for each at-risk job in each industry, based on the OSHA estimate of worker exposure rates for each job category.

2 The per unit cost of individual controls has been adjusted to reflect industry sector estimates of the true cost of these controls.

3 The average cost of LEV has been increased to reflect the added costs of providing makeup air, contracting engineered designs, and general renovation work required to install new more powerful LEV units. This increased the capital cost from OSHA's estimate of $12.83 to $22.00 per cfm. The operating and maintenance cost is based on OSHA's estimated 25% of capital cost. URS considers this to be a conservative cost estimate based on reports from industry representatives that the actual costs could be much higher. This conservative cost is further supported by reports from EPA (EPA-452/F-03-025) on the average costs of bag house filtration systems which would be part of a LEV control.

4 After consulting with experts in the affected industries, some job descriptions have been assigned additional controls in order to reach the required PEL.

5 The cfm requirement for most LEV controls has been upgraded to a higher amount for reaching the 50 µg/m³ PEL as a reflection of the increased air capture velocity and filtration necessary to achieve this stricter control level. Man cfm values were doubled for the 50 µg/m³ PEL, unless alternative information was provided by industry. OSHA incorrectly assumed that textbook air velocities of 100 to 250 ft./min. would be sufficient to meet both the 100 µg/m³ PEL and the proposed 50 µg/m³ PEL. Industry experience in lowering exposure levels has typically shown that an increasingly higher capture velocity and cfm is required for each incremental change in exposure value.

6 OSHA assumed certain controls would be used to reduce worker exposures to achieve a PEL of 100 µg/m³, and thus assigned all of those costs solely to achieving compliance with the current 100 µg/m³ PEL. Contrary to this approach in its cost model, the PEA often stated that a combination of the listed controls would be necessary to reach the proposed 50 µg/m³ PEL; therefore, URS applied these controls to achieve both limits. In other instances, extremely expensive controls were applied to the 100 µg/m³ PEL only, when other less costly controls would likely be sufficient to reach a 100 µg/m³ PEL. URS adjusted for these instances.

7 The controls necessary to reach a PEL of 50 µg/m³ have been adjusted to better reflect the increased control necessary for reaching this stricter limit. Some controls discussed in the PEA as necessary to achieve the 50 µg/m³ PEL were not included in OSHA's cost estimates and have been included by URS.

8 The maximum number of workers covered by a single control has been adjusted to reflect the actual usage of controls. For example: the maximum capacity of employees covered by an enclosed vehicle cab was reduced from four to two employees, based on one employee being in the cab per shift, with two shifts assumed.

9 These cost estimates do not include the trial-and-error that likely will be necessary to comply with the 50 µg/m³ PEL and 25 µg/m³ AL. That could easily increase these costs by 25% or more.

10 These cost estimates do not reflect the additional cost expected from the lack of precision in measuring low-level silica exposures. The lack of precision at low levels means that facilities will have to set average exposure targets far below the proposed 50 µg/m3 PEL in order to achieve 95% statistical confidence that silica exposures will never exceed the proposed PEL

