



**Paragon Technical Services, Inc.**

**Recommendation to US Department of Labor  
Office of Workers' Compensation Programs  
Division of Energy Employees Occupational Illness Compensation**

**For**

**Integrating the Recommendation of the Department of Labor  
Advisory Board on Toxic Substances and Worker Health  
Jobs Presumed Asbestos Exposure**

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## Acronyms

ABTSWH	Advisory Board on Toxic Substances and Worker Health
BLS	U.S. Bureau of Labor Statistics
DOE	Department of Energy
DOL	Department of Labor
EEOICP	Energy Employees Occupational Illness Compensation Program
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
HVAC	Heating, Ventilation, and Air Conditioning
NOMS	National Occupational Mortality System
PMR	Proportionate Mortality Ratio
PTS	Paragon Technical Services, Inc.
SEM	Site Exposure Matrix
SOC	Standard Occupational Classification

## EXECUTIVE SUMMARY

The Department of Labor (DOL) Advisory Board on Toxic Substances and Worker Health (ABTSWH) submitted a recommendation on June 19, 2020 (Attachment 1), to the Secretary of Labor for consideration of changes to the Energy Employees Occupational Illness Compensation Program (EEOICP) regarding the determination of asbestos exposure under EEOICP compensation cases. DOL tasked Paragon Technical Services, Inc. (PTS) to review the information in the literature provided by the ABTSWH, and to suggest labor categories that provide sufficient evidence to be added to the EEOICP Asbestos Exposure Presumption List.

The literature provided by the ABTSWH highlighted 49 occupation groupings for consideration by DOL for inclusion in the Asbestos Exposure Presumption List. The PTS review and evaluation determined that:

- Eighteen of the 49 occupations are currently included in the EEOICP Asbestos Exposure Presumption List. The review of the corresponding Site Exposure Matrix (SEM) labor categories validated that the list adequately covers these occupations, as defined in the ABTSWH highlighted literature.
- Based on the analysis of the occupation groups and the corresponding definition and associated industry codes, four occupations are recommended to be added to the Asbestos Exposure Presumption List. These occupations include **Stationary Engineers; Precision Instrument and Equipment Repairers** (integrated as electronics and instrument maintenance work process); **Heating, Ventilation, and Air Conditioning (HVAC) Mechanics, Installers, and Repairer;** and **Firefighters and Supervisors of Firefighters.**
- Three of the occupations considered are not recommended to be added to the Asbestos Exposure Presumption List since they are not present at Department of Energy (DOE) facilities. These occupations include **Marine Engineers and Naval Architects; Aircraft and Structural Metal Fabricators;** and **Ship Captains and Mates and Engineers.**
- Four of the occupations considered are not recommended to be included as being so broad and nonspecific that it would be impossible to integrate them into the DOE labor categories. These occupations include **Supervisors, Production Operations; Drafting Occupations; Engineers, NEC (Not Elsewhere Classified);** and **Machine Operators Not Specified.**

This report also includes the evaluation and rationale for not recommending the addition of the remaining 20 occupations. Among these occupations, three occupations (Layout Workers, Materials Engineers, and Molding and Casting Machine Operators) were not recommended to be added to the Asbestos Exposure Presumption List because the National Occupational Mortality System (NOMS) sample could have come from a broad range of industries. Many of the associated industries for these occupations are drastically different from the nature of potential exposures at DOE sites. Additionally, the NOMS sample sizes for these occupations were small. Therefore, PTS recommends that the actual industry codes associated with the death certificates for these occupations be examined by DOL to determine whether the small sample came from industries that are similar to the DOE environment; if so, these occupations should be reconsidered for inclusion.

## 1.0 BACKGROUND

The Department of Labor (DOL) Advisory Board on Toxic Substances and Worker Health (ABTSWH) submitted a recommendation on June 19, 2020 (Attachment 1), to the Secretary of Labor for consideration of changes to the Energy Employees Occupational Illness Compensation Program (EEOICP) regarding the determination of asbestos exposure under EEOICP compensation cases. The ABTSWH Recommendation in part stated:

“We recommend that the Department of Labor evaluate the job categories and associated aliases for all DOE sites in the Site Exposure Matrix (SEM) and revise its list of occupations with presumed pre-1995 asbestos exposure (Exhibit 15-4) to reflect current knowledge as summarized in this rationale and associated data and references. Supervisors of the listed job categories should also be considered for inclusion.”

DOL tasked Paragon Technical Services, Inc. (PTS) to review the information in the literature provided by the ABTSWH for review and analysis. The primary focus of this review was on the occupations highlighted in the analysis presented by the ABTSWH of the National Occupational Mortality System (NOMS) for the purpose of identifying occupations with exposure to asbestos. This PTS report is structured around Table 3, *Occupations with Elevated PMR's [proportionate mortality ratios] for Malignant Mesothelioma in Descending Order of PMR, (NOMS, 1999, 2003, 2004, 2007-2014)*, of the attached ABTSWH Recommendation for highlighting occupations for consideration.

### 1.1 History of Asbestos Exposure Presumption

In September 2017, a procedure for Presumptions of Exposures was included in the EEOICP Procedure Manual. This procedure provided for certain presumptions to be made as to the nature, frequency, and duration of a specific exposure. These presumptions are included in the manual as Exhibit 15-4, *Exposure and Causation Presumptions with Development Guidance for Certain Conditions*. This exhibit is referenced in the ABTSWH Recommendation. The labor categories used in the Asbestos Exposure Presumption List primarily relied on the scientific research conducted and compiled by the Agency for Toxic Substances and Disease Registry (ATSDR) within the Department of Health and Human Services. ATSDR published a booklet on January 29, 2014, entitled *Case Studies in Environmental Medicine, Asbestos Toxicity*, that included a list of occupations determined to entail significant asbestos exposures. This ATSDR list was tailored to labor categories relevant to the DOE complex and DOE facility job descriptions.

The exposure presumptions are specific to certain labor categories, work processes, and/or timeframes. The exposure presumption for asbestos recognizes that asbestos is a toxic material that was present in all Department of Energy (DOE) facility locations. For labor categories identified in the Energy Employees Occupational Illness Compensation Program Act (EEOICPA) Procedure Manual for asbestos exposure presumption, the worker is presumed to have had significant exposure to asbestos based on job tasks. For labor categories not included, the case is referred to an industrial hygienist to determine the level, extent, nature, and frequency of exposure, including whether the exposure was significant (high, moderate, or low) or not significant (incidental – occurring in passing only).

### 1.2 SEM Labor Categories versus Standardized Occupational Codes

The labor categories shown in SEM are site specific and linked to the labor title terminology used at each site. Each DOE site that has been profiled has a unique SEM profile, and each profile includes the labor category titles used at the applicable site, as defined in site procedures, union contracts, and site personnel

records. This design facilitates and simplifies SEM use by both DOL and the public. In contrast, the NOMS uses broad “Occupations” that include work activities across multiple industries and labor categories. Although some NOMS occupations are similar to the labor categories used at many DOE sites, e.g., Heating, Ventilation, and Air Conditioning (HVAC) Mechanics and Chemical Engineers, other NOMS occupations group multiple labor categories into a single occupation. For example, the occupation “Maintenance and Repair: General and Helper” includes workers who help install, maintain, and repair vehicles, industrial machinery, and electronic equipment; repair building floors and stairs; repair tears in fabrics, such as parachutes and tents; and several other work activities. Although each of these work activities is performed by workers with different skills, different labor category titles, and with exposure to different workplace hazards, they are grouped into a single NOMS occupation. Statistics for such occupations are difficult to apply to activities at DOE sites, where labor categories are defined much more narrowly. This PTS review and evaluation included the integration of the occupation codes reported in the ABTSWH Recommendation into the corresponding labor categories used in SEM.

### **1.3 SEM Asbestos Exposure Profiles**

Potential toxic substance exposures included in SEM are validated in two manners. Most substances are added to a site profile based on documented evidence from research of documents obtained from the DOE sites. These documents include a variety of records that typically include site hazard assessments, site industrial hygiene program records, occupation health questionnaires from claimants, independent site evaluation studies, training records, and many other sources. The source documents are recorded for each entry into the SEM spreadsheet. Additionally, as SEM evolved, it became apparent that many sites performed similar work, with the same equipment, and under similar conditions. To address these situations, PTS researchers developed a series of Generic Profiles for certain work processes; these Generic Profiles could then be applied to DOE sites where the work processes were known to have been employed.

These Generic Profiles are work-process based, but there are obvious correlations to job titles/labor categories (Carpentry/Carpenter, Electrical maintenance/Electrician, Mechanical maintenance/Mechanic, Pipefitting/Plumber, Painting/Painter, etc.). The profiles were developed using reference documents that included the Surveillance of Former Construction Workers at Oak Ridge Reservation: A Needs Assessment (1997 by Dr. Eula Bingham), the National Institutes of Health Haz-Map Database and HAZ-Map Index of Occupational Diseases, a comprehensive Idaho National Laboratory Job Task Description document, multiple industrial sources, Occupational Safety and Health Administration documents, hazard assessments for various construction trades, and various training course materials for specific job/labor categories. Ultimately, PTS researchers developed a comprehensive picture of potential hazards to which a “generic” worker might reasonably be exposed in a typical job/trade at a typical DOE site.

Asbestos exposure is included in the Generic Profile for 22 individual work processes. These work processes (and associated labor categories/job titles, where appropriate) include: Boiler maintenance, Carpentry, Demolition, Electrical maintenance, Electronics and instrumentation maintenance, Fire protection, HVAC maintenance, Insulating, Ironworking, Janitorial activities, Laundry, Masonry, Mechanical maintenance, Painting, Pipefitting/Plumbing, Power/Communication line maintenance, Rigging, Roofing, Sheet metal fabrication, Torch cutting, Vehicle maintenance, and Welding. The Generic Profiles will be applied for each DOE site where there is documented evidence that the work processes were performed, and any labor category/job title with documented performance of that work process will be assigned the exposure.

## 2.0 METHODOLOGY

### 2.1 Scope of PTS Evaluation

PTS reviewed the literature presented in the ABTSWH Recommendation on jobs presumed to have pre-1995 asbestos exposure. The purpose of this review was to evaluate the information and rationale provided for additions of the corresponding SEM labor categories (and aliases) to the EEOICP Procedure Manual Asbestos Exposure Presumptions. PTS did not evaluate the methodology or applicability of the searches of the NOMS for the purpose of identifying occupations with exposure to asbestos. Rather, the PTS evaluation was limited to determining whether the occupations identified by the ABTSWH analysis had corresponding labor categories at DOE facilities; whether the sample from the NOMS search was from industries that reasonably reflected the nature, frequency, and duration of asbestos exposure at DOE facilities; and whether there was any evidence of asbestos exposure associated with these labor categories that was validated during the extensive research for SEM.

### 2.2 PTS Evaluation Criteria

The general objective of the PTS evaluation was to review the occupations highlighted in the literature provided by the ABTSWH as having an excess occupation-specific PMR. The purpose was to determine whether those highlighted occupations contained sufficient information to demonstrate that the identified occupations reasonably resemble the nature of the exposure environment at DOE facilities. The occupations determined to be reflective of DOE facilities were evaluated to determine whether those occupations could be integrated with corresponding DOE facility labor categories.

For occupations reviewed, the data in SEM was further evaluated to determine whether asbestos exposure was included in the exposure profiles of the subject occupations. This information was considered in the PTS recommendation to DOL.

## 3.0 ANALYSIS OF OCCUPATIONS CONSIDERED

### 3.1 ABTSWH Recommendation Occupations Included on the Current Presumption List

Eighteen of the 49 occupation groups identified are currently included in the EEOICP Asbestos Exposure Presumption List. Even though many of the occupations listed below are typically skilled trade workers and are relatively well defined, the PTS analysis included a review to determine whether the labor categories listed in the manual are complete or whether additional labor categories should be added to the list based on the information in the ABTSWH Recommendation. The occupation groupings are:

- **Insulation Workers** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Plumbers, Pipefitters, and Steamfitters** – This occupation grouping at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Millwrights, Engine Installers** – This occupation grouping at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Sheetmetal Workers** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Drywall Installers** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.

- **Electricians** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Furnace, Kilns, and Oven Operators** – Analysis of the occupations associated with this occupation group indicated that only those defined by operating and tending furnaces would be applicable, and therefore, no additional labor categories are necessary.
- **Structural Iron and Steel Workers** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Supervisors of Mechanics and Repairers** – Maintenance mechanics are included in the manual, and in SEM, supervisors are considered to have the same toxic substance exposures as those they supervise.
- **Welders and Cutters** – This occupation grouping at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Brick Masons and Stonemasons** – This occupation grouping at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **First Line Supervisors, Construction Trades, and Extraction Workers** – These occupations are included in the manual, and in SEM, supervisors are considered to have the same toxic substance exposures as those they supervise.
- **Heavy Equipment and Mobile Equipment Mechanics** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Carpenters** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Painters, Paperhangers, and Plasterers** – Painters and plasterers are labor categories currently included in the Asbestos Exposure Presumption List, which adequately covers this occupational grouping.
- **Painting and Paint Spraying Machine Operators** – These occupations are presented in the ABTSWH Recommendation as separate occupation groupings from painters. However, there are no corresponding labor categories for a separate occupation of Painting and Paint Spray Machine Operators at DOE facilities. This type of operation would most likely be identified as a work process in SEM conducted by painters. Painters are covered in the current Asbestos Exposure Presumption List in the occupation grouping Painters, Paperhangers, and Plasterers. Therefore, this occupation grouping is also adequately covered by the Painters, Paperhangers, and Plasterers labor category.
- **Boilermakers and Operating Engineers** – This occupation at DOE facilities is similar to those in other industries, and the inclusion adequately covers this occupation.
- **Industrial and Refractory Machinery Mechanics** – Forty-six DOE sites have industrial and refractory machinery mechanics. The corresponding DOE labor categories would be Maintenance Mechanic or Machinery Mechanics; these occupations are currently on the Asbestos Exposure Presumption List. This occupation is adequately covered by the current listing.

PTS's analysis validates that the labor categories currently included in the Asbestos Exposure Presumption List adequately reflect the occupations identified by the ABTSWH for these 18 occupation groupings.

### 3.2 Occupation Groupings in the ABTSWH Recommendation with Limited Applicability to DOE Facilities

Three of the occupation groups considered were determined not to be associated with typical DOE contractor activities and therefore not recommended to be added to the Asbestos Exposure Presumption List. This PTS determination is supported by considering the definitions associated with these occupational groupings based on the 2000 Census Codes. The relevant Equivalent 2000 Standard Occupational Classification (SOC)/U.S. Bureau of Labor Statistics (BLS) Occupation Codes and definitions are:

- **Marine Engineers and Naval Architects** – The SOC/BLS Occupation Code 17-2121, Marine Engineers and Naval Architects, is defined as, “Design, develop, and evaluate the operation of marine vessels, ship machinery, and related equipment, such as power supply and propulsion systems,” and Occupation Code 53-5031, Ship Engineers, is defined as, “supervise and coordinate activities of crew engaged in operating and maintaining engines, boilers, deck machinery, and electrical, sanitary, and refrigeration equipment aboard ship.” This occupation grouping is not present at DOE facilities.
- **Aircraft and Structural Metal Fabricators** – The SOC/BLS Occupation Code 51-2011, Aircraft Structure, Surfaces, Rigging, and Systems Assemblers, is defined as, “assemble, fit, fasten, and install parts of airplanes, space vehicles, or missiles, such as tails, and wings, fuselage, bulkheads, stabilizers, landing gear, rigging and control equipment, or heating and ventilating systems,” and Occupation Code 51-2041, Structural Metal Fabricators and Fitters, is defined as, “Fabricate, lay out, position, align, and fit parts of structural metal products.” This occupation grouping is not present at DOE facilities.
- **Ship Captains and Mates, Engineers** – The SOC/BLS Occupation Code 53-5020, Ship and Boat Captains and Operators, consists of two separate Codes: 53-5021, Captains, Mates, and Pilots of Water Vessels, and 53-5022, Motorboat Operators. Neither of these occupations are present at DOE facilities. This grouping also includes SOC/BLS Occupation Code 53-5011, Sailors and Marine Oilers, which is also not present at DOE facilities.

Six additional occupation groups considered have limited applicability to DOE facilities. These occupation groups were reviewed and analyzed to determine whether, based on the occupation definitions, there were any similarities to DOE labor categories. The PTS evaluation and conclusion for each occupation group is presented below.

**Layout Workers** – Only one DOE site has a Layout Worker labor category. The Equivalent SOC/BLS Occupation Code for this occupation is 51-4192 defined as, “Lay out reference points and dimensions on metal or plastic stock or workpieces, such as sheets, plates, tubes, structural shapes, castings, or machine parts, for further processing. Include shipfitters.” Most layout work that meets the BLS definition is performed by craftsmen (i.e., machinists, welders, sheet metal mechanics, model makers) in DOE sites, and is incidental to their primary job duties. Only two DOE sites have a dedicated Layout Worker or similar job title, Sandia National Laboratories - Albuquerque (Layout Operator) and the Kansas City Plant (Layout Inspector).

Industry groups and job titles identified for these codes in the *NIOSH Industry and Occupation Computerized Coding System* (NIOCCS) data site confirm that it is unlikely that the occupations in this sample (five deaths) in NOMS represent DOE workers. The industries associated with these occupation codes are very diverse, and most do not represent the nature of work at DOE facilities. Therefore, the NOMS data **does not support adding** this occupation to the Asbestos Exposure Presumption List. The occupation and industry codes for these five **death certificates should be reviewed by DOL** to determine whether the sample represents industries that reflect the nature of asbestos exposures of this labor category at DOE facilities. PTS does not have access to the information necessary to conduct such reviews.

**Separating, Filtering, and Clarifying Machine Operators** – No DOE sites have labor category titles or aliases for separating or clarifying machine operators, but four DOE sites have filter operators (primary or alias). The Equivalent SOC/BLS Occupation Code is 51-9010, Chemical Processing Machine Setters, Operators, and Tenders. This broad occupation includes the following two detailed occupations: 51-9011, Chemical Equipment Operators and Tenders, and 51-9012, Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders. The latter occupation is defined as, “Set up, operate, or tend continuous flow or vat-type equipment; filter presses; shaker screens; centrifuges; condenser tubes; precipitating, fermenting, or evaporating tanks; scrubbing towers; or batch stills. These machines extract, sort, or separate liquids, gases, or solids from other materials to recover a refined product.” Based on this definition, this occupation would be representative of the filter operators at these four DOE sites. Of the four DOE sites that have filter operators, only one has asbestos in the SEM profile of that labor category. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Mixing and Blending Machine Operators** – The Equivalent SOC/BLS Occupation Code is 51-9020, Crushing, Grinding, Polishing, Mixing, and Blending Worker. This broad occupation includes the following three detailed occupations: (1) 51-9021, Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders; (2) 51-9022, Grinding and Polishing Workers, Hand; and (3) 51-9023, Mixing and Blending Machine Setters, Operators, and Tenders. No DOE sites have Mixing or Mixing Machine Operators. Blending Operators (alias) were present at the Mallinckrodt facilities at Weldon Spring and Destrehan Street. Asbestos is in the SEM profile at Weldon Spring Plant (Mallinckrodt) for the Operator labor category (Blending Operator is an alias) but not in the Production Operator (Blending Operator is an alias) profile at the Destrehan Street Facility. Therefore, the NOMS analysis is **not sufficient to add** the Blending Operator labor category to the Asbestos Exposure Presumption List.

**Molding and Casting Machine Operators** – Eight DOE sites have some type of casting operator. The Equivalent SOC/BLS Occupation Codes for these occupations are: 51-4070, Molders and Molding Machine Setters, Operators, and Tenders, Metal and Plastic, and 51-9197, Tire Builders. Only 51-4070 is relevant to DOE sites. The 51-4070 occupation code is a broad code that includes the following two detailed occupations: (1) 51-4071, Foundry Mold and Coremakers, and (2) 51-4072, Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic. This occupation covers a variety of occupations and a diverse group of associated industries. While some may be environments that reflect DOE facilities, many are not. The NOMS sample for these occupations is ten deaths, and due to the small sample size and diverse scope of covered industries, the information presented in the NOMS analysis is **not sufficient to add** these occupations to the Asbestos Exposure Presumption List as presented. The occupation and industry codes for these ten **death certificates should be reviewed** to determine whether the sample represents industries that reflect the nature of asbestos exposures of this labor category at DOE facilities.

**Extruding/Drawing Machine Operators** – The Equivalent SOC/BLS Occupation Codes are: 51-6091, Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers; 51-4021, Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic; and 51-9041, Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders. Based on the definition of these occupations and associated industries, only the 51-4021 category has any resemblance to the DOE facility exposure potential. However, the associated industries are very diverse, with many that do not represent DOE facilities. Additionally, there are no corresponding labor categories that meet the occupation code definition. Therefore, the information in the NOMS analysis is **not sufficient to add** Extruding/Drawing Machine Operators to the Asbestos Exposure Presumption List.

**Production Samplers and Weighers** – The Equivalent SOC/BLS Occupation Code is 51-9061, Inspectors, Testers, Sorters, Samplers, and Weighers, defined as, “Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.” This occupation grouping covers virtually every industry employing quality control standards and is so broad that the analysis is not applicable to DOE sites. The NOMS data also shows a very weak association with the PMR reported. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

### **3.3 Occupation Groupings in the ABTSWH Recommendation with SEM Labor Categories**

Eighteen occupation groupings considered were identified as having labor categories at DOE facilities. PTS reviewed and analyzed these occupation groupings to evaluate whether the NOMS data provided sufficient information to determine that the sample was representative of work by these labor categories. The PTS evaluation and conclusion are presented below.

**Precision Instrument and Equipment Repairers** – Similar labor categories, such as Instrument Technician, Instrument Mechanic, Electronics Maintenance, or Instrument Maker, are found at 48 DOE sites. The Equivalent SOC/BLS Occupation Code is 49-9060, Precision Instrument and Equipment Repairers. This broad occupation includes the following five detailed occupations: (1) 49-9061, Camera and Photographic Equipment Repairers; (2) 49-9062, Medical Equipment Repairers; (3) 49-9063, Musical Instrument Repairers and Tuners; (4) 49-9064, Watch Repairers; and (5) 49-9069, Precision Instrument and Equipment Repairers, All Other. Of these SOC/BLS Occupation Codes, only the last, 49-9069, appears to be potentially applicable to DOE work. The job titles in this code grouping accounted for 29 out of 100 job titles associated with this 2000 Census data. The electronics and instrument maintenance work processes are included in the SEM Asbestos Generic Profile. In this instance, work processes, rather than labor categories, are better suited for identifying those functions at DOE facilities that would reflect the work covered by the applicable SOC/BLS Occupation Codes. Therefore, the information from the NOMS analysis is **sufficient to add** the electronics and instrument maintenance work process to the Asbestos Exposure Presumption List.

**Stationary Engineers** – Sixteen larger DOE sites have Stationary Engineers/Boiler Operators. The Equivalent SOC/BLS Occupation Codes for this occupation are 51-8021, Stationary Engineers and Boiler Operators, and 53-7070, Pumping Station Operators. The 51-8021 category is defined as, “Operate or maintain stationary engines, boilers, or other mechanical equipment to provide utilities for buildings or industrial processes. Operate equipment, such as steam engines, generators, motors, turbines, and steam boilers.” The definition is accurate for similar occupations at DOE sites. The 53-7070 category is primarily tied to natural gas drilling and compressed gas transmission, and is not reflective of DOE labor categories. The extensive presence of asbestos insulation is known to have existed in DOE steam boiler

plants. Eight of 16 SEM profiles for Boiler Operators/Stationary Engineers include asbestos, and the SEM Asbestos Generic Profile includes this work process. The information presented in the NOMS analysis is **sufficient to add** the Stationary Engineers and Boiler Operators in DOE facilities to the Asbestos Exposure Presumption List.

**Chemical Engineers** – SEM shows Chemical Engineer labor categories at 22 DOE sites, most of which are larger facilities. The Equivalent SOC/BLS Occupation Code for this occupation is 17-2041, Chemical Engineer, defined as, “Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.”

Although 22 mostly large DOE sites have SEM profiles for Chemical Engineers, the roles of those engineers are not the same as those of Chemical Engineers in the NOMS study. Further, only 1 of the 22 sites is documented in the SEM Library as showing the potential for asbestos exposure. Within DOE, most chemical engineers are involved in the design of small-scale processes and maintaining/improving existing process equipment. Design of large production-scale facilities, like those constructed at sites like the gaseous diffusion plants and reactors, was completed by engineers employed by architecture and engineering firms or major construction contractors. Therefore, the information in the NOMS analysis is **not sufficient to add** Chemical Engineers to the Asbestos Exposure Presumption List.

**Chemical Technicians** – The Equivalent SOC/BLS Occupation Code for this occupation is 19-4031, Chemical Technicians, defined as, “Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes, such as research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences.” There is not a standard DOE title used for the BLS definition of a Chemical Technician, because the definition does not encompass DOE Chemical Operators; rather, it describes DOE chemical and physical laboratory workers with titles such as Laboratory Technician (most common title at 45 DOE sites), Laboratory Assistant, Laboratory Associate, and Laboratory Worker. Some of these labor categories have asbestos in their profiles, but those categories tended to be labor categories performing asbestos sample analysis. It is unclear how other DOE site Laboratory Technicians would have been exposed to asbestos. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Architects** – The Equivalent SOC/BLS Occupation Code is 17-1010, Architects, except Naval. This broad occupation includes the following two detailed occupations: (1) 17-1011, Architects, Except Landscape and Naval, and (2) 17-1012, Landscape Architects. Thirteen DOE sites have Architects, Architectural Engineers, or similar titles. Analysis of the associated industry codes was of little value in determining the nature of the environments associated with where this work was performed, in that the associated industries mainly referenced the types of building the architects designed, such as schools, retail establishments, commercial buildings, office complexes, industrial plants, etc. Therefore, there is no information presented to determine whether this occupation group is similar to work at DOE facilities. Thirteen DOE sites have Architect or Architectural Engineer labor categories, but only Argon National Laboratory - East has asbestos in its profile. Therefore, the information presented in the NOMS analysis is **not sufficient to add** Architects or Architectural Engineers in DOE facilities to the Asbestos Exposure Presumption List.

**Materials Engineers** – The Equivalent SOC/BLS Occupation Code for this occupation is 17-2131, Materials Engineer, defined as, “Evaluate materials and develop machinery and processes to manufacture

materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Include those working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics and glass, plastics, and polymers, and naturally occurring materials. Include metallurgists and metallurgical engineers, ceramic engineers, and welding engineers.” Twenty DOE sites have Metallurgists, six have Welding Engineers, six have Ceramics Engineers, and four have Materials Engineers or Materials Scientists. This occupation grouping covers virtually every industry since most industries rely on material engineering skills. The majority of the job titles associated with this occupation involve industry codes that do not have exposure environments like DOE facilities, such as iron and steel, aluminum production, nonferrous metals, foundries, railroad rolling stock manufacturing, and veneer and plywood production. This labor category at DOE facilities covers a wide array of potential asbestos exposures depending on the project and function in a specific situation. Actual potential asbestos exposure profiles and industrial hygiene assessments for specific work histories would be a better predictor of asbestos exposure. The NOMS data also shows a very weak association with the PMR reported from a sample of only seven death certificates. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List. The occupation and industry codes for these ten **death certificates should be reviewed** to determine whether the sample represents industries that reflect the nature of asbestos exposures of this labor category at DOE facilities.

**HVAC Mechanics, Installers, and Repairer** – The Equivalent SOC/BLS Occupation Code for this occupation is 49-9021, Heating, Air Conditioning, and Refrigeration Mechanics and Installers, defined as, “Install or repair heating, central air conditioning, or refrigeration systems, including oil burners, hot-air furnaces, and heating stoves.” Twenty DOE sites have HVAC Technicians, HVAC Mechanics, Air Conditioning Mechanics, or similar titles. The SEM Generic Profile applies asbestos to this labor category for HVAC work prior to 1981, and the SEM Asbestos Generic Profile includes this work process. This occupation at DOE facilities is similar to those in other industries, and therefore, information presented in the NOMS analysis is **sufficient to add** the HVAC Mechanics, Installers, and Repairers in DOE facilities to the Asbestos Exposure Presumption List.

**Industrial, Health, and Safety Engineers** – Comparable labor categories at DOE sites would be Safety Engineers and Industrial Engineers. Thirty DOE sites have these labor categories, and almost all DOE sites have a Safety Professional, Safety Engineer, Industrial Hygienist, or similar labor category. A total of 18 DOE sites had Industrial Engineers. The Equivalent SOC/BLS Occupation Code for this occupation is 17-2110, Industrial Engineers, including Health and Safety. This broad occupation includes the following two detailed occupations: (1) 17-2111, Health and Safety Engineers, Except Mining Safety Engineers and Inspectors, and (2) 17-2112, Industrial Engineers. Health and Safety Engineer is defined as, “Promote worksite or product safety by applying knowledge of industrial processes, mechanics, chemistry, psychology, and industrial health and safety laws. Include industrial product safety engineers.” Industrial Engineer is defined as, “Design, develop, test, and evaluate integrated systems for managing industrial production processes including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination. Exclude health and safety engineers, except mining safety engineers and inspectors.” Based on the broad application of these diverse occupations at DOE sites with varied exposure profiles for asbestos, actual potential asbestos exposure profiles and industrial hygiene assessments for specific work histories would be a better predictor of asbestos exposure. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Mechanical Engineers** – Mechanical Engineer is a labor category at 19 DOE sites. The Equivalent SOC/BLS Occupation Code for this occupation is 17-2141, Mechanical Engineer, defined as, “Perform engineering duties in planning and designing tools, engines, machines, and other mechanically functioning equipment. Oversee installation, operation, maintenance, and repair of such equipment as centralized heat, gas, water, and steam systems.” This occupation grouping covers virtually every industry since most industries rely on mechanical engineering skills. This labor category at DOE facilities covers a wide array of potential asbestos exposures, depending on the project and function in a specific situation. Actual potential asbestos exposure profiles and industrial hygiene assessments for specific work histories would be a better predictor of asbestos exposure. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Engineering Technicians (except Drafters)** – The Equivalent SOC/BLS Occupation Code for this occupation is 17-3020, Engineering Technicians, except Drafters. This broad occupation includes the following eight detailed occupations: (1) 17-3021, Aerospace Engineering and Operations Technicians; (2) 17-3022, Civil Engineering Technicians; (3) 17-3023, Electrical and Electronic Engineering Technicians; (4) 17-3024, Electro-Mechanical Technicians; (5) 17-3025, Environmental Engineering Technicians; (6) 17-3026, Industrial Engineering Technicians; (7) 17-3027, Mechanical Engineering Technicians; and (8) 17-3029, Engineering Technicians, Except Drafters, All Other. This occupation covers a broad range of technicians involved in varied activities with diverse hazards. This occupation grouping covers virtually every industry since most industries rely on engineering technician skills. Actual potential asbestos exposure profiles and industrial hygiene assessments for specific work histories would be a better predictor of asbestos exposure. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Firefighters and Supervisors of Firefighters** – Almost all larger DOE sites have an onsite fire department. The Equivalent SOC/BLS Occupation Codes for this occupation are 33-1021, First-Line Supervisors/Managers of Fire Fighting and Prevention Workers, and 33-2011, Fire Fighters. In SEM, supervisors are considered to have the same toxic substance exposures as those they supervise. The SEM profile applies asbestos for firefighting before 1981, and the SEM Asbestos Generic Profile includes this work process. Therefore, the information from the NOMS analysis is **sufficient to add** Firefighters and Supervisors of Firefighters at DOE facilities to the Asbestos Exposure Presumption List.

**Electrical and Electronic Engineers** – Twenty DOE sites have Electrical Engineers in their SEM profiles, and eight DOE sites have Electronic Engineers in their SEM profiles. Most DOE Electronic Engineers were involved in instrumentation design. The Equivalent SOC/BLS Occupation Code for this occupation is 17-2070, Electrical and Electronics Engineers. This broad occupation includes the following two detailed occupations: (1) 17-2071, Electrical Engineers, and (2) 17-2072, Electronics Engineers, Except Computer. Electrical Engineer is defined as, “Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use.” Job titles categorized as involving electric power generation, distribution, and transmission are included in the electrical engineering occupation, along with numerous job titles that do not reflect jobs at DOE facilities. However, these activities are typically handled by Electricians or Linesmen (higher voltage) at DOE sites; both of those trades already have asbestos in their profiles and are included in the current Asbestos Exposure Presumption List. The typical DOE/Contractor Engineer would have no significant exposure to asbestos because they would not be active in a hands-on manner.

Electronics Engineer is defined as, “Research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use utilizing knowledge of electronic theory and materials properties. Design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls. Exclude Computer Hardware Engineers.” The associated industry codes for these occupations include a variety of communications equipment manufacturing, instrument manufacturing, household appliance manufacturing, electric light equipment manufacturing, radio and TV broadcasting, wired telecommunications carriers, and other telecom services that are not reflective of the work these labor categories perform at DOE sites. Information presented in the NOMS analysis is **not sufficient to add** the Electrical and Electronic Engineers in DOE facilities to the Asbestos Exposure Presumption List.

**Maintenance and Repair, General Helper** – The Equivalent SOC/BLS Occupation Codes are: 40-9098, Helpers - Installation, Maintenance, and Repair Workers; 49-3090, Miscellaneous Vehicle and Mobile Equipment Mechanics, Installers, and Repairers; 49-9041, Industrial Machinery Mechanics; 49-9045, Refractory Materials Repairers, except Brickmasons; 49-9042, Maintenance and Repair Workers, General; 49-9043, Maintenance Workers, Machinery; 49-9060, Precision Instrument and Equipment Repairers (addressed as a separate labor category in the ABTSWH Recommendation); 49-9091, Coin, Vending, and Amusement Machine Servicers and Repairers; 49-9095, Manufactured Building and Mobile Home Installers; 49-9099, Installation, Maintenance, and Repair Workers, All Other; and 49-9093, Fabric Menders, except Garment. The broad scope of this occupation group is also a “catch all” category for maintenance workers and helpers. Several of these Equivalent SOC/BLS Occupation Codes are also included in other occupation groupings in the ABTSWH Recommendation, such as Precision Instrument Repairers. Additionally, Maintenance Mechanics at DOE facilities are already included on the Asbestos Exposure Presumption List. Therefore, information presented in the NOMS analysis is **not sufficient to add** the Maintenance and Repair, General Helpers at DOE facilities to the Asbestos Exposure Presumption List, other than those covered by the more specific occupations addressed.

**Machinist** – Sixty-three DOE sites had a Machinist labor category. The Equivalent SOC/BLS Occupation Code is 51-4041, Machinists, defined as, “Set up and operate a variety of machine tools to produce precision parts and instruments, including precision instrument makers who fabricate, modify, or repair mechanical instruments. May also fabricate and modify parts to make or repair machine tools or maintain industrial machines, applying knowledge of mechanics, shop mathematics, metal properties, layout, and machining procedures.” Many Machinists at DOE sites performed the functions of Tool and Die Maker, which is described later in Section 3.3. This occupation at DOE facilities is similar to those in other industries. SEM does not have an asbestos reference in the generic profiles for Machining, and there are no background reference documents to support asbestos exposure for this category at DOE facilities. Therefore, the information presented in the NOMS analysis is **not sufficient to add** machinists in DOE facilities to the Asbestos Exposure Presumption List except Machinist (machine grinding), which is on the Asbestos Exposure Presumption List.

**Crane and Tower Operators** – The Equivalent SOC/BLS Occupation Code is 53-7021, Crane and Tower Operators. While only 18 DOE sites have a Crane Operator or similar labor category, many other labor categories operate cranes. Exposures associated with crane operations at most DOE sites are listed under crane operations, related work processes. Therefore, exposures associated by work processes are more appropriate for this category. The NOMS data also shows a very weak association with the PMR reported from a sample of only 15 death certificates. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Civil Engineers** – The Equivalent SOC/BLS Occupation Code is 17-2051, Civil Engineers, defined as, “Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, water and sewage systems, and waste disposal units. Includes architectural, structural, traffic, ocean, and geo-technical engineers. Excludes hydrologists.” Fourteen DOE sites have Civil Engineer labor categories, such as Civil Engineer, Structural Engineer, and Construction Engineer. However, none of the SEM profiles for Civil Engineers at these sites include asbestos exposure. Therefore, information presented in the NOMS analysis is **not sufficient to add** Civil Engineers in DOE facilities to the Asbestos Exposure Presumption List.

**Tool and Die Makers** – At many DOE sites, Machinists performed the function of tool and die making. Only seven sites had a Tool and Die Making labor category. The Equivalent SOC/BLS Occupation Code is 51-4111, Tool and Die Makers, defined as, “Analyze specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gauges, and machinists’ hand tools.” The definition of this occupation is almost identical to that of Machinists. This occupation at DOE facilities is similar to those in other industries. SEM does not have an asbestos reference in the generic profiles for Machining, and there are no background reference documents to support asbestos exposure for this category at DOE facilities. Therefore, the information presented in the NOMS analysis is **not sufficient to add** the Tool and Die Makers in DOE facilities to the Asbestos Exposure Presumption List except Machinist (machine grinding), which is on the Asbestos Exposure Presumption List.

**Detectives, Criminal Investigators, Police and Sheriff’s Patrol Officers** – The corresponding DOE labor categories for these occupations are Guard, Officer, or Patrolman. At DOE facilities, the potential exposures to these labor categories are completely dependent on the locations where their duties are performed, and these assignments vary greatly across the DOE complex. Therefore, the potential for asbestos exposure is better determined by the locations assigned, which dramatically impacts not only the nature of potential exposures but also the frequency and degree of exposure. The information presented in the NOMS analysis is **not sufficient to add** these labor categories in DOE facilities to the Asbestos Exposure Presumption List.

### **3.4 Nonspecific Categories**

**Supervisors, Production Operations** – The Equivalent SOC/BLS Occupation Code is 51-1011, First-Line Supervisors/Managers of Production and Operating Workers. This occupation grouping covers virtually every production industry and is so broad that there are no corresponding DOE site labor categories. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List. DOL treats the exposures of all supervisors to be the same as those of the persons supervised.

**Drafting Occupations** – The Equivalent SOC/BLS Occupation Code is 17-3010, Drafters. This broad occupation includes the following four detailed occupations: (1) 17-3011, Architectural and Civil Drafters; (2) 17-3012, Electrical and Electronics Drafters; (3) 17-3013, Mechanical Drafters; and (4) 17-3019, Drafters, All Other. This occupation grouping covers virtually every industry employing drafters and is so broad that the analysis is not applicable to DOE sites. The NOMS data also shows a very weak association with the PMR reported from a sample of only 17 death certificates. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Engineers, NEC (Not Elsewhere Classified)** – This occupation grouping is a “catch all” that covers virtually every industry and is so broad that there are no corresponding DOE site labor categories. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

**Machine Operators Not Specified** – The Equivalent SOC/BLS Occupation Code is 51-9080, Medical, Dental, and Ophthalmic Laboratory Technicians, and 51-9199, Production Workers, All Other. The Medical, Dental, and Ophthalmic Laboratory Technicians group would not be applicable to DOE facilities. The Production Workers, All Other group covers virtually every production industry and is so broad that there are no corresponding DOE site labor categories. Therefore, the information from the NOMS analysis is **not sufficient to add** this labor category to the Asbestos Exposure Presumption List.

#### **4.0 CONCLUSIONS AND RECOMMENDATIONS**

The current EEOICPA Procedure Manual Appendix 1, Exhibit 15-4, adequately covers 18 of the 49 Census Occupational Code Groups highlighted in the ABTSWH Asbestos Exposure Presumption Recommendation. These occupational groups are listed above.

Based on PTS’s analysis of the occupation groups and the corresponding definition and associated industry codes, the following four occupations are recommended to be added to the Asbestos Exposure Presumption List to integrate the ABTSWH Recommendation into the SEM labor categories:

- **Stationary Engineers**
- **Precision Instrument and Equipment Repairers – as electronics and instrument maintenance work process**
- **HVAC Mechanics, Installers, and Repairer**
- **Firefighters and Supervisors of Firefighters.**

Of the remaining 27 occupations recommended for consideration, three are not recommended to be added to the Asbestos Exposure Presumption List because they are not present at DOE facilities. Four are not recommended to be included because they are so broad and nonspecific that it would be impossible to integrate them into the DOE labor categories. The rationale for not recommending the remaining 20 occupations is presented in the Analysis of Occupations Considered section. Salient information related to the review and evaluation is presented in Attachment 2, NOMS Analysis Summary.

Three occupations, i.e., Layout Workers, Materials Engineers, and Molding and Casting Machine Operators, that were not recommended to be added to the Asbestos Exposure Presumption List are occupations in which the NOMS sample could have come from a very broad range of industries. Many of the associated industries for these occupations are drastically different from the nature of potential exposures at DOE sites. Additionally, these occupations had very small NOMS sample sizes. Therefore, it is recommended that the actual industry codes associated with the death certificates for these occupations be examined by DOL to determine whether the small sample came from industries like the DOE environment and, therefore, should be reconsidered for inclusion.

#### **5.0 REFERENCES**

1. US Census Bureau, *Census 2000 Occupational Relationship Between The 1990 Census and Census 2000 Industry and Occupation Classification Systems*, October 30, 2003
2. US Census Bureau, *Industry and Occupation Code Lists and Crosswalks*

3. NIOSH, *National Occupational Mortality Surveillance (NOMS)*. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Surveillance, Hazard Evaluation and Field Studies, Surveillance Branch, 2019
4. NIOSH, *NIOSH Industry and Occupation Computerized Coding System (NIOCCS)*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Surveillance, Hazard Evaluation and Field Studies, Surveillance Branch, 2018

## **Attachment 1**

### **Advisory Board on Toxic Substances and Worker Health Recommendations**

**Advisory Board on Toxic Substances and Worker Health**

June 19, 2020

Mr. Eugene Scalia  
Secretary, U.S. Department of Labor  
Frances Perkins Building  
200 Constitution Ave.  
Washington, DC

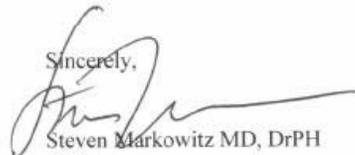
Dear Mr. Scalia:

I am pleased to transmit two recommendations of the Department of Labor Advisory Board on Toxic Substances and Worker Health in relation to the Board's advisory capacity to the Energy Employees' Occupational Illness Compensation Program (EEOICP). These were adopted unanimously at our June 16, 2020 meeting. They include:

- 1) Revised Recommendation: Jobs Presumed to have pre-1995 Asbestos Exposure
- 2) Recommendation on Parkinson Disorders in the Energy Employees' Occupational Illness Compensation Program

The Board hopes that our input is useful to EEOICP. It remains an honor for the Board to be consulted on important issues that face the Program. I am available to answer any questions.

Sincerely,



Steven Markowitz MD, DrPH  
Chair  
Advisory Board on Toxic Substances  
and Worker Health

## **Advisory Board on Toxic Substances and Worker Health**

### **Revised Recommendation: Jobs Presumed to have pre-1995 Asbestos Exposure**

#### **Recommendation**

We recommend that the Department of Labor evaluate the job categories and associated aliases for all DOE sites in the Site Exposure Matrices and revise its list of occupations with presumed pre-1995 asbestos exposure (Exhibit 15-4) to reflect current knowledge as summarized in the rationale provided below and associated data and references. Supervisors of the listed job categories should also be considered for inclusion. For people who have other job titles with claims in relation to asbestos exposure, a careful investigation of possible occupational sources of asbestos exposure should be undertaken. In the case of mesothelioma, with greater than 90% linkage to asbestos exposure, all cases should have additional inquiry into potential asbestos exposure, even if their job titles are not among those that have presumed asbestos exposure. A Committee of the Board should work with the Department to conduct this exercise and achieve a consensus on a revised list of occupations with presumed pre-1995 asbestos exposure.

#### **Rationale**

The Board previously recommended that the EEOICP expand the list of presumed asbestos-exposed job titles as provided in EEOICP Procedure Manual (PM) 4.2, Appendix 1, Exhibit 15-4 to include additional titles that can be reasonably presumed to have had asbestos exposure prior to 1995. The current list is shown in Table 1.

The Board agrees that all of the job titles currently listed in PM 4.2 can be presumed to be exposed to asbestos. The list includes mostly construction and maintenance occupations. It encompasses most, but not all, of the occupations listed as such under construction trades in the Census 2000 occupational coding system (Census 2000). There are also several job titles on the list that correspond to job titles under two other job groups of the Census 2000 occupational codes: 1) Installation, Maintenance, and Repair Workers, and 2) Production occupations (Census 2000).

For the purposes of this recommendation, we refer to the names of job titles used by the Census 2000 occupational coding system, since they are standardized, are or were widely utilized, and most closely reflect the job titles used in the published medical literature and available databases. These job titles may differ somewhat from the categories used in the Department of Labor's Site Exposure Matrices (SEM). We note that the job categories and their aliases that appear in the SEM appear to vary appreciably by DOE site. The DOE Former Worker Programs have encountered similar challenges: a large number of job titles, which vary across DOE sites and evolve over time. We note that the claims evaluation process requires that

the claims examiners or others conform the job title(s) reported by the claimants to the classification system used in the SEM in order to access the information about potential exposures contained in the SEM.

The Board was asked by the Department to provide medical evidence for its proposal to add job titles to the current list in Table 1. We found that available published medical studies and database information use job classification systems that generally corresponds to the U.S. Census occupational coding system (or the related SOC) that is widely used, including by the Census Bureau and the Department of Labor. Studies from other countries use different standardized classification systems that bear substantial similarities to the U.S. Census occupational coding system. Cross-walking job titles over system versions that evolve over time or differ by geography can be challenging. We note that the SEM has undoubtedly spent considerable effort deciding which job titles are equivalent (cross-walking), since the SEM has matched job titles with aliases to facilitate use of the SEM in the claims evaluation process.

To identify job titles with presumed asbestos exposure prior to 1995, we focused on available research and database information that link job titles with the cardinal asbestos-related disease, malignant mesothelioma (MM). Since MM is very closely linked to a prior history of occupational asbestos exposure, and since it occurs with relatively modest level of asbestos exposure, MM is the best disease candidate for identifying at risk occupations for whom a presumption of significant prior asbestos exposure can be made, per EEOICP PM 4.2. Any occupations that entail asbestos exposure and are associated with excess risk of asbestosis, lung cancer, ovarian cancer and laryngeal cancer would very likely also be identified in studies of occupation and MM, since the non-MM asbestos-related diseases generally require a higher dose of asbestos exposure. In addition, the three other asbestos-related cancers have other causes, which can obfuscate the relationships between job titles, asbestos exposures, and these cancers.

#### National Occupational Mortality System (NOMS)

The National Occupational Mortality Surveillance System (NOMS) is a compilation of causes of death (underlying cause) in the United States by NIOSH according to ICD codes 9 and 10, together with usual occupation and industry of decedents as recorded on the death certificate, and coded according to the U.S. Census occupational coding systems (NIOSH 2019). NIOSH has maintained this system for nearly three decades, collecting mortality data from 26 states, according to a recent report (Robinson 2015) and the NOMS website (<https://www.cdc.gov/niosh/topics/noms/about.html>). A succinct description of NOMS and its recent application to occupation- and industry-based risk of leukemia and heart disease are available (Robinson 2015). NOMS data have been used in over 140 publications since its inception. NOMS calculates occupation- and industry-specific proportionate mortality ratios (PMR) as a measure of risk. PMR is the ratio of the proportion of deaths caused by the disease of interest in the specified occupation of interest compared to the proportion of deaths caused by the disease of interest in the total population of decedents in the data set. A PMR above 100

represents an increase in the proportion of the disease in the occupation of interest relative to the overall population.

In April 2020, Board member John Dement PhD queried the online NOMS data set to obtain proportionate mortality ratios for malignant mesothelioma (ICD code C45) by usual occupation of decedents for the years 1999, 2003-2004, and 2007-2014 in aggregate. Data included deaths for decedents aged 18-90 of all races and both sexes in 26 U.S. states, involving 550 occupational categories (NIOSH 2019). The total number of deaths due to malignant mesothelioma (C45) in the NOMS data set was approximately 6,800. Note that not all mesotheliomas are included in ICD code C45, because some cases are instead coded as malignant neoplasm of the pleura or peritoneum (C384 and C48). However, ICD code C45 in NOMS includes at least three-quarters of the deaths due to malignant mesothelioma in the NOMS dataset.

Table 2 shows the 62 occupations (2000 Census codes) that had statistically significant excess mortality (elevated PMR's) due to malignant mesothelioma in the combined years of 1999, 2003-2004, and 2007-2014 in the 26 states included in NOMS. All occupations on the list have increased proportions of deaths due to malignant mesothelioma (All PMR's with a lower 95% confidence interval  $\geq 100$  represent statistically significant excess PMR's.) Table 2 shows the occupations with elevated PMR's in the order in which the occupational titles appear in the 2000 Census coding system. Table 2 color codes the occupations with excess PMR's according to standardized hierarchy of job groupings used by the coding system. Major occupational groups (indicated in green) with excess PMR's include: 1) Architecture and Engineering Occupations, 2) Life, Physical, and Social Science Occupations, 3) Construction and Extraction Occupations, 4) Installation, Maintenance, and Repair Occupations, 5) Production Occupations, and 6) Transportation and Material Moving Occupations. It should be noted that census 2000 occupation classifications were based on the government-wide 2000 Standard Occupation Classification (SOC) system. In the SOC system supervisors of professional occupations are not coded separately and are assigned the same code as the occupation they supervise. Supervisors of professional occupations are classified with the occupations they supervise because they often need the same type of training, education, and experience as the workers they supervise.

Table 2 shows a significant number of occupations in engineering, maintenance and repair and production that are not included in PM 4.2, Appendix 1, Exhibit 15-4 (Table 1)

Table 3 shows the same NOMS occupations with elevated PMR's in descending order of the magnitude of the PMR. This listing provides the usual way that occupational risks are illustrated. The top occupations in terms of MM risk are those that customarily demonstrate the highest risk of MM in the scientific literature

Strengths of the NOMS data, especially for the purpose of updating the EEOICP procedure Manual and the SEM include: 1) use of a national dataset; 2) inclusion of deaths from

a time period that is both broad (1999 to 2014) and recent (2007-2014); 3) use of a well-tested methodology; 4) employment of a standardized and broadly used set of codes for cause of death and occupation; 5) access to a large and geographically diverse data set. The latter feature is important, because it provides increased statistical power and increases the representativeness of the data, features that are important to a national compensation program such as EEOICP.

#### Other U.S. Studies of Malignant Mesothelioma

Attachment A includes excerpted Tables from published studies of occupational risk of MM. Copies of their source articles are also provided.

Mazurek and NIOSH colleagues combined a U.S. national mortality data set (CDC Wonder) with NOMS data to describe basic demographics of MM in the U.S. during 1999-2015 and to evaluate occupational risk of malignant mesothelioma death (n = 1,830) in 23 states during 1999-2007 (Mazurek 2016). Results from their 2016 publication are shown in the table on Attachment A (p. 10). 17 occupations showed a statistically significant elevation in PMR for malignant mesothelioma. These titles are also seen among the titles on our NOMS analysis of MM deaths. The number of MM deaths in the dataset analyzed by Mazurek et al was one-third of the deaths in our NOMS analysis and thus limited statistical power. Additional job titles with elevated PMR's may not have attained statistical significance.

In 2006, Bang and NIOSH colleagues performed a similar analysis of MM that occurred in the U.S. during 1999-2001 (Bang 2006). Their overall data set was a smaller data set than the one used by Mazurek. They evaluated MM deaths (ICD-10 code C45) that occurred in 1999 in 19 states for which occupation and industry data were available. The number of MM deaths analyzed for occupation is not provided. Four occupations demonstrated statistically significant PMR elevations [see Attachment A (p. 11)]. To gain a sense of the size and statistical power of the Bang and Mazurek analyses versus our NOMS query, compare the number of deaths that occurred among "plumber, pipefitters and steamfitters": 18 deaths in the Bang study, 67 deaths in the Mazurek study, and 219 deaths in our NOMS analysis.

Tomasallo and colleagues recently published a case control study, profiling occupational and industrial risks of MM incidence and mortality in Wisconsin from 1997 to 2013 (Tomasallo 2018). They evaluated 1,083 deaths and 1,246 incident cases of MM. As indicated in the attached table [see Attachment A (p. 12)], constructions trades; installation, maintenance, repair workers; metal and plastics workers, and engineers showed significantly increased risk. The analysis was constrained by a relatively small number of cases of MM.

#### International Studies of Malignant Mesothelioma

We identified large case control and PMR studies from Great Britain, France, Canada, Spain, Germany, and Northern Ireland [see Attachment A (pp. 13-19)]. These will not be reviewed individually in this summary. A perusal of the key published tables from the relevant

articles, as provided in Attachment A, pp. 10-20, indicates a relatively consistent increased MM risk for construction, maintenance, engineering, and selected production occupations.

#### Comments

Use of the NOMS results for the purpose of updating the list of job titles with presumptive asbestos exposure in EEOICP has several advantages. NOMS and DOE are both nationwide in scope and include many and varied facets of industry, so NOMS results may be more illustrative and relevant than more specific studies that reflect a single dominant geographic area or only one or a few industries. NOMS uses a standard classification system (Standard Occupational Classification, SOC) that is broadly used by agencies in the U.S. Government (U.S. Bureau of Labor Statistics, 2000). The SOC system includes detailed descriptions of each job title, which should facilitate cross-walking the NOMS job categories with SEM job categories and claimant-derived job titles. An additional Federal classification system, O\*NET, which is based on the SOC, can also be used to classify job titles.

The NOMS –derived list of occupations at high risk of malignant mesothelioma differs from the current job list included in EEOICP, Exhibit 15-4 (Table 1) principally in adding titles in engineering, maintenance and repair, and selected production activities. The NOMS analysis represents an updated evaluation of the same type of national mortality data that was used in the data source for Exhibit 15-4, which is a 2014 report by ATSDR. The ATSDR report relied on NIOSH occupational mortality analyses; however, the ATSDR report had limited ability to address occupational mesothelioma risk as occupational data were only available for calendar year 1999. Advantages of the current NOMS analysis include 1) its inclusion of the most recent data available, i.e., the 1999-2014 period; and 2) the size of the NOMS data set, which includes many more mesothelioma deaths than previous analyses (and three times as many deaths as the most recent analysis published by Mazurek in 2016). The ability to examine large numbers of mesothelioma deaths adds statistical power, that is, the ability to understand the meaning of PMR estimates (i.e., detect an effect) in a much greater number of occupations.

Interestingly, the SEM currently recognizes that many of the additional job titles revealed by NOMS versus Exhibit 15-4 have potential exposure to asbestos. In the claims evaluation process, inclusion of a link between a job category and asbestos exposure in the SEM initiates consideration of the degree and extent of asbestos exposure by the claims examiner or industrial hygienist. Adding job titles to the list in Exhibit 15-4 based on results of NOMS and other studies recognizes that current scientific evidence justifies re-categorizing the asbestos exposure from “potential,” as in the SEM to “presumed to be significant,” as described in the EEOICP procedure manual.

Embedded in the list of job titles with elevated malignant mesothelioma risks in NOMS is the inclusion of numerous job titles that primarily have bystander exposure to asbestos, rather than direct asbestos exposure through manipulation of asbestos-containing materials. This is an

important finding, because claimants may not report such exposure in completing the occupational health questionnaire as part of their claims submission. Industrial hygienists may also not factor in bystander exposure in their claims evaluations.

#### Conclusion

We recommend that the Department of Labor evaluate the job categories and associated aliases for all DOE sites in the Site Exposure Matrices and revise its list of occupations with presumed pre-1995 asbestos exposure (Exhibit 15-4) to reflect current knowledge as summarized in this rationale and associated data and references. Supervisors of the listed job categories should also be considered for inclusion. A Committee of the Board should work with the Department to conduct this exercise and achieve a consensus on a revised list of occupations with presumed pre-1995 asbestos exposure.

**Table 1**

EEOICP Procedure Manual (PM) 4.2, Appendix 1, Exhibit 15-4

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a. Asbestos exposure through December 31, 1995.

- (1) CE is to consider the following labor categories to have had significant exposure to asbestos based on their job tasks.
- Automotive mechanic; Vehicle mechanic; Vehicle maintenance mechanic
  - Boilermaker
  - Carpenter; Drywaller; Plasterer
  - Demolition technician; Laborer
  - Electrical mechanic; Electrician; Floor covering worker
  - Furnace & saw operator; Furnace builder; Furnace operator; Furnace puller;Furnace technician; Furnace tender; Furnace unloader
  - Glazier; Glass installer; Glazer
  - Grinder operator; Mason (concrete grinding); Tool grinder; Maintenance mechanic (general grinding); Welder (general grinding); Machinist (machine grinding)
  - Insulation worker; Insulation trade worker; Insulator
  - Ironworker; Ironworker-rigger
  - Maintenance mechanic; Electrician; Insulator;
  - Mason; Brick & tile mason; Concrete and terrazzo worker; Bricklayer, Tilesetter
  - Millwright
  - Heavy equipment operator; Operating Engineer
  - Painter
  - Pipefitter, Plumber steamfitter; Plumber/pipefitter; Plumbing & pipefittingmechanic; Plumbing technician, Steamfitter
  - Roofer
  - Sheet metal mechanic; Sheet metal fabricator/installer
  - Welder; Welder burner; Welder mechanic
  - Uranium Miner/Miller

**Table 2 Occupations with Elevated PMR's for Malignant Mesothelioma according to Major and Specific Census Occupational Titles, (NOMS, 1999, 2003, 2004, 2007-2014)**

2000 Census Major Occupational Groupings & NOMS Occupation Title	2000 Census Code	1990 Census Code	PMR	Number of deaths	95% CI Lower	95% CI Upper
<b>Architects, Surveyors, and Cartographers (17-1000)</b>						
Architects	130	43	337	19	203	526
<b>Engineers (17-2000)</b>						
Marine Engineers & Naval Architects	144	58	1031	9	471	1957
Chemical Engineers	135	48	449	30	303	642
Materials Engineers	145	45	266	7	107	549
Industrial, Health, & Safety Engineers	143	56	259	30	175	370
Mechanical Engineers	146	57	253	50	187	333
Electrical & Electronic Engineers	141	55	207	43	150	279
Civil Engineers	136	53	176	36	123	243
Engineers, NEC	153	59	174	28	115	251
<b>Drafters, Engineering, and Mapping Technicians (17-3000)</b>						
Engineering Technicians (except drafters)	155	214, 215, 216	228	38	161	312
Drafting Occupations	154	217	171	17	100	274
<b>Life, Physical, and Social Science Technicians (19-4000)</b>						
Chemical Technicians	192	224	369	15	206	608
<b>Supervisors, Protective Service Workers (33-1000)</b>						
Firefighters & Supervisors of Firefighters <sup>1</sup>	372, 374	413, 417	211	35	147	293
<b>Law Enforcement Workers (33-3000)</b>						
Detectives, criminal investigators, police & sheriff's patrol officers	382, 385	418	140	49	104	185
<b>Supervisors, Construction and Extraction Workers (47-1000)</b>						
First line Supervisors Const. & Ext Occupations	620	553-558, 613	215	97	174	262
<b>Construction Trades Workers (47-2000)</b>						
Insulation Workers	640	593	3539	52	2643	4641
Plumbers, pipefitters, & steamfitters	644	557, 585, 587	642	219	560	733
Sheetmetal Workers	652	596	418	34	289	584
Drywall Installers	633	573	412	18	244	651
Electricians <sup>2</sup>	635, 713	555, 575-577	405	197	351	466
Structural Iron & Steel Workers	653	597	299	21	185	457
Brickmasons & Stonemasons	622	553, 563, 564	242	42	174	327
Carpenters	623	554, 567, 569	185	137	156	219
Painters, Paperhangers, & Plasterers	642-643, 646	556, 579-584	158	44	115	213
Boilermakers & Oper. Engineers	621, 632	643, 844	153	54	115	199
<b>Supervisors of Installation, Maintenance, and Repair Workers (49-1000)</b>						
Supervisors of Mechanics & Repairers	700	503	275	47	202	366
<b>Vehicle and Mobile Equipment Mechanics, Installers, and Repairers (49-3000)</b>						
Heavy Vehicle & Mobile Equipment Mechanics	722	516, 517	190	21	118	290
<b>Other Installation, Maintenance, and Repair Occupations (49-9000)</b>						
Precision Instrument & Equipment Repairers	743	535	472	12	244	825
Heating, Air Conditioning, & Refrigeration Mechanics, Installers/Repairer	731	534	263	20	161	406
Maintenance and Repair: General and Helper	761-762, 734	865, 547, 549	199	54	149	260
Industrial & Refractory Machinery Mechanics <sup>3</sup>	733, 821	518	188	26	123	276

<b>Supervisors, Production Workers (51-1000)</b>						
Supervisors, production occupations	770	628	207	138	174	245
<b>Assemblers and Fabricators (51-2000)</b>						
Millwrights, Engine Installers <sup>4</sup>	773, 736	544	440	50	327	580
Aircraft & Structural Metal Fabricators	771, 774	636	186	15	104	308
<b>Food Processing Workers (51-3000)</b>						
Furnace, Kiln, & Oven Operators, exc. Food <sup>5</sup>	783, 804, 873	766	374	15	209	617
<b>Metal Workers and Plastic Workers (51-4000)</b>						
Lay-out Workers	816	646	752	5	244	1755
Molding & Casting Machine Operators	810	719	262	10	126	483
Welders & Cutters	814	783	250	98	203	304
Machinists	803	637, 639	196	110	161	237
Extruding/Drawing Machine Operators	792	755, 777	193	16	110	314
Tool & Die Makers	813	634, 635	151	27	100	220
<b>Plant and System Operators (51-8000)</b>						
Stationary Engineers <sup>6</sup>	861, 965	696	453	55	341	589
<b>Other Production Occupations (51-9000)</b>						
Separating, Filtering, & Clarifying Machine Operators	864	757	315	16	180	511
Mixing & Blending Machine Operators	865	756	291	11	146	522
Painting & Paint Spraying Machine Operators	881	759	202	14	110	338
Production Samplers & Weighers	874	798	148	38	105	203
Machine Operators, not specified	896	779	124	122	103	148
<b>Water Transportation Workers (53-5000)</b>						
Ship Captains & Mates, Engineers exc. Fishing Boats	930-931	828, 833	293	19	176	458
<b>Material Moving Workers (53-7000)</b>						
Crane & Tower Operators	951	849	183	15	103	302

1. Groups 372 in Supervisors, Protective Service Workers 33-1000 & 374 in Firefighting and Prevention Workers 33-2000

2. Groups 635 in Construction and Trades Workers 47-2000 & 713 in Electrical and Electronic Equipment Mechanics, Installers, and Repairers 49-2000

3. Groups 733 in Other Installation, Maintenance, and Repair Occupations 49-9000 & 821 in Metal Workers and Plastic Workers 51-4000

4. Groups 773 in Assemblers and Fabricators 51-2000 & 736 in Other Installation, Maintenance, and Repair Occupations 49-9000

5. Groups 783 in Food Processing Workers 51-3000, 804 in Metal Workers and Plastic Workers 51-4000, & 873 in Other Production Occupations 51-9000

6. Groups 861 in Plant & System Operators 51-8000 & 965 in Material Moving Workers 53-7000

**Table 3 Occupations with Elevated PMR's for Malignant Mesothelioma in Descending Order of PMR, (NOMS, 1999, 2003, 2004, 2007-2014)**

Census Occupational Code Job Titles As Used in NOMS	2000 Census Code	1990 Census Code	PMR	Number of deaths	95% CI Lower	95% CI Upper
Insulation Workers	640	593	3539	52	2643	4641
Marine Engineers & Naval Architects	144	58	1031	9	471	1957
Lay-out Workers	816	646	752	5	244	1755
Plumbers, pipefitters, & steamfitters	644	557, 585, 587	642	219	560	733
Precision Instrument & Equipment Repairers	743	535	472	12	244	825
Stationary Engineers	861, 965	696	453	55	341	589
Chemical Engineers	135	48	449	30	303	642
Millwrights, Engine Installers	773, 736	544	440	50	327	580
Sheetmetal Workers	652	596	418	34	289	584
Drywall Installers	633	573	412	18	244	651
Electricians	635, 713	555, 575-577	405	197	351	466
Furnace, Kiln, & Oven Operators, exc. Food	783, 804, 873	766	374	15	209	617
Chemical Technicians	192	224	369	15	206	608
Architects	130	43	337	19	203	526
Separating, Filtering, & Clarifying Machine Operators	864	757	315	16	180	511
Structural Iron & Steel Workers	653	597	299	21	185	457
Ship Captains & Mates, Engineers exc. Fishing Boats	930-931	828, 833	293	19	176	458
Mixing & Blending Machine Operators	865	756	291	11	146	522
Supervisors of Mechanics & Repairers	700	503	275	47	202	366
Materials Engineers	145	45	266	7	107	549
Heating, Air Conditioning, & Refrigeration Mechanics, Installers/Repairer	731	534	263	20	161	406
Molding & Casting Machine Operators	810	719	262	10	126	483
Industrial, Health, & Safety Engineers	143	56	259	30	175	370
Mechanical Engineers	146	57	253	50	187	333
Welders & Cutters	814	783	250	98	203	304
Brick masons & Stonemasons	622	553, 563, 564	242	42	174	327
Engineering Technicians (except drafters)	155	214, 215, 216	228	38	161	312
First line Supervisors Const. & Ext Occupations	620	553-558, 613	215	97	174	262
Firefighters & Supervisors of Firefighters	372, 374	413, 417	211	35	147	293
Electrical & Electronic Engineers	141	55	207	43	150	279
Supervisors, production occupations	770	628	207	138	174	245
Painting & Paint Spraying Machine Operators	881	759	202	14	110	338
Maintenance and Repair: General and Helper	761-762, 734	865, 547, 549	199	54	149	260
Machinists	803	637, 639	196	110	161	237
Extruding/Drawing Machine Operators	792	755, 777	193	16	110	314
Heavy Vehicle & Mobile Equipment Mechanics	722	516, 517	190	21	118	290
Industrial & Refractory Machinery Mechanics	733, 821	518	188	26	123	276
Aircraft & Structural Metal Fabricators	771, 774	636	186	15	104	308
Carpenters	623	554, 567, 569	185	137	156	219
Crane & Tower Operators	951	849	183	15	103	302
Civil Engineers	136	53	176	36	123	243
Engineers, NEC	153	59	174	28	115	251
Drafting Occupations	154	217	171	17	100	274
Painters, Paperhangers, & Plasterers	642-643, 646	556, 579-584	168	44	115	213
Boilermakers & Operating Engineers	621, 632	643, 844	163	54	115	199
Tool & Die Makers	813	634, 635	161	27	100	220
Production Samplers & Weighers	874	798	148	38	105	203
Detectives, criminal investigators, police & sheriff's patrol officers	382, 385	418	140	49	104	185
Machine Operators, not specified	896	779	124	122	103	148

## **Attachment A**

### **Case control and surveillance studies from various countries that identify occupations at high risk for malignant mesothelioma**

1. US – Mazurek (2016), Bang (2016), Tomasallo (2018)
2. England- Peto (1995); McElvenny (2012)
3. France - Rolland (2010)
4. Canada – Teschke (1997)
5. Spain – Agudo (2000)
6. Germany - Rodelsperger (2001)
7. Northern Ireland - O'Reilly (1999)

## Malignant Mesothelioma Mortality — United States, 1999–2015

Jacek M. Mazurek, MD, PhD<sup>1</sup>; Girija Syamal, MBBS<sup>1</sup>; John M. Wood, MS<sup>1</sup>; Scott A. Hendricks, MS<sup>2</sup>; Ainsley Weston, PhD<sup>1</sup>**TABLE 2. Industries and occupations with significantly elevated proportionate mortality ratios, 1,830 malignant mesothelioma decedents aged ≥25 years — 23 states,\* 1999, 2003, 2004, and 2007**

Characteristic	No. of deaths	PMR† (95% CI)
<b>Industry</b>		
Ship and boat building	24	6.7 (4.3–9.9)
Petroleum refining	25	4.1 (2.6–6.0)
Industrial and miscellaneous chemicals	58	3.8 (2.9–5.0)
Labor unions	7	3.7 (1.5–7.6)
Miscellaneous nonmetallic mineral product manufacturing	5	3.6 (1.2–8.4)
Electric and gas and other combinations	7	3.1 (1.3–6.5)
Water transportation	12	2.3 (1.2–3.9)
Electric power generation transmission and distribution	24	2.2 (1.4–3.3)
U.S. Navy	11	2.0 (1.0–3.6)
Architectural, engineering, and related services	23	1.9 (1.2–2.8)
Construction	280	1.6 (1.4–1.8)
Unknown	42	—
All other industries	1,312	—
<b>Occupation</b>		
Insulation workers	19	26.9 (16.2–42.0)
Chemical technicians	8	4.9 (2.1–9.6)
Pipelayers, plumbers, pipefitters, and steamfitters	67	4.8 (3.7–6.1)
Chemical engineers	12	4.0 (2.1–7.1)
Sheet metal workers	17	3.5 (2.0–5.5)
Sailors and marine oilers	5	3.4 (1.1–8.0)
Structural iron and steel workers	10	3.3 (1.6–6.0)
Milwrights	14	3.1 (1.7–5.2)
Stationary engineers and boiler operators	15	2.9 (1.6–4.8)
Electricians	53	2.8 (2.1–3.7)
Welding, soldering, and brazing workers	30	2.1 (1.4–3.0)
Construction managers	37	2.0 (1.4–2.8)
Engineers, all other	12	2.0 (1.0–3.5)
Mechanical engineers	14	1.9 (1.0–3.2)
First-line supervisors or managers of mechanics, installers, and repairers	27	1.8 (1.2–2.6)
Machinists	39	1.6 (1.1–2.1)
First-line supervisors or managers of production and operating workers	40	1.4 (1.0–2.0)
Unknown	40	—
All other occupations	1,362	—

Abbreviations: CI = confidence interval; PMR = proportionate mortality ratio.

\* Multiple cause-of-death mortality files. <https://webappa.cdc.gov/ords/norms-io14.html>.

† PMR is defined as the observed number of deaths with malignant mesothelioma in a specified industry/occupation, divided by the expected number of deaths with malignant mesothelioma. The expected number of deaths is the total number of deaths in industry or occupation of interest multiplied by a proportion defined as the number of malignant mesothelioma deaths in all industries and/or occupations, divided by the total number of deaths in all industries/occupations. The malignant mesothelioma PMRs were internally adjusted by five-year age groups, gender, and race. CIs were calculated assuming Poisson distribution of the data.

# Malignant Mesothelioma Mortality in the United States, 1999–2001

KI MOON BANG, PHD, MPH, GERMANIA A. PINHEIRO, MD, MSC, PHD,  
JOHN M. WOOD, MS, GIRIJA SYAMLAL, MBBS, MPH

Malignant mesothelioma is strongly associated with asbestos exposure. This paper describes demographic, geographic, and occupational distributions of mesothelioma mortality in the United States, 1999–2001. The data ( $n = 7,524$ ) were obtained from the National Center for Health Statistics multiple-cause-of-death records. Mortality rates (per million per year) were age-adjusted to the 2000 U.S. standard population, and proportionate mortality ratios (PMRs) were calculated by occupation and industry, and adjusted for age, sex, and race. The overall age-adjusted mortality rate was 11.52, with males (22.34) showing a sixfold higher rate than females (3.94). Geographic distribution of mesothelioma mortality is predominantly coastal. Occupations with significantly elevated PMRs included plumbers/pipefitters and mechanical engineers. Industries with significantly elevated PMRs included ship and boat building and repairing, and industrial and miscellaneous chemicals. These surveillance findings can be useful in generating hypotheses and developing strategies to prevent mesothelioma. *Key words:* mesothelioma; mortality; occupations; industries.

Some cases of mesothelioma have been associated with exposure to chrysotile.<sup>7</sup>

In the past, asbestos was used for many applications, including building materials (e.g., insulation materials), manufacturing products (e.g., asbestos cement pipe), and automobile industry (e.g., vehicle brake shoes and clutch pads). Asbestos use declined substantially in the 1980s in the United States and is still currently decreasing.<sup>8</sup> However, legacy exposures still occur during remediation and handling of existing asbestos applications. For example, approximately 1.3 million workers were exposed to asbestos in the United States in 2002,<sup>4</sup> including shipbuilders, miners, construction workers (e.g., insulation workers, plumbers, and pipe fitters), electricians, sheet metal workers, and makers of asbestos products. Although asbestos was eliminated in the manufacturing of some products such as electric hair dryers, gas fireplaces, and wall-board patching compounds, the product is still used in the United States.

In 1999, the 10th revision of the International Classification of Diseases (ICD-10) was adopted by the

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**TABLE 3 Malignant Mesothelioma Proportionate Mortality Ratios (PMRs) by Usual Industry and Occupation, 1999 (19 States)\***

Census Industry Code (CIC)	Industry	Number of Deaths	PMR	95% CI
360	Ship and boat building and repairing	7	5.95	2.39–12.27
192	Industrial and miscellaneous chemicals	19	4.81	2.90–7.51
200	Petroleum refining	5	3.80	1.23–8.87
460	Electric light and power	10	3.08	1.48–5.66
60	Construction	77	1.55	1.23–1.94
Census Occupation Code (COC)	Occupation	Number of Deaths	PMR	95% CI
585	Plumber, pipefitters, and steamfitters	18	4.76	2.81–7.51
57	Mechanical engineers	6	3.04	1.11–6.62
575	Electricians	12	2.42	1.25–4.22
156	Teachers, elementary school	13	2.13	1.13–3.64

\*Colorado, Georgia, Hawaii, Idaho, Indiana, Kansas, Kentucky, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Rhode Island, South Carolina, Utah, Vermont, West Virginia, and Wisconsin.

## ORIGINAL ARTICLE

## An Occupational Legacy

*Malignant Mesothelioma Incidence and Mortality in Wisconsin*

Carrie D. Tomasallo, PhD, MPH, Krista Y. Christensen, PhD, MPH, Michelle Raymond, MS,  
Paul D. Creswell, PhD, Henry A. Anderson, MD, and Jon G. Meiman, MD

**Objectives:** The aim of the study was to describe mesothelioma occurrence in Wisconsin from 1997 to 2013 by usual industry and occupation (I&O), including occupations generally considered low risk. **Methods:** Population-

mesothelioma per year in the United States.<sup>1</sup> However, previous surveillance indicates that mesothelioma incidence rate per million residents over 15 years in Wisconsin is elevated compared with the

TABLE 5. Detailed Industry and Occupation Groups\* With Significantly Elevated Adjusted Odds Ratios<sup>†</sup> (ORs) and 95% Confidence Intervals (CIs) for Mesothelioma Death

Industry or Occupation Group	Total (n)	Cases (n)	OR (95% CI)
<i>Industry Group – Reference is Public Administration</i>			
Chemical manufacturing	20	15	3.92 (1.36–13.07)
Construction	240	160	2.93 (1.79–4.84)
Utilities	50	33	2.66 (1.30–5.58)
Fabricated metal product manufacturing	34	23	2.65 (1.17–6.30)
Paper manufacturing	59	37	2.38 (1.22–4.73)
<i>Occupation Group – Reference is Other Management Occupations</i>			
Construction trades workers	115	157	4.20 (2.78–6.42)
Operations specialties managers	35	21	2.37 (1.13–5.12)
Primary, secondary, and special education school teachers	49	28	2.10 (1.05–4.26)
Engineers	51	28	2.02 (1.07–3.86)
Other installation, maintenance, and repair occupations	52	29	1.92 (1.03–3.62)
Metal workers and plastic workers	115	62	1.77 (1.11–2.85)

\*Limited to those industries and occupation groups with at least five mesothelioma cases and five controls.

<sup>†</sup>Model adjusted for frequency matched characteristics of age, race and sex, in addition to ethnicity, year of death, industry or occupation group, and educational attainment.

## Continuing increase in mesothelioma mortality in Britain

Julian Peto, John T Hodgson, Fiona E Matthews, Jacqueline R Jones

### Summary

Mesothelioma is closely related to exposure to asbestos, and mesothelioma mortality can be taken as an index of

### Introduction

Mesothelioma is almost always fatal; most patients affected die within a year of diagnosis. The majority of

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Table 3: **Proportional mortality ratios (PMR) of men aged 16-74 from mesothelioma in England and Wales 1979-80, 1982-90**

Job	PMR (all men=100)	Number	Percent	Cumulative percent
Metal plate workers	700.4*	110	2.5	2.5
Vehicle body builders	618.7*	35	0.8	3.2
Plumbers and gas fitters	442.8*	201	4.5	7.7
Carpenters	365.7*	258	5.7	13.5
Electricians	290.5*	161	3.6	17.0
Upholsterers	283.3†	19	0.4	17.5
Construction workers nec	255.6*	187	4.2	21.6
Boiler operators	253.9*	39	0.9	22.5
Electrical plant operators	253.5*	16	0.4	22.9
Chemical engineers & scientists	248.4*	18	0.4	23.3
Sheet metal workers	233.2*	48	1.1	24.4
Scaffolders	225.6‡	11	0.2	24.6
Production fitters	216.3*	304	6.8	31.4
Professional engineers nec	210.6*	105	2.3	33.7
Plasterers	202.8*	27	0.6	34.3
Welders	202.6*	70	1.6	35.9
Managers in construction	196.8*	40	0.9	36.8
Dockers and goods porters	195.1*	69	1.5	38.3
Electrical engineers	187.0*	39	0.9	39.2
Technicians nec	171.9‡	24	0.5	39.7
Buildings and handymen	164.4*	98	2.2	41.9
Laboratory technicians	164.2‡	27	0.6	42.5
Draughtsmen	160.6‡	28	0.6	43.1
Machine tool operators	133.0*	179	4.0	47.1
Painters and decorators	131.0‡	100	2.2	49.4

\*p<0.001, †p<0.01, ‡p<0.05. Highest 25 occupational PMRs based on 10 or more deaths

## Mesothelioma mortality in Great Britain from 1968 to 2001

Damien M. McElvenny, Andrew J. Darnton, Malcolm J. Price and John T. Hodgson

**Background** The British mesothelioma register contains all deaths from 1968 to 2001 where mesothelioma was mentioned on the death certificate.

**Aims** To present summary statistics of the British mesothelioma epidemic including summaries by occupation and geographical area.

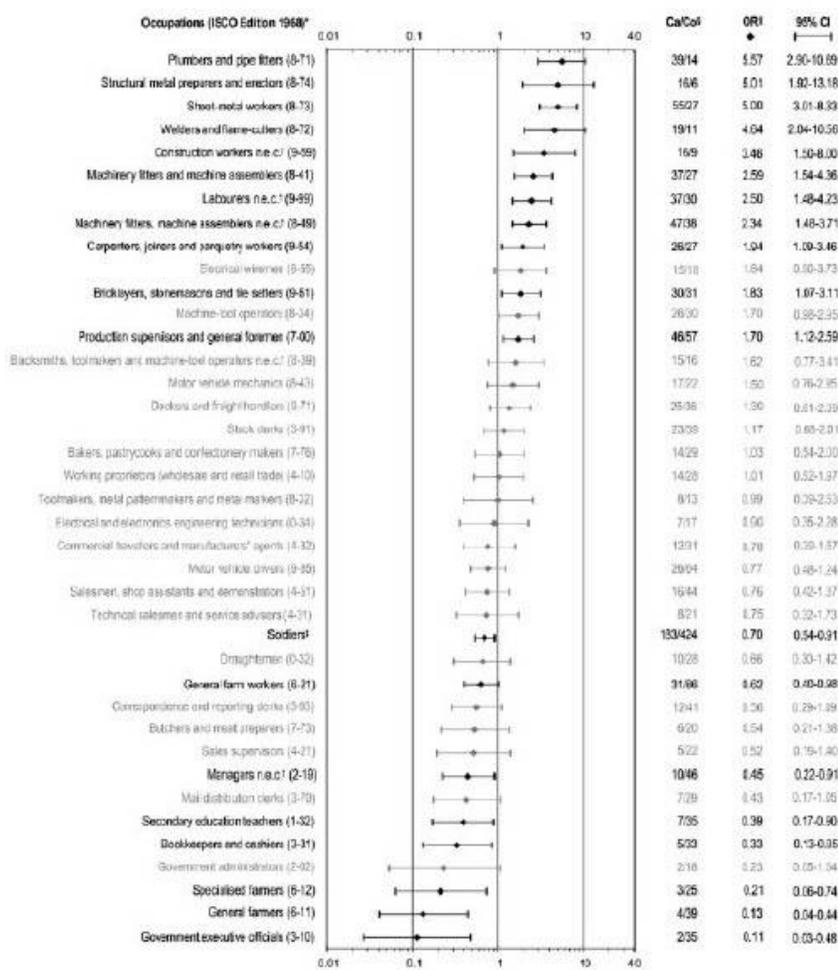
**Table 3.** Highest and lowest risk occupations for males

Southampton occupation code*	Occupation description	Deaths	Expected deaths	PMR	95% CI	
					Lower	Upper
Top 20 ranked occupations with PMRs greater than 100						
146	Metal plate workers	265	53	502	444	565
153	Vehicle body builders	83	16	526	419	652
144	Plumbers and gas fitters	619	150	413	381	446
104	Carpenters	887	229	388	362	413
137	Electricians	406	178	279	255	304
145	Sheet metal workers	144	61	235	198	275
138	Electrical plant operators	54	21	263	197	343
132	Production fitters	850	406	209	196	224
174	Construction workers nec	486	228	213	195	232
143	Electrical engineers (so described)	140	65	216	181	253
194	Boiler operators	83	38	219	175	272
136	Electrical and electronic production fitters	27	10	260	171	378
39	Managers in construction	123	61	200	166	237
27	Chemical engineers and scientists	52	24	221	165	290
149	Welders	204	108	188	163	215
169	Builders etc.	338	195	174	156	193
30	Professional engineers nec	276	160	173	153	194
160	Painters and decorators nec	361	224	161	145	178
111(O)	Managers nec	212	138	154	134	175
148	Scaffolders	36	19	188	132	260

## Occupations and Industries in France at High Risk for Pleural Mesothelioma: A Population-Based Case-Control Study (1998-2002)

Patrick Rolland,<sup>1,2</sup> Celine Gramond,<sup>3</sup> Aude Lacourt,<sup>3</sup> Philippe Astoul, MD, PhD,<sup>4</sup> Soizick Chamming's,<sup>5</sup> Stephane Ducamp,<sup>1,2</sup> Catherine Frenay, MD,<sup>4</sup> Françoise Galateau-Salle, MD,<sup>2,6</sup> Anabelle Gilg Soit Ilg, PhD,<sup>2,7</sup> Ellen Imbernon, MD,<sup>1,7</sup> Nolwenn Le Stang,<sup>2</sup> Jean Claude Pairon, MD, PhD,<sup>8,9</sup> Marcel Goldberg, MD, PhD,<sup>7</sup> and Patrick Brochard, MD<sup>3</sup> for the PNSM Study Group

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\*ISCO codes with at least 20 subjects (cases and controls); †n.e.c.: not elsewhere classified; ‡NAF code 75.20  
Ca/Co: number of cases and controls who held a job in the occupation (job coded with a minimum of 3 months duration)  
Matched for age and district; reference category defined by cases and controls who never held a job in that occupation

**FIGURE 2.** Pleural mesothelioma among men: odds ratios in occupations (ISCO Edition 1968), 1,033 subjects (377 cases; 732 controls), French case-control study 1998-2002.

## A B S T R A C T

To determine whether there were previously unrecognized sources of asbestos exposure in British Columbia, incident mesothelioma cases (n=51) and population-based controls (n=154) were interviewed about their occupational histories and asbestos exposures. The following occupations were at elevated risk: sheet metal workers (OR=9.6, 95% CI: 1.5-

## Mesothelioma Surveillance to Locate Sources of Exposure to Asbestos

Kay Teschke, PhD,<sup>1</sup> Michael S. Morgan, ScD,<sup>2</sup> Harvey Checkoway, PhD,<sup>2</sup>  
Gary Franklin, MD,<sup>2</sup> John J. Spinelli, PhD,<sup>1</sup> Gerald van Belle, PhD,<sup>2</sup>  
Noel S. Weiss, MD, DrPH<sup>2</sup>

**TABLE II**  
Odds Ratios\* Showing Associations Between Occupational Groups and Pleural Mesothelioma, All Cases (n = 51) and Controls (n = 154) Included

	Ever Employed			Most Recent 20 Years Removed		
	Number of Cases/Controls	Odds Ratio Ever Employed	95% Confidence Interval	Number of Cases/Controls	Odds Ratio Ever Employed	Confidence Interval
<b>Occupational Groups with OR <math>\geq</math> 3.0</b>						
Sheet metal workers <sup>M</sup>	6/2	9.6	1.5-106	6/2	9.6	1.5-106
Plumbers and pipelitters <sup>M</sup>	7/2	8.3	1.5-86.3	6/2	7.1	1.2-75.1
Shipbuilding workers, nec <sup>M</sup>	7/5	5.0	1.2-22.7	7/4	6.9	1.5-37.1
Painters	6/4	4.5	1.0-23.7	5/3	5.4	0.9-39.3
Welders <sup>M</sup>	5/4	3.9	0.8-21.8	5/3	4.9	0.9-34.5
Gardeners <sup>M</sup>	5/4	3.9	0.8-21.9	3/4	2.5	0.3-16.8
Bricklayers, plasterers, & cement workers <sup>M</sup>	7/6	3.5	0.9-14.0	7/5	4.5	1.1-19.8
Miners, drillers, & blasters <sup>M</sup>	7/7	3.4	0.9-13.1	7/7	3.4	0.9-13.1
Machinists <sup>M</sup>	8/8	3.2	1.0-11.1	8/7	3.9	1.1-14.2
Construction foremen <sup>M</sup>	8/7	3.1	0.9-11.0	7/5	3.7	0.9-16.0
Electricians & electrical equipment installers <sup>M</sup>	6/8	3.0	0.8-11.6	6/7	3.7	0.9-15.6
<b>A Priori Suspect Occupational Groups</b>						
Industrial mechanics <sup>M</sup>	7/9	2.4	0.7-8.2	6/9	2.1	0.6-7.3
Stationary engineers, boilermakers <sup>M</sup>	6/11	1.8	0.5-5.9	6/11	1.8	0.5-5.9
Construction labourers	11/22	1.5	0.6-3.8	10/19	1.5	0.6-3.9
Transport engineers & fitters <sup>M</sup>	2/6	1.3	0.1-8.3	2/6	1.3	0.1-8.3
Vehicle mechanics <sup>M</sup>	6/20	0.8	0.2-2.3	6/20	0.8	0.2-2.3

## Occupation and Risk of Malignant Pleural Mesothelioma: A Case-Control Study in Spain

**TABLE IV.** Risk of Pleural Malignant Mesothelioma for Occupations with Risk of Exposure to Asbestos, According to the Experts Evaluation<sup>a</sup>

ISCO code	Job title	Cases/controls	OR	CI-95%
560	Laundrers, dry-cleaners, and pressers	6/1	17.91	(2.08-155)
841	Machinery fitters	6/6	3.59	(1.08-12.0)
849	Machinery fitters and assemblers n.e.c.	9/8	4.07	(1.44-11.5)
851	Electrical fitters	5/2	9.10	(1.68-49.4)
855	Electricians	7/9	2.87	(0.97-8.45)
871	Plumbers	4/2	7.49	(1.30-43.3)
872	Welders	6/8	2.45	(0.78-7.63)
873	Sheet metal workers	5/7	2.53	(0.74-8.64)
943	Manufacture of non-metallic products	12/2	21.17	(4.45-101)
951	Bricklayers	20/36	1.99	(1.01-3.95)
974	Driver of material-handling and related equipment	3/1	10.76	(1.08-107)
	Any occupation with high risk of exposure to asbestos <sup>b</sup>	81/109	2.59	(1.60-4.22)

<sup>a</sup>See text for definition of occupations with risk of asbestos exposure. Only occupations with at least 5 cases or a significant OR are presented in the table. In addition to those in the table, other occupations with risk of asbestos exposure are listed below with the corresponding ISCO code and job title (in parentheses, cases/controls): 089 Draughtsman (1/2), 043 Ships officers (1/-), 079 Nurses, medical assistants (-/3), 322 Card- and type-punching machine operators (-/1), 399 Other clerical and related workers n.e.c. (-/1), 410 Working proprietors (who in sale and retail trade) (1/2), 500 Managers catering and lodging services (1/-), 589 Protective services workers n.e.c. (2/6), 722 Metal processors, rolling mill (-/1), 723 Metal processors, smelters (3/7), 724 Metal processors, casting (3/-), 726 Metal processors, treating and coating (1/-), 741 Chemical processors, crushing and mixing (2/3), 744 Chemical processors, still operator (1/-), 771 Food processors, miller (1/-), 833 Machine-tool fitters (1/-), 834 Machine-tool operators (3/4), 839 Blacksmiths, machine-tool operators n.e.c. (4/10), 843 Mechanics, motor vehicles (3/14), 874 Structural metal workers (2/-), 891 Glass formers (3/5), 893 Glass workers, furnace operator (2/3), 932 Painters, vehicles (-/1), 959 Construction workers n.e.c. (3/-), 969 Stationary engine and related equipment operators (3/4), 973 Driver of material-handling and elevator equipment (2/4), 981 Sailor, dockhand and toleman (1/1).

<sup>b</sup>The reference category is always formed by the 51 cases and 148 controls who had never worked in any of the listed occupations.

## Asbestos and Man-Made Vitreous Fibers as Risk Factors for Diffuse Malignant Mesothelioma: Results From a German Hospital-Based Case-Control Study

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*Background* This study examines the role of occupational factors in the development of diffuse malignant mesothelioma with special emphasis on the dose-response relationship

**TABLE V.** Number of Cases and Controls and Odds Ratio from an Ever/Never Evaluation of 22 of 32 Occupations Where At Least Five Cases or Five Controls were Exposed. Within Each of the Occupations the Job Periods are Characterized by the Percentage of Jobs with an Asbestos Exposure and by the Arithmetic Mean of the Fiber Concentration

Key <sup>a</sup>	Occupation <sup>b</sup>	Cases No.	Controls No.	OR <sup>b</sup>	Jobs periods of cases and controls		Fiber concentration GM × 5 f/ml
					All periods	Only periods with an asbestos exposure	
11,41-43	Farmer	17	25	0.60	92	0	0.00
21-32	Forestry worker, fisherman						
44,52	Animal husbandry worker	4	6	0.67	15	13.3	0.10
12,51	Gardener, vineyard worker	2	5	0.40	16	0	0.00
71-91	Miner	6	8	0.75	21	0	0.00
141-150	Chemical processor and related worker	13	11	1.18	48	60.4	1.39
181-184, 501-504	Joiner, wood processing worker	9	8	1.12	79	21.5	0.34
191-252	Metal production and processing worker	26	14	2.09*	81	45.7	0.80
261-306	Mechanic, fitter, plumber	62	21	2.82*	359	72.1	0.79
311-315	Electrician	15	5	3.00*	88	37.5	0.41
391-433	Food production and processing worker	3	5	0.60	47	0	0.00
441-453	Carpenter, bricklayer, roofer	8	10	0.78	96	34.4	0.69
461-472	Road construction worker, pipe layer, well digger, unskilled construction worker	17	17	1.00	96	15.6	0.73
481-492	Tile setter, plasterer, painter, upholsterer	11	3	3.67*	30	63.3	2.94
531	Unskilled worker not elsewhere classified	5	8	0.57	19	31.6	0.14
541-549	Stationary engine and heavy equipment operator	19	7	3.40*	41	65.9	0.70
601-635	Technician/engineer	19	9	2.25	89	46.1	0.28
681-706	Sales/insurance agent	11	26	0.38*	80	3.8	0.06
711-744	Transportation & store worker	48	39	1.32	227	22.9	0.20
751-784	Administrative & organization clerk	34	49	0.57*	201	4.0	0.07
791-805	Protective service worker	59	71	0.56	240	7.5	0.09
861-893	Teacher, scientist, social worker	4	7	0.57	41	14.6	0.10
901-937	Housekeeper, cleaner, hairdresser, bartender	5	7	0.71	28	14.3	0.62

<sup>a</sup> A priori defined occupational groups, see [Jöckel et al., 1994, 1998], code according to standard classification of industries [Statistisches Bundesamt, 1975, 1979].

<sup>b</sup> Odds ratio matched for age and region of residence.

<sup>c</sup> Cases, population controls and control patients.

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## Asbestos related mortality in Northern Ireland: 1985-1994

D. O'Reilly, J. Reid, R. Middleton and A. T. Gavin

### Abstract

**Background** The association between Belfast and research into the hazardous effects of asbestos exposure goes back many years. This paper aims to update previous papers and review the burden of asbestos related disease in Northern Ireland today.

**Methods** A study was carried out of all deaths in Northern Ireland between 1985 and 1994 inclusive, in which an asbestos related disease was mentioned anywhere on the death certificate.

of asbestos exposure goes back many years.<sup>1</sup> A cluster of three cases of pleural tumour had been reported as early as 1935,<sup>2</sup> and in 1950 a pathological description of 15 pleural tumours was collected and subsequently reported.<sup>3</sup> However, the link between mesothelioma and asbestos exposure was made by Wagner *et al.* in a study of crocidolite miners in South Africa in 1960.<sup>4</sup> Elmes in 1965<sup>5</sup> established the association between occupational exposure to asbestos and pleural cancer in Belfast shipyard workers. He also showed that about 20 per cent of

**Table 3** Proportional mortality ratios for pleural cancer and asbestosis by occupation: Northern Ireland 1985-1994 (inclusive)

Occupation	Pleural cancer					Asbestosis				
	No.	%	PMR	LL	UL	No.	%	PMR	LL	UL
Builder	<4					6	5.55	998*	366	2172
Builder's mate	<4					4	3.6	1863*	508	4772
Building labourer	<4					7	6.4	554*	223	1143
Carpenter or joiner	21	6.8	397*	245	607	12	10.9	626*	329	1095
Docker	5	1.6	108	12	253	<4				
Electrical fitter	18	5.8	555*	229	977	<4				
Fitter	37	11.9	403*	284	556	6	5.5	201	74	437
Fitter's mate	9	2.9	717*	373	1378	<4				
General labourer	21	6.8	89	43	105	12	10.9	109	57	110
Painter or decorator	7	2.3	170	68	350	<4				
Plate metal worker	15	4.8	675*	378	1100	14	12.7	1648*	901	2765
Plumber	10	3.2	480*	230	882	6	5.5	825*	302	1796
Sheet metal worker	4	1.3	385*	105	985	<4				
Storeman	5	1.6	238	77	555	<4				
Welder	4	1.3	241	66	618	7	6.4	1231*	495	2538
All other	164	49.6				36	32.7			
Total cases	310					110				

\*All confidence levels are at 5 per cent level.

## References

1. Agudo A., Gonzalez C.A., Bleda M.J., Ramirez J., Hernandez S., Lopez F., Calleja A., Panades R., Turuguet D., Escoar A., et al. Occupation and risks of malignant pleural mesothelioma: A case-control study in Spain. *Am J Ind Med.* 2000;37:159–168.
2. ATSDR (2014), Case Studies in Environmental Medicine – Asbestos Toxicity. Course WB 2344. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.
3. Bang KM, Pinheiro GA, Wood JM, Syamlal G. Malignant Mesothelioma Mortality in the United States, 1999–2001 *Int J Occup Environ Health* Jan-Mar 2006;12(1):9-15.
4. Mazurek JM, Syamlal G, Wood JM, Hendricks SA, Weston A. Malignant Mesothelioma Mortality - United States, 1999–2015. *MMWR Morb Mortal Wkly Rep.* 2017;66(8):214–218. doi:10.15585/mmwr.mm6608a3.
5. McElvenny DM, Damton AJ, Price MJ, Hodgson JT. Mesothelioma mortality in Great Britain from 1968 to 2001. *Occup Med (Lond).* 2005;55:79–87. doi: 10.1093/occmed/kqi034.
6. NIOSH. Census 2000 Occupational Classification System. Industry and Occupation Coding: I&O Classifications. <https://www.cdc.gov/niosh/topics/coding/nioccsuserdocumentation.html>. Page last reviewed: March 6, 2019. Accessed May 1, 2020.
7. NIOSH (2019). National Occupational Mortality Surveillance (NOMS). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Field Studies and Engineering, Health Informatics Branch. Date accessed May 1, 2020.
8. O'Reilly D, Reid J, Middleton R, Gavin AT. Asbestos related mortality in Northern Ireland. *J Pub Health Med.* 1999;21(1):95–101.
9. Peto J, Hodgson JT, Matthews FE, Jones JR. Continuing increase in mesothelioma mortality in Britain. *Lancet.* 1995;345:535–539. doi: 10.1016/S0140-6736(95)90462-X.
10. Robinson CF, Walker JT, Sweeney MH et al. Overview of the National Occupational Mortality Surveillance (NOMS) System: Leukemia and Acute Myocardial Infarction Risk by Industry and Occupation in 30 US States 1985–1999, 2003–2004, and 2007. *AJIM* 2015 Feb;58(2):123-37.
11. Rödelsperger K, Jöckel KH, Pohlabein H, Römer W, Weitowitz HJ. Asbestos and man-made vitreous fibers as risk factors for diffuse malignant mesothelioma: results from a German hospital-based case-control study. *Am J Ind Med.* 2001;39:262–275.
12. Rolland P, Gramond C, Lacourt A, Astoul P, Chamming's S, Ducamp S, Frenay C, Galateau-Salle F, Ilg AG, Imbernon E, Le Stang N, Pairon JC, Goldberg M, Brochard P, PNSM Study Group Occupations and industries in France at high risk for pleural mesothelioma: a population-based case-control study (1998–2002). *Am J Ind Med.* 2010;53(12):1207–1219. doi: 10.1002/ajim.20895.
13. Teschke K, Morgan MS, Checkoway H, et al. Mesothelioma surveillance to locate sources of exposure to asbestos. *Can J Public Health.* 1997;88(3):163-168. doi:10.1007/BF03403881.

14. Tomasallo CD, Christensen KY, Raymond M, Creswell PD, Anderson HA, Meiman JG. An occupational legacy: malignant mesothelioma incidence and mortality in Wisconsin. *J Occup Environ Med.* 2018;60(12):1143–1149.
15. U.S. Bureau of Labor Statistics, 2000 Standard Occupational Classification (SOC) User Guide. (<https://www.bls.gov/soc/2000/socguide.htm>). Accessed 5/20/2020.
16. United States Census. Census 2000 Occupational Categories, With Standard Occupational Classification (SOC) Equivalents: Census 2000 Code Order. Industry and Occupation Code Lists & Crosswalks. <https://www.census.gov/topics/employment/industry-occupation/guidance/code-lists.html>. Page last revised: November 14, 2019. Accessed may 6, 2020.

## **Attachment 2**

### **NOMS Analysis Summary**

## Attachment 2 - NOMS Analysis Summary

NOMS Table 3 labor category	Already in DOL Procedure Manual?	Applicable to DOE?	2000; 1990 Census Occupation Code	Equivalent 2000 SOC/BLS Occupation Code (Note 1)	2000 BLS/SOC Occupational Code definition (Note 2)	Comments about SOC/BLS definition and DOE workplaces	# of deaths (Board Table 3)	Generic Profile Applicability & Content	Evidence supports adding to DOL Procedure Manual?
Insulation workers	Yes	Yes						Insulation GP includes asbestos.	Occupation is already in the Manual.
Marine engineers & Naval architects	No	No					9		<b>No.</b> Occupation is not present in DOE facilities.
Lay-out workers	No	Limited	816; 646	51-492	51-4192 defined as, "Lay out reference points and dimensions on metal or plastic stock or workpieces, such as sheets, plates, tubes, structural shapes, castings, or machine parts, for further processing."	Most layout work meeting the BLS definition is performed by craftsmen (machinists, welders, sheet metal mechanics, model makers) in DOE sites, and is incidental to their primary job duties. The only DOE site with a dedicated "Layout Worker" or similar job title is Sandia NL-Albuquerque (Layout Operator). The Kansas City Plant has Layout Inspectors. Industry Groups and Job Titles associated with these codes indicate that it is unlikely the occupations of the deaths included in NOMS for this group represents DOE workers.	5		<b>No.</b> Only one DOE site has a Layout worker. The BLS definition includes shipfitters and shipbuilders, occupations that do not apply to DOE.
Plumbers, pipefitters & steamfitters	Yes	Yes						Pipefitter GP includes asbestos.	Occupation is already in the Manual.
Precision instrument & Equipment repairers	No	Yes; 48 DOE sites have labor categories such as Instrument Technician, Instrument Mechanic, Electronics Maintenance, ETI Mechanic, or Instrument Maker.	743; 535	49-9060	49-9060 which is defined as: This broad occupation includes the following five detailed occupations: (1) 49-9061 Camera and Photographic Equipment Repairers, (2) 49-9062 Medical Equipment Repairers, (3) 49-9063 Musical Instrument Repairers and Tuners, (4) 49-9064 Watch Repairers, and (5) 49-9069 Precision Instrument and Equipment Repairers, All Other. Of these SOC Target codes this is the only one that is potentially applicable to DOE work.	It is unclear whether this Occupation includes Electronic and Instrument Technicians found in 48 DOE sites.	12	Electronic and Instrument maintenance GP includes asbestos. GP will typically be applied based on job title and/or in lab/shop where work is performed.	<b>Yes.</b> The electronics and instrument maintenance work processes are included in the SEM Asbestos Generic Profile. In this instance, work processes rather than labor categories are better suited for identifying those functions at DOE facilities that would reflect the work covered by the applicable SOC/BLS occupation codes. Therefore, the information from the NOMS analysis is sufficient to add the electronics and instrument maintenance work process to the asbestos exposure presumption list.

NOMS Table 3 labor category	Already in DOL Procedure Manual?	Applicable to DOE?	2000; 1990 Census Occupation Code	Equivalent 2000 SOC/BLS Occupation Code (Note 1)	2000 BLS/SOC Occupational Code definition (Note 2)	Comments about SOC/BLS definition and DOE workplaces	# of deaths (Board Table 3)	Generic Profile Applicability & Content	Evidence supports adding to DOL Procedure Manual?
Stationary Engineers	No	Yes; 16 larger DOE sites have Stationary Engineers/Boiler Operators	861, 965; 696	51-8021; 53-7070	51-8021, Stationary Engineers and Boiler Operators and 53-7070, Pumping Station Operators. Operate or maintain stationary engines, boilers, or other mechanical equipment to provide utilities for buildings or industrial processes. Operate equipment, such as steam engines, generators, motors, turbines, and steam boilers.	The definition is accurate for similar occupations at DOE sites.	55	Boiler maintenance GP includes asbestos. No profile for boiler/utility operators.	<b>Yes.</b> Although Table 3 of the Board's memo to Scalia has confusing information for this position, the BLS OC definition applies to the work of Stationary Engineers and Boiler Operators in DOE facilities. Extensive presence of asbestos insulation is known to have existed in DOE steam boiler plants. Eight (8) of 16 SEM profiles for Boiler Operators/Stationary Engineers contain asbestos, mostly where coal-fired boilers were used.
Chemical Engineers	No	Yes; SEM shows Chemical Engineers being at 22 DOE sites, most larger facilities.	135; 48	17-2041	17-2041 defined as, "Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering."	In DOE, most chemical engineers are involved in the design of small scale processes and maintaining/improving existing process equipment. Design of large production scale facilities like those constructed at sites like the GDPs and reactors were done by engineers employed by A&E firms or major construction contractors. Of the 22 DOE sites in SEM with Chemical Engineers, only 1 has documentation showing the labor category had potential for exposure to asbestos.	30		<b>No.</b> Although 22 mostly large DOE sites have SEM profiles for Chemical Engineers, the roles of those Engineers are not the same as those of Chemical Engineers in the NOMS study. Further, only 1 of the 22 sites has documentation in the SEM Library showing potential for asbestos exposure.
Millwrights, Engine Installers	Yes	Yes						Similar to Maintenance Mechanic (which GP includes asbestos).	Occupation is already in the Manual.
Sheetmetal workers	Yes	Yes						Sheet Metal GP includes asbestos.	Occupation is already in the Manual.
Drywall installers	Yes	Yes						Carpenters would typically perform this activity in DOE. Carpentry GP includes asbestos.	Occupation is already in the Manual.
Electricians	Yes	Yes						Electrical maintenance GP includes asbestos.	Occupation is already in the Manual.
Furnace, Kiln, & Oven Operators (exc. Food)	Yes (Furnace Operator)	Yes						No GP for Furnace/Kiln operators. No automatic asbestos application.	Occupation is already in the Manual.

NOMS Table 3 labor category	Already in DOL Procedure Manual?	Applicable to DOE?	2000; 1990 Census Occupation Code	Equivalent 2000 SOC/BLS Occupation Code (Note 1)	2000 BLS/SOC Occupational Code definition (Note 2)	Comments about SOC/BLS definition and DOE workplaces	# of deaths (Board Table 3)	Generic Profile Applicability & Content	Evidence supports adding to DOL Procedure Manual?
Chemical Technicians	No	Yes (Laboratory Technician)	192; 224	19-4031 (63 individual job titles make up this occupation, NIOCCS, 2000 COC)	19-4031 Chemical Technician defined as, "Conduct chemical and physical laboratory tests to assist scientists in making qualitative and quantitative analyses of solids, liquids, and gaseous materials for purposes, such as research and development of new products or processes, quality control, maintenance of environmental standards, and other work involving experimental, theoretical, or practical application of chemistry and related sciences."	The definition does not seem to include DOE Chemical Operators and instead describes DOE chemical and physical laboratory workers with titles such as Laboratory Technician (most common--at approx. 45 DOE sites), Laboratory Assistant, Laboratory Associate, and Laboratory Worker. I checked 9 DOE sites in SEM; 4 had asbestos in their profiles, 5 did not. The ones with asbestos did asbestos sample analysis.	15	Chemistry lab GP does <b>NOT</b> include asbestos.	<b>No.</b> The only DOE sites in the sample of 9 that have asbestos in their profile are ones that do asbestos sample analysis that presents very little potential for exposure. It is very unclear how other DOE site Laboratory Technicians would have been exposed to asbestos. Require more analysis of the industries where the deaths occurred.
Architects	No	Yes	130; 43	17-1010	17-1010 Architects, except Naval. This broad occupation includes the following two detailed occupations: (1) 17-1011 Architects, Except Landscape and Naval, and (2) 17-1012 Landscape Architects defined as. "Plan and design structures, such as private residences, office buildings, theaters, factories, and other structural property; 17-1012: Plan and design land areas for such projects as parks and other recreational facilities, airports, highways, hospitals, schools, land subdivisions, and commercial, industrial, and residential sites."	13 DOE sites have Architects, Architectural Engineers or similar titles. None have asbestos in their SEM profile. Analysis of the associated industry odes was of little value in determining the nature of the environments associated with where this work was performed in that the associated industries referenced the type of building the architects designed such as schools, retail establishments, commercial buildings, office complexes, industrial plants, etc.	19		<b>No.</b> Nothing suggests Architects in DOE facilities had asbestos exposure. Further, there are 2 subcategories of the SOC Code and only one (17-1011) appears to apply to DOE facilities.

NOMS Table 3 labor category	Already in DOL Procedure Manual?	Applicable to DOE?	2000; 1990 Census Occupation Code	Equivalent 2000 SOC/BLS Occupation Code (Note 1)	2000 BLS/SOC Occupational Code definition (Note 2)	Comments about SOC/BLS definition and DOE workplaces	# of deaths (Board Table 3)	Generic Profile Applicability & Content	Evidence supports adding to DOL Procedure Manual?
Separating, Filtering, & Clarifying Machine Operators	No	Yes	864; 757	51-9010	51-9010 Chemical Processing Machine Setters, Operators, and Tenders which is defined as: This broad occupation includes the following detailed occupations: 51-9011 Chemical Equipment Operators and Tenders, and 51-9012 Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders defined as, "Operate or tend equipment to control chemical changes or reactions in the processing of industrial or consumer products. Equipment used includes devulcanizers, steam-jacketed kettles, and reactor vessels. Excludes "Chemical Plant and System Operators" (51-8091). 51-9012: Set up, operate, or tend continuous flow or vat-type equipment; filter presses; shaker screens; centrifuges; condenser tubes; precipitating, fermenting, or evaporating tanks; scrubbing towers; or batch stills. These machines extract, sort, or separate liquids, gases, or solids from other materials to recover a refined product. Includes dairy processing equipment operators. Excludes "Chemical Equipment Operators and Tenders" (51-9011)."	BLS defines 51-9010 as "Chemical Processing Machine Setters, Operators, and Tenders." Four (4) DOE sites have filter operators (primary or alias). Only 1 of the 4 sites have asbestos in SEM profile of the labor category. 0 sites have Separating Operators or Clarifying Machine Operators. ORGDP and Portsmouth GDP operated centrifuge facilities but available documentation on these facilities has been insufficient to construct full SEM profiles of the activities. Asbestos was not known to be present in the Portsmouth GDP facilities which were constructed after the use of asbestos in building materials and in other applications was controlled.	16		<b>No.</b> Only one (51-9012) of the two subcategories of this Occupation apply to DOE, and it applies to only 4 sites. Only 1 of those sites has asbestos in its SEM profile.
Structural Iron & Steel Workers	Yes (Ironworker)	Yes						Ironworking GP includes asbestos.	Occupation is already in the Manual.
Ship Captains & Mates, Engineers, etc. except Fishing Boats	No	No							<b>No.</b> Occupation is not present in DOE facilities.
Mixing and Blending Machine Operators	No	Yes	865; 756	51-9020	Equivalent SOC/BLS Occupation Code SOC/BLS is 51-9020 Crushing, Grinding, Polishing, Mixing, and Blending Worker. This broad occupation includes the following three detailed occupations: (1) 51-9021 Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders, (2) 51-9022 Grinding and Polishing Workers, Hand, and (3) 51-9023 Mixing and Blending Machine Setters, Operators, and Tenders.	Blending Operators (51-9023) were present at the Mallinckrodt facilities at Weldon Spring and Destrehan St. The Destrehan St. position has asbestos in the profile; Weldon Spring does not. 0 sites had Mixing or Mixing Machine Operators, or Crushing, Grinding, and Polishing Machine Setters.	11	Abrasives blasting GP does <b>NOT</b> include asbestos.	<b>No.</b> Very limited presence of these Occupations in DOE. Only 2 DOE sites had Blending Operators.

NOMS Table 3 labor category	Already in DOL Procedure Manual?	Applicable to DOE?	2000; 1990 Census Occupation Code	Equivalent 2000 SOC/BLS Occupation Code (Note 1)	2000 BLS/SOC Occupational Code definition (Note 2)	Comments about SOC/BLS definition and DOE workplaces	# of deaths (Board Table 3)	Generic Profile Applicability & Content	Evidence supports adding to DOL Procedure Manual?
Supervisors of Mechanics & Repairers	Yes	Yes				Supervisors are considered to have the same toxic substance exposures as those they supervise.		Mechanical maintenance GP includes asbestos.	Occupation (Maintenance Mechanic) is already in the Manual.
Materials Engineers	No	Yes	145; 45	17-2131	17-2131 Materials Engineer defined as, "Evaluate materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Include those working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics and glass, plastics and polymers, and naturally occurring materials. Include metallurgists and metallurgical engineers, ceramic engineers, and welding engineers."	Only two (2) SEM profiles for DOE sites have Metallurgists. 6 DOE sites have Welding Engineers. 3 DOE sites have Ceramics Engineers. 5 DOE sites have Materials Engineers or Materials Scientists. Three (3) of the 14 SEM profiles include asbestos.	7		<b>No.</b> Only 11 DOE sites have one or more of the labor categories that fall under Materials Engineer. Only 3 of the 14 profiles for these labor categories contain asbestos. Small number of deaths indicates need to examine industries and classification of Material Engineer where the 7 occupational deaths occurred.
HVAC Mechanics, Installers/Repairer	No	Yes	731; 534	49-9021	49-9021 defined as, "Install or repair heating, central air conditioning, or refrigeration systems, including oil burners, hot-air furnaces, and heating stoves."	20 DOE sites have HVAC Technicians, HVAC Mechanics, Air Conditioning Mechanics, or similar titles. The SEM generic profile applies asbestos to this labor category for HVAC work prior to 1981.	20	HVAC maintenance GP includes asbestos.	<b>Yes.</b> This labor category should be added.
Molding & Casting Machine Operators	No	Partial	810; 719	51-4070 includes: 51-4071 Foundry Mold and Coremakers, and 51-4072 Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	51-4071 defined as, "Make or form wax or sand cores or molds used in the production of metal castings in foundries. 51-4072: Set up, operate, or tend metal or plastic molding, casting, or coremaking machines to mold or cast metal or thermoplastic parts or products	No DOE sites are known to have used sand casting in production applications (51-4011). Six (6) DOE sites have some type of casting operator involved with metal casting operations (51-4072). None of the SEM profiles for those positions contain asbestos for casting activities.	10		<b>No.</b> Limited casting work in DOE facilities and those with the activity do not have asbestos in their SEM profiles. Only occupational subcategory 51-4072 applies to DOE. The small number of deaths need analysis to determine the deaths applicable to 51-4072 have a PMR>100.

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Industrial, Health & Safety Engineers	No	Yes	143; 56	17-2110 includes 17-2111 Health and Safety Engineers, Except Mining Safety Engineers and Inspectors; and 17-2112 Industrial Engineers	17-2110 Industrial Engineers, including Health and Safety. This broad occupation includes the following two detailed occupations: (1) 17-2111 Health and Safety Engineers, Except Mining Safety Engineers and Inspectors defined as :Promote worksite or product safety by applying knowledge of industrial processes, mechanics, chemistry, psychology, and industrial health and safety laws. Includes industrial product safety engineers." and (2) 17-2112 Industrial Engineers defined as, "Design, develop, test, and evaluate integrated systems for managing industrial production processes, including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination."	Almost every DOE site had a safety professional, safety engineer, industrial hygienist, or similar labor category. A total of 18 DOE sites had Industrial Engineers in their SEM profiles. Most DOE site industrial engineers focus on efficiency improvements, not health and safety. Asbestos was not in the SEM profiles of these Occupations in any of the 20 DOE SEM profiles checked.	30		<b>No.</b> Nothing suggests that either Safety or Industrial Engineers in DOE facilities had asbestos exposure.
Mechanical Engineers	No	Yes	146; 57	17-2141	17-2141 is defined as, "Perform engineering duties in planning and designing tools, engines, machines, and other mechanically functioning equipment. Oversee installation, operation, maintenance, and repair of such equipment as centralized heat, gas, water, and steam systems."	18 DOE sites have Mechanical Engineer as a SEM labor category. Most are design engineers and few have regular field presence. 0 of 18 have asbestos in their SEM Mechanical Engineer profile.	50		<b>No.</b> It is unclear how design mechanical engineers would have significant exposure to asbestos. Further 0 of 18 Mechanical Engineer profiles in SEM contain asbestos.
Welders & Cutters	Yes	Yes						Welding GP and Torch cutting GP includes asbestos per DOL direction.	Occupation is already in the Manual.
Brick Masons & Stonemasons	Yes (Mason)	Yes						Masonry GP includes asbestos.	Occupation is already in the Manual.
Engineering Technicians (exc. Drafters)	No	Yes	155; 214, 215, 216	17-3020	17-3020 includes 8 Engineering Technician subcategories (excludes Drafters). Included are Electrical, Civil, Mechanical, and others. Example--17-3022: Civil Engineering Technician: Apply theory and principles of civil engineering in planning, designing, and overseeing construction and maintenance of structures and facilities under the direction of engineering staff or physical scientists. (Example; others are similar)	This occupation covers a broad range of technicians involved in many varied activities with diverse hazards. 3 of 16 Engineering Technician profiles in SEM contain asbestos.	38		<b>No.</b> Only 3 of 16 SEM profiles of Engineering Technicians contain asbestos. Need to examine industries and classification (if available) of 38 fatalities in this occupation. Further, Table 3 shows a PMR > 100 only for the combined group (155/17-3020) of technicians. Need to know the PMR for each of the 8 subcategories of 17-3020.

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First Line Supervisors, Construction Trades & Extraction Workers	Yes (Note 4)	Yes						General construction trades (Carpenter, Electrician, Mason, Ironworker, etc.) include asbestos in the GP.	Occupation is already in the Manual.
Firefighters & Supervisors or Firefighters	No	Yes	372, 374; 413, 417	33-1021; 33-2011	Control and extinguish fires or respond to emergency situations where life, property, or the environment is at risk. Duties may include fire prevention, emergency medical service, hazardous material response, search and rescue, and disaster management. (Firefighter)	The SEM profile applies asbestos for firefighting before 1981. Almost all larger DOE sites had an on-site fire department.	35	Firefighting GP's include asbestos.	Yes. Candidate for addition to Manual, especially for pre-1981 employment.
Electrical & Electronic Engineers	No	Yes	141; 55	17-2070	17-2070 includes 17-2071 Electrical Engineers; and 17-2072 Electronics Engineers, Except Computer. 17-2071: Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use. Exclude "Computer Hardware Engineers" (17-2061, Electrical Engineer). 17-2072: Research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use utilizing knowledge of electronic theory and materials properties. Design electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls. Exclude "Computer Hardware Engineers" (17-2061, Electronic Engineers, exc Computer).	18 DOE sites have Electrical Engineers in their SEM profiles. 7 DOE sites have Electronic Engineers in their SEM profiles. Most DOE Electronic Engineers were involved in Instrumentation design. In DOE sites, it is unusual for an Electrical or Electronic engineer to "supervise manufacturing or installation of electrical equipment" while functioning in the Engineering labor category. This may be more common in Construction work.	43		No. Only 4 of 21 sites with one or both of these engineering labor categories contain asbestos. Need to examine industries and activities of the 43 fatalities in this occupation. Further, Table 3 shows a PMR > 100 only for the combined group (141/172070). Need to know the PMR of each subcategory (17-2071 and 17-2072).
Supervisors, production operations	Yes	Yes	770; 628	51-1011	Supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators. Exclude team or work leaders.	Very broad definition that includes supervisors from many different industries.	138		Occupation is already in the Manual.

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Painting & Paint Spraying Machine Operators ("Painting Workers")	No	No	881; 759	51-9120	51-9120 includes 51-9121, Coating, Painting, and Spraying Machine Setters, Operators, and Tenders; 51-9122, Painters, Transportation Equipment; and 51-9123, Painting, Coating, and Decorating Workers. 51-9121: Set up, operate, or tend machines to coat or paint any of a wide variety of products including, glassware, cloth, ceramics, metal, plastic, paper, or wood, with lacquer, silver, copper, rubber, varnish, glaze, enamel, oil, or rust-proofing materials. Excludes "Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic" (51-4193) and "Painters, Transportation Equipment" (51-9122). 51-9122: Operate or tend painting machines to paint surfaces of transportation equipment, such as automobiles, buses, trucks, trains, boats, and airplanes. Includes painters in auto body repair facilities. 51-9123: Paint, coat, or decorate articles, such as furniture, glass, plateware, pottery, jewelry, toys, books, or leather. Excludes "Artists and Related Workers" (27-1010), "Designers" (27-1020), "Photographic Process Workers and Processing Machine Operators" (51-9151), and "Etchers and Engravers" (51-9194).	Painting in DOE sites is most performed by the Painter labor category. Very little automated painting operations were used. Many (most?) DOE sites send vehicles that needed body work and painting offsite for such repairs.	14	Painting GP includes asbestos.	<b>No.</b> Overall, this Occupation does not apply to DOE sites. Vehicle painting was usually performed offsite by non-DOE body shops.

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Maintenance and Repair: General and Helper	No	No	761-762, 734; 865, 547, 549	49-9098 (Helpers-- Installation, Maintenance, and Repair Workers), 49-9093/49-9099 (Fabric Menders (other than garment)/ Installation, Maintenance, and Repair Workers, All Other), 49-9042 (Maintenance and Repair Workers, General)	Help installation, maintenance, and repair workers in maintenance, parts replacement, and repair of vehicles, industrial machinery, and electrical and electronic equipment. Perform duties, such as furnishing tools, materials, and supplies to other workers; cleaning work area, machines, and tools; and holding materials or tools for other workers (Helpers, 49-9098). Repair tears, holes, and other defects in fabrics, such as draperies, linens, parachutes, and tents (Fabric Menders, 49-9093). All mechanical, installation, and repair workers and helpers not listed separately (Repair Workers, 49-9099). Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of an establishment in repair. Duties may involve pipe fitting; boiler making; insulating; welding; machining; carpentry; repairing electrical or mechanical equipment; installing, aligning, and balancing new equipment; and repairing buildings, floors, or stairs. Exclude "Maintenance Workers, Machinery" (49-9043).	Very broad definition that includes many different industries. SEM treats Helpers as having the same potential exposures to toxic materials as the craft or other group they are helping. Fabric menders (49-9093) not applicable to DOE sites. Repair workers (49-9099) not applicable to DOE; specific crafts performed such repairs in DOE sites. Multi-craft maintenance and repair workers are rare in DOE sites due to union contracts. Almost all maintenance/repair workers are attached to a single craft.	54		No. Very broad occupational category which, overall, does not apply to DOE facilities.
Machinists	Yes (for machine grinding)	Yes						Machining GP does <b>NOT</b> include asbestos.	Occupation is already in the Manual for machine grinding.
Extruding/Drawing Machine Operators	No	Yes	792; 755, 777	51-4021	Set up, operate, or tend machines to extrude or draw thermoplastic or metal materials into tubes, rods, hoses, wire, bars, or structural shapes.	Five (5) DOE sites have Extrusion Operators or similar titles/aliases. 2 of the 5 positions have asbestos in their profiles. There may be others where extrusion operations occurred but the operator was called something other than an Extrusion Operator. Only one (1) of those sites (SRS) is currently operating. No DOE sites have Drawing Machine Operators.	16		No. Need to examine industries and classification (if available) of the 16 fatalities in this occupation.
Heavy Vehicle & Mobile Equipment Mechanics	Yes	Yes						Vehicle maintenance GP includes asbestos.	Occupation is already in the Manual.

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Industrial & Refractory Machinery Mechanics	No (but see Column I)	No (but see Column I)	733, 821; 518	49-9041, 49-9045	49-9041 is defined as, "Repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems. Exclude "Millwrights" (49-9044), "Mobile Heavy Equipment Mechanics, Except Engines" (49-3042), and "Maintenance Workers, Machinery" (49-9043) who perform only routine tasks. (49-9045) Build or repair furnaces, kilns, cupolas, boilers, converters, ladles, soaking pits, ovens, etc., using refractory materials (excludes Brickmasons)."	No DOE sites have "Industrial Machinery Mechanics". The duties described in the definition are mostly performed by Maintenance Mechanics and Millwrights in DOE sites. There are no DOE occupations with 'refractory' in their titles. Refractory replacement and repair is largely performed by Masons and Maintenance Mechanics in DOE sites.	26	Mechanical maintenance, Millwright/Ironwork, and Masonry GP's include asbestos.	The DOE labor categories (Maintenance Mechanics, Millwrights, and Masons) performing the duties of this Occupation are already in the Manual.
Aircraft & Structural Metal Fabricators	No	No							<b>No.</b> DOE does not employ workers in this Occupation.
Carpenters	Yes	Yes						Carpentry GP includes asbestos.	Occupation is already in the Manual.
Crane & Tower Operators	No	Yes	951; 849	53-7021	Operate mechanical boom and cable or tower and cable equipment to lift and move materials, machines, or products in many directions. Exclude "Excavating and Loading Machine and Dragline Operators" (53-7032).	A total of 21 DOE sites have the Crane Operator labor category or similar title. 4 of the 21 SEM profiles for these Crane Operators contain asbestos. Most appear to have operated bridge cranes, gantry cranes, or large mobile cranes.	15	Crane operations alone GP does <b>NOT</b> include asbestos. Rigging GP does include asbestos.	<b>No.</b> Limited asbestos exposure in applicable labor category profiles.
Civil Engineers	No	Yes	136; 53	17-2051	Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, water and sewage systems, and waste disposal units. Include architectural, structural, traffic, ocean, and geo-technical engineers. Exclude "Hydrologists" (19-2043).	A total of 15 DOE sites have Civil Engineer as a labor category or alias. 0 of the 15 SEM profiles contained asbestos. Civil Engineers employed by DOE Operating Contractors are design engineers and are typically not routinely involved in overseeing construction and maintenance as major elements of their jobs.	36		<b>No.</b> It is unclear how DOE site Civil Engineers would have been exposed to asbestos on a regular basis. Need to examine industries and classification (if available) of the 36 fatalities in this occupation.
Engineers, Not Elsewhere Classified (NEC)	No	No	153; 59	17-2199	All engineers not listed separately.	Almost all engineers in DOE sites fall into one of the SOC/BLS Occupation Codes.	28		<b>No.</b> However, further analysis of the 28 fatalities would be helpful if it showed the actual Occupations.

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Drafting Occupations	No	Yes	154; 217	17-3010. Includes 17-3011, Architectural and Civil Drafters; 17-3012, Electrical and Electronics Drafters; 17-3013, Mechanical Drafters; and 17-3019, Drafters, All others.	17-3011: Prepare detailed drawings of architectural and structural features of buildings or drawings and topographical relief maps used in civil engineering projects, such as highways, bridges, and public works. Use knowledge of building materials, engineering practices, and mathematics to complete drawings. 17-3012: Prepare wiring diagrams, circuit board assembly diagrams, and layout drawings used for the manufacture, installation, or repair of electrical equipment. 17-3013: Prepare detailed working diagrams of machinery and mechanical devices, including dimensions, fastening methods, and other engineering information. 17-3019: All drafters not listed separately.	A total of 41 DOE sites have drafters, drafting technicians, or similar positions. SEM profiles of Drafters at 20 DOE sites were checked. 0 of 20 had asbestos in their profile. Larger DOE sites had drafters involved in each of the identified subcategories of this Occupation. SEM does not assign asbestos to drafter profiles.	17		No. 0 of 20 Drafter profiles in SEM contained asbestos. It is unclear how drafters involved with design work and limited in-field presence would have had significant exposure to asbestos. May want to examine industries and classification (if available) of the 17 fatalities in this occupation.
Painters, Paperhangers, & Plasterers	Yes	Yes				Only one (1) DOE site (Los Alamos National Lab) has a Paperhanger labor category.		Painting GP includes asbestos.	Occupations (Painter and Plasterer) are already in the Manual.
Boilermakers and Operating Engineers	Yes	Yes (see Column G)	621; 632	47-2011	(Boilermaker) Construct, assemble, maintain, and repair stationary steam boilers and boiler house auxiliaries. Align structures or plate sections to assemble boiler frame tanks or vats, following blueprints. Work involves use of hand and power tools, plumb bobs, levels, wedges, dogs, or turnbuckles. Assist in testing assembled vessels. Direct cleaning of boilers and boiler furnaces. Inspect and repair boiler fittings, such as safety valves, regulators, automatic-control mechanisms, water columns, and auxiliary machines.	Odd combination of labor categories in Table 3 - may be an error. The SOC Code 621 applies only to Boilermaker.		Boiler maintenance GP includes asbestos. No profile for boiler/utility operators. Unlikely DOE sites would manufacture or install boilers themselves.	Occupations (Boilermaker and Operating Engineer) are already in the Manual.
Tool & Die Makers	Yes (Tool Grinder and Machinist)	Yes	813; 634, 635	51-4111	Analyze specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gauges, and machinists' hand tools.	At many DOE sites, Tool & Die Makers are advanced Machinists. DOE sites with large machining operations typically have dedicated Tool & Die Makers or similarly titled labor categories.	27	Machining GP does <b>NOT</b> include asbestos.	Occupations (Machinist, Tool Grinder) are already in the Manual.

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Production Samplers & Weighers (see Column G)	No	Yes (see Column G)	874; 798	51-9061	Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.	SOC Code is described as "Inspectors, Testers, Sorters, Samplers, and Weighers". It is unclear why Table 3 limits the Occupation to Weighers. May be an error. A total of five (5) DOE sites have Weigher, Weighmaster, or similar labor categories. A Weighmaster usually weighed trucks and appears to be excluded from the definition. Weighing was also a related duty of multiple other occupations. Most DOE sites had Inspectors.	38		<b>No.</b> This occupation grouping covers virtually every industry employing quality control standards and is so broad the analysis is not applicable to DOE sites. The NOMS data also shows a very weak association with the PMR reported.
Detectives, criminal investigators, police & sheriff's patrol officers	No	Yes	382, 385; 418	33-3021 (382, Detectives and Criminal Investigators), 33-3051 (385, Police and Sheriff's Patrol Officers)	33-3021: Conduct investigations related to suspected violations of Federal, State, or local laws to prevent or solve crimes. Exclude "Private Detectives and Investigators" (33-9021). 33-3051: Maintain order, enforce laws and ordinances, and protect life and property in an assigned patrol district. Perform combination of following duties: patrol a specific area on foot or in a vehicle; direct traffic; issue traffic summonses; investigate accidents; apprehend and arrest suspects, or serve legal processes of courts.	Few Detectives and Criminal Investigators in DOE sites. Almost all DOE sites have Guards, Security Officers, Police, or similarly titled labor categories. Some of those personnel perform detective duties and would be much more likely to be exposed to asbestos than would Detectives who were mainly office positions.	49	Weapons GP does <b>NOT</b> include asbestos.	<b>No.</b> Potential asbestos exposure for this labor category is better determined by the locations assigned which dramatically impacts not only the nature of potential exposures but also the frequency and degree of exposure. Need to examine industries and classification (if available) of the 49 fatalities in this occupation. Asbestos is in the profile of Security Guards at some DOE sites, e.g., Y-12 and Hanford.
Machine Operators, not specified	No	No (See Column G)	896; 779	51-9199	All production workers not listed separately.	The 2000 SOC Code title of this position is Production Workers, All Other. Very broad definition of this Occupation. Machine Operator implies a production line position. DOE workers are not usually considered Production Workers. Only 1 DOE site has a "Machine Operator" labor category in a production situation.	122		<b>No.</b> Very general Occupation that has limited applicability to DOE sites.