airborne fibers during this operation. (It should be noted, however, that such exposures may be reduced through modern packing methods.) Fibers may also become airborne when compacted asbestos fiber is removed from the supplier's sealed containers prior to mixing. Depending on the product line, the compacted fiber may be "willowed" or "fluffed" to facilitate mixing. Asbestos fiber may become airborne due to leakage or spillage during mixing, mixer unloading, or processing operations. In a dry-mix process, fibrous asbestos may become airborne as the batch is weighed and additional materials are added. Once the fiber has been wetted with water or other substances, encapsulated, or bonded with other materials, fiber release is significantly reduced.

In product finishing operations, asbestos fibers become airborne when they are torn loose from the parent product as it is cut, sawed, drilled, texturized, shaped, or otherwise modified to form a finished product. Occupational exposures may also occur after the finishing operation or in the handling and disposing of asbestos-containing wastes. The number of plants and the number of potentially exposed workers are presented in Table 7.

Secondary Manufacturing

Secondary fabricators are defined as establishments that receive products from primary manufacturers and further process or fabricate these products to produce other intermediate or finished products. Primary asbestos products that undergo significant secondary processing include flat asbestos-cement (A/C) sheet, friction products, gaskets and packings, plastics, and textiles. Secondary processing involves sawing, pressing, slitting or drilling of asbestos-containing materials and, hence, produces some relatively high exposure levels. The number of plants and workers are presented in Table 8.

Service Industries and Construction

In the service sectors two industries are affected: (1) Automotive brake and clutch repair and (2) shipbuilding repair. The number of sites and the number of potentially exposed workers in these sectors are shown in Table 9.

TABLE 7.—ANNUAL PRODUCTION AND ESTIMATED NUMBER OF ESTABLISHMENTS, WORKERS EXPOSED, AND EXPOSURE LEVELS FOR PRIMARY MANUFACTURERS OF ASBESTOS PRODUCTS

Product line	Annual production	Estimated number of workers exposed	Estimated number of establishments	Estimated 8-hour TWA exposure levels (f/cc)
A/C pipe	258,060 tons	512	5	0.01–1.21
A/C sheet	604,310 squares	203	6	N/D–2.4
Friction materials	260,000,000 pieces	5,104	51	N/D–7.9
Textiles	4,730 tons	413	3	N/D–3.79
Flooring	750 (10^6) ft²	276	3	N/D–0.3
Gaskets	35.8 (10^6) ft²	214	[1] 19	0.03–2.06
Packings	51.4 tons	101	[1] 19	0.03–2.06
Paper	72,324 tons	387	22	N/D–1.42
Coatings	177 (10^6) gallons	1,327	78	N/D–3.3
Plastics	8,409 tons	324	4	N/D–1.11
Total		8,861	191	

[1] The same plants make both gaskets and packings.
N/D = Non-Detectable.

Sources: RTI 1984 Survey Data [Exhibit. 84–473]; OSHA MIS Files; OSHA Hearing; and ICF Inc., Asbestos Products and Their Substitutes, Appendix C, December 1983.

TABLE 8.—ESTIMATED NUMBER OF PLANTS, WORKERS EXPOSED, AND EXPOSURE LEVELS FOR SECONDARY FABRICATORS OF ASBESTOS PRODUCTS

Product line	Estimated number of establishments	Estimated number of workers exposed	Estimated 8-hour TWA exposure levels (f/cc)
Gaskets/packings	289	9,972	N/D–0.77
Automotive remanufacturing	181	4,750	N/D–1.6
Plastics	245	2,450	N/D–0.29
Friction materials	40	1,504	N/D–0.75
A/C sheet	23	345	N/D–3.2
Textiles	51	172	N/D–1.8
Total	829	19,193	

N/D = Non-detectable.

Sources: RTI 1984 Survey Data [Exhibit. 84–473]; OSHA MIS Files; OSHA Hearing; and ICF Inc., Asbestos Products and Their Substitutes, Appendix C, December 1983.

TABLE 9.—ESTIMATED NUMBER OF ESTABLISHMENTS, WORKERS EXPOSED AND ASBESTOS EXPOSURE LEVELS IN SERVICE AND REPAIR INDUSTRIES

Sector	Number of establishments	Number of workers exposed	8-hour TWA exposure levels (f/cc)[1]
Automotive brake and clutch repair	285,188	526,998	N/D–0.94
Shipbuilding and repair	400	15,000	[1] N/D–1.42
Total	285,588	541,998	

[1] These data do not include nuclear rip-out where wet methods are not permitted. The 8-hour TWA exposures during nuclear rip-out range from 0.2 f/cc to 7.2 f/cc.
N/D = Non-detectable.

Source: U.S. Department of Labor, OSHA, Office of Regulatory Analysis, based on RTI 1984 Survey Data, Phase 1 Report, Regulatory Analysis of the Proposed Standard on Asbestos (Exhibit No. 84–473); Management Information Systems (MIS) Files; OSHA Hearing; ICF Inc., Asbestos Products and Their Substitutes, Appendix C, December 1983.

Asbestos exposures in the construction industry occur during various activities (see Table 10). For example, such exposures occur when installing A/C pipe and sheet, finishing drywall, sanding vinyl-asbestos floor tiles, installing build-up roofing, removing old insulation, removing or repairing drywall, demolishing buildings containing asbestos products, and removing old built-up roofing. Workers involved in the maintenance and repair of pipes, boilers, or furnaces in a wide variety of buildings are also exposed to asbestos.

Availability of Substitutes

The extensive tort litigation in the area of occupational exposure to asbestos and the awareness of the health effects associated with asbestos exposure have provided a strong incentive for producers and users of asbestos products to utilize substitutes. For example, approximately 50–75 percent of producers of phenolic molding compounds have substituted other materials such as clay or fiberglass