Table 3A: Overall OSHA Engineering Control Annualized Costs

	Full Cost to Reach 50 PEL from existing conditions				Cost to Reach 100 PEL from existing conditions				Incremental Cost of New Rule*
Industrial Sector	Very Small (OSHA 50)	Small (OSHA 50)	Large (OSHA 50)	Full Cost Total (OSHA 50)	Very Small (OSHA 100)	Small (OSHA 100)	Large (OSHA 100)	Total (OSHA 100)	Final Cost
Asphalt Paving Products	$ 19,148	$ 80,997	$ 78,967	$ 179,111	$ -	$ -	$ -	$ -	$ 179,111
Asphalt Roofing Materials	$ 104,227	$ 1,108,625	$ 3,175,442	$ 4,388,294	$ 52,113	$ 554,313	$ 1,587,721	$ 2,194,147	$ 2,194,147
Concrete Products	$ 3,944,978	$ 17,045,222	$ 12,994,335	$ 33,984,535	$ 2,581,626	$ 11,154,535	$ 8,503,600	$ 22,239,761	$ 11,744,774
Costume Jewelry	$ 41,363	$ 72,950	$ 8,114	$ 122,427	$ 29,545	$ 52,107	$ 5,795	$ 87,448	$ 34,979
Cut Stone	$ 4,560,740	$ 9,588,627	$ 1,628,063	$ 15,777,429	$ 2,856,834	$ 6,006,287	$ 1,019,814	$ 9,882,934	$ 5,894,495
Fine Jewelry	$ 283,237	$ 590,085	$ 225,413	$ 1,098,734	$ 202,312	$ 421,489	$ 161,009	$ 784,810	$ 313,924
Flat Glass	$ 5,431	$ 26,668	$ 323,576	$ 355,675	$ 1,952	$ 9,588	$ 116,330	$ 127,870	$ 227,805
Iron Foundries**	$ 548,839	$ 8,768,478	$ 19,088,483	$ 28,405,800	$ 356,190	$ 5,690,628	$ 12,388,178	$ 18,434,996	$ 9,970,804
Mineral Processing	$ 417,012	$ 1,965,800	$ 2,995,350	$ 5,378,162	$ 139,004	$ 655,267	$ 998,450	$ 1,792,721	$ 3,585,441
Mineral Wool	$ 60,374	$ 322,044	$ 1,055,274	$ 1,437,692	$ 22,665	$ 120,896	$ 396,152	$ 539,713	$ 897,979
Nonferrous Sand Casting Foundries**	$ 1,000,306	$ 5,610,683	$ 3,157,278	$ 9,768,267	$ 649,329	$ 3,642,065	$ 2,049,485	$ 6,340,879	$ 3,427,388
Non-Sand Casting Foundries**	$ 801,327	$ 7,060,528	$ 8,432,382	$ 16,294,237	$ 520,166	$ 4,583,203	$ 5,473,716	$ 10,577,084	$ 5,717,152
Other Ferrous Sand Casting Foundries**	$ 270,099	$ 4,153,199	$ 4,078,838	$ 8,502,137	$ 175,291	$ 2,695,372	$ 2,647,113	$ 5,517,776	$ 2,984,360
Other Glass Products	$ 118,128	$ 286,863	$ 2,073,453	$ 2,478,444	$ 45,072	$ 109,453	$ 791,129	$ 945,654	$ 1,532,790
Paint and Coatings	$ 80,788	$ 274,745	$ 459,915	$ 815,448	$ 80,788	$ 274,745	$ 459,915	$ 815,448	$ -
Pottery	$ 1,296,163	$ 3,727,296	$ 5,176,334	$ 10,199,792	$ 776,633	$ 2,233,316	$ 3,101,549	$ 6,111,498	$ 4,088,295
Ready-Mix Concrete	$ 1,041,574	$ 5,320,817	$ 4,418,442	$ 10,780,833	$ 362,409	$ 1,851,345	$ 1,537,369	$ 3,751,123	$ 7,029,710
Refractories	$ 85,229	$ 542,678	$ 1,029,955	$ 1,657,862	$ 49,831	$ 317,293	$ 602,194	$ 969,318	$ 688,544
Structural Clay	$ 1,304,326	$ 13,317,835	$ 18,862,512	$ 33,484,673	$ 858,254	$ 8,763,217	$ 12,411,649	$ 22,033,121	$ 11,451,552
Grand Total	**$ 15,983,288**	**$ 79,864,141**	**$ 89,262,124**	**$ 185,109,552**	**$ 9,760,014**	**$ 49,135,119**	**$ 54,251,167**	**$ 113,146,301**	**$ 71,963,251**

Notes:

* Uses OSHA method of calculating incremental cost (matches cost shown in PEA). This incremental cost is calculated by subtracting the cost to reach the 100 μg/m³ PEL from the cost to reach 50 100 μg/m³ PEL.

** Does not match PEA cost due to a mistake in the calculations made by OSHA.

Table 3B: Per Facility OSHA Engineering Control Annualized Costs

	Facilities			Full Cost per facility to reach 50 PEL			Cost per facility to reach 100 PEL			Incremental Cost per facility for new rule		
Industrial Sector	**Very Small**	**Small**	**Large**	**Very Small**	**Small**	**Large**	**Very Small**	**Small**	**Large**	**Very Small**	**Small**	**Large**
Asphalt Paving Products	265	448	718	$ 72	$ 181	$ 110	$ -	$ -	$ -	$ 72	$ 181	$ 110
Asphalt Roofing Materials	57	74	93	$ 1,829	$ 14,981	$ 34,145	$ 914	$ 7,491	$ 17,072	$ 914	$ 7,491	$ 17,072
Concrete Products	1,973	1,277	832	$ 1,999	$ 13,348	$ 15,618	$ 1,308	$ 8,735	$ 10,221	$ 691	$ 4,613	$ 5,398
Costume Jewelry	514	74	2	$ 80	$ 986	$ 4,057	$ 57	$ 704	$ 2,898	$ 23	$ 282	$ 1,159
Cut Stone	1,473	429	41	$ 3,096	$ 22,351	$ 39,709	$ 1,939	$ 14,001	$ 24,874	$ 1,157	$ 8,350	$ 14,835
Fine Jewelry	1,751	268	22	$ 162	$ 2,202	$ 10,246	$ 116	$ 1,573	$ 7,319	$ 46	$ 629	$ 2,927
Flat Glass	37	10	36	$ 147	$ 2,667	$ 8,988	$ 53	$ 959	$ 3,231	$ 94	$ 1,708	$ 5,757
Iron Foundries**	201	221	105	$ 2,731	$ 39,676	$ 181,795	$ 1,772	$ 25,749	$ 117,983	$ 958	$ 13,927	$ 63,812
Mineral Processing	78	86	107	$ 5,346	$ 22,858	$ 27,994	$ 1,782	$ 7,619	$ 9,331	$ 3,564	$ 15,239	$ 18,663
Mineral Wool	118	75	128	$ 512	$ 4,294	$ 8,244	$ 192	$ 1,612	$ 3,095	$ 320	$ 2,682	$ 5,149
Nonferrous Sand Casting Foundries**	274	178	31	$ 3,656	$ 31,580	$ 103,219	$ 2,373	$ 20,500	$ 67,002	$ 1,283	$ 11,081	$ 36,216
Non-Sand Casting Foundries**	229	205	61	$ 3,493	$ 34,385	$ 137,309	$ 2,268	$ 22,320	$ 89,131	$ 1,226	$ 12,065	$ 48,178
Other Ferrous Sand Casting Foundries**	102	93	27	$ 2,648	$ 44,658	$ 151,068	$ 1,719	$ 28,982	$ 98,041	$ 929	$ 15,676	$ 53,027
Other Glass Products	392	72	107	$ 301	$ 3,984	$ 19,378	$ 115	$ 1,520	$ 7,394	$ 186	$ 2,464	$ 11,984
Paint and Coatings	743	378	223	$ 109	$ 727	$ 2,062	$ 109	$ 727	$ 2,062	$ -	$ -	$ -
Pottery	722	128	47	$ 1,795	$ 29,119	$ 110,135	$ 1,076	$ 17,448	$ 65,990	$ 720	$ 11,672	$ 44,144
Ready-Mix Concrete	1,454	2,337	2,273	$ 716	$ 2,277	$ 1,944	$ 249	$ 792	$ 676	$ 467	$ 1,485	$ 1,268
Refractories	95	79	60	$ 897	$ 6,869	$ 17,166	$ 525	$ 4,016	$ 10,037	$ 373	$ 2,853	$ 7,129
Structural Clay	192	138	116	$ 6,793	$ 96,506	$ 162,608	$ 4,470	$ 63,502	$ 106,997	$ 2,323	$ 33,004	$ 55,611
Grand Total	**10,670**	**6,570**	**5,029**									

Notes:

* Uses OSHA method of calculating incremental cost (matches cost shown in PEA). This incremental cost is calculated by subtracting the cost to reach the 100 μg/m³ PEL from the cost to reach 50 100 μg/m³ PEL.

** Does not match PEA cost due to a mistake in the calculations made by OSHA.

Table 4A: Total Ancillary Provisions Annualized Costs

Sector	Total OSHA Ancillary Costs				Total URS Ancillary Costs			
	OSHA (Very Small)	OSHA (Small)	OSHA (Large)	OSHA (Total)	URS (Very Small)	URS (Small)	URS (Large)	URS (Total)
Asphalt Paving Products	$ 6,731	$ 28,471	$ 27,757	$ 62,959	$ 332,428	$ 1,121,938	$ 2,304,969	$ 3,759,335
Asphalt Roofing Materials	$ 22,875	$ 243,312	$ 696,920	$ 963,107	$ 198,648	$ 1,950,294	$ 5,238,607	$ 7,387,549
Concrete Products	$ 842,144	$ 3,636,868	$ 2,773,749	$ 7,252,760	$ 47,881,320	$ 97,611,730	$ 192,631,685	$ 338,124,735
Costume Jewelry	$ 30,760	$ 54,250	$ 6,034	$ 91,043	$ 642,744	$ 1,054,116	$ 115,478	$ 1,812,338
Cut Stone	$ 782,156	$ 1,644,427	$ 279,209	$ 2,705,792	$ 7,745,819	$ 15,367,073	$ 2,565,954	$ 25,678,846
Fine Jewelry	$ 404,028	$ 841,736	$ 321,544	$ 1,567,308	$ 4,440,247	$ 8,605,874	$ 3,050,194	$ 16,096,315
Flat Glass	$ 723	$ 3,550	$ 43,077	$ 47,351	$ 11,444	$ 43,028	$ 504,092	$ 558,563
Iron Foundries	$ 76,101	$ 1,215,819	$ 2,646,769	$ 3,938,688	$ 4,863,915	$ 23,673,179	$ 47,211,077	$ 75,748,170
Mineral Processing	$ 78,280	$ 369,012	$ 562,275	$ 1,009,567	$ 1,957,484	$ 5,924,916	$ 23,554,513	$ 31,436,913
Mineral Wool	$ 8,255	$ 44,032	$ 144,285	$ 196,572	$ 98,641	$ 487,981	$ 1,613,997	$ 2,200,619
Nonferrous Sand Casting Foundries	$ 147,046	$ 813,952	$ 448,922	$ 1,409,920	$ 7,006,346	$ 16,968,842	$ 10,658,695	$ 34,633,883
Non-Sand Casting Foundries	$ 113,094	$ 992,029	$ 1,179,777	$ 2,284,900	$ 5,822,016	$ 20,448,083	$ 24,089,846	$ 50,359,945
Other Ferrous Sand Casting Foundries	$ 37,901	$ 582,790	$ 572,355	$ 1,193,047	$ 2,457,491	$ 10,637,918	$ 11,066,941	$ 24,162,351
Other Glass Products	$ 14,720	$ 35,744	$ 258,343	$ 308,806	$ 181,624	$ 407,919	$ 2,837,711	$ 3,427,254
Paint and Coatings	$ 14,294	$ 48,612	$ 81,375	$ 144,281	$ 283,457	$ 815,423	$ 1,189,515	$ 2,288,395
Pottery	$ 244,073	$ 701,867	$ 974,727	$ 1,920,668	$ 17,185,341	$ 13,817,750	$ 19,164,595	$ 50,167,685
Ready-Mix Concrete	$ 916,028	$ 4,679,475	$ 3,885,867	$ 9,481,370	$ 5,627,657	$ 26,012,486	$ 24,949,650	$ 56,589,793
Refractories	$ 20,662	$ 131,560	$ 249,689	$ 401,910	$ 180,496	$ 976,047	$ 1,696,695	$ 2,853,238
Structural Clay	$ 57,692	$ 579,825	$ 817,786	$ 1,455,302	$ 4,524,559	$ 13,415,053	$ 32,252,208	$ 50,191,820
Grand Total	**$ 3,817,562**	**$ 16,647,329**	**$ 15,970,460**	**$ 36,435,351**	**$ 111,441,674**	**$ 259,339,652**	**$ 406,696,421**	**$ 777,477,747**

Notes:

1 The OSHA cost model underestimates the number of impacted employees by using only 10% of the workers currently exposed over 50 $\mu g/m^3$. The URS cost model assumes half of the percentage of the workers currently exposed over the existing PEL of 100 $\mu g/m^3$ will remain exposed over the new PEL of 50 $\mu g/m^3$ after all engineering controls have been installed. This method conservatively accounts for the same difficulty facilities have faced in achieving the current PEL. This subset of workers was used to calculate the costs for quarterly exposure monitoring, triennial medical exams, respirators, and regulated areas.

2 After consulting with many industry professionals and reviewing recent expenses incurred by industry, some of the cost basis numbers have been adjusted from those used by OSHA.

3 Professional cleaning once per year has been included in the URS Ancillary costs as a necessary item for all foundry sectors, and for concrete products, mineral processing, pottery, and structural clay sectors. This method of controlling exposure was highlighted and recommended in the PEA as part of the steps required to achieve the proposed PEL, but no cost for it was included in OSHA's estimate of either engineering control costs or ancillary costs. As this control is necessarily applied to the whole facility instead of individual jobs, URS chose to add the expense as an ancillary cost. Professional cleaning accounts for approximately 60% of the total ancillary costs.

4 The OSHA cost model lists professional cleaning for all foundry sectors as well as the mineral processing and pottery sectors. URS has added the concrete products and structural clay sectors to the list requiring professional cleaning because the description of controls in the PEA states that use of professional cleaning services may be necessary to achieve the 50 $\mu g/m^3$ PEL in these sectors.

5 A professional cleaning process typically involves a thorough cleaning of the entire industrial facility. Based on consultation with industry representatives, URS has estimated the cleaning would cost approximately $1 per square foot of a facility. However, to be conservative, URS has assumed the professional cleaning would occur when a facility is not otherwise operating (such as during a planned end-of-year maintenance period). Thus, no cost for productivity loss has been included in these calculations.

Table 4B: Per Facility Ancillary Provisions Annualized Costs

	Facilities			OSHA Cost per facility			URS Cost per facility		
Sector	**Very Small**	**Small**	**Large**	**Very Small**	**Small**	**Large**	**Very Small**	**Small**	**Large**
Asphalt Paving Products	265	448	718	$ 25	$ 64	$ 39	$ 1,254	$ 2,504	$ 3,210
Asphalt Roofing Materials	57	74	93	$ 401	$ 3,288	$ 7,494	$ 3,485	$ 26,355	$ 56,329
Concrete Products	1,973	1,277	832	$ 427	$ 2,848	$ 3,334	$ 24,268	$ 76,438	$ 231,528
Costume Jewelry	514	74	2	$ 60	$ 733	$ 3,017	$ 1,250	$ 14,245	$ 57,739
Cut Stone	1,473	429	41	$ 531	$ 3,833	$ 6,810	$ 5,259	$ 35,821	$ 62,584
Fine Jewelry	1,751	268	22	$ 231	$ 3,141	$ 14,616	$ 2,536	$ 32,111	$ 138,645
Flat Glass	37	10	36	$ 20	$ 355	$ 1,197	$ 309	$ 4,303	$ 14,003
Iron Foundries	201	221	105	$ 379	$ 5,501	$ 25,207	$ 24,199	$ 107,118	$ 449,629
Mineral Processing	78	86	107	$ 1,004	$ 4,291	$ 5,255	$ 25,096	$ 68,894	$ 220,136
Mineral Wool	118	75	128	$ 70	$ 587	$ 1,127	$ 836	$ 6,506	$ 12,609
Nonferrous Sand Casting Foundries	274	178	31	$ 537	$ 4,581	$ 14,676	$ 25,606	$ 95,511	$ 348,457
Non-Sand Casting Foundries	229	205	61	$ 493	$ 4,831	$ 19,211	$ 25,381	$ 99,583	$ 392,268
Other Ferrous Sand Casting Foundries	102	93	27	$ 372	$ 6,267	$ 21,198	$ 24,093	$ 114,386	$ 409,887
Other Glass Products	392	72	107	$ 38	$ 496	$ 2,414	$ 463	$ 5,666	$ 26,521
Paint and Coatings	248	126	74	$ 58	$ 386	$ 1,095	$ 1,145	$ 6,472	$ 16,002
Pottery	722	128	47	$ 338	$ 5,483	$ 20,739	$ 23,802	$ 107,951	$ 407,757
Ready-Mix Concrete	1,454	2,337	2,273	$ 630	$ 2,002	$ 1,710	$ 3,870	$ 11,131	$ 10,977
Refractories	95	79	60	$ 217	$ 1,665	$ 4,161	$ 1,900	$ 12,355	$ 28,278
Structural Clay	192	138	116	$ 300	$ 4,202	$ 7,050	$ 23,565	$ 97,211	$ 278,036
Grand Total	**10,175**	**6,318**	**4,880**						

Notes:

1 The OSHA cost model underestimates the number of impacted employees by using only 10% of the workers currently exposed over 50 μg/m³. The URS cost model assumes half of the percentage of the workers currently exposed over the existing PEL of 100 μg/m³ will remain exposed over the new PEL of 50 μg/m³ after all engineering controls have been installed. This method conservatively accounts for the same difficulty facilities have faced in achieving the current PEL. This subset of workers was used to calculate the costs for quarterly exposure monitoring, triennial medical exams, respirators, and regulated areas.

2 After consulting with many industry professionals and reviewing recent expenses incurred by industry, some of the cost basis numbers have been adjusted from those used by OSHA.

3 Professional cleaning once per year has been included in the URS Ancillary costs as a necessary item for all foundry sectors, and for concrete products, mineral processing, pottery, and structural clay sectors. This method of controlling exposure was highlighted and recommended in the PEA as part of the steps required to achieve the proposed PEL, but no cost for it was included in OSHA's estimate of either engineering control costs or ancillary costs. As this control is necessarily applied to the whole facility instead of individual jobs, URS chose to add the expense as an ancillary cost. Professional cleaning accounts for approximately 60% of the total ancillary costs.

4 The OSHA cost model lists professional cleaning for all foundry sectors as well as the mineral processing and pottery sectors. URS has added the concrete products and structural clay sectors to the list requiring professional cleaning because the description of controls in the PEA states that use of professional cleaning services may be necessary to achieve the 50 μg/m³ PEL in these sectors.

5 A professional cleaning process typically involves a thorough cleaning of the entire industrial facility. Based on consultation with industry representatives, URS has estimated the cleaning would cost approximately $1 per square foot of a facility. However, to be conservative, URS has assumed the professional cleaning would occur when a facility is not otherwise operating (such as during a planned end-of-year maintenance period). Thus, no cost for productivity loss has been included in these calculations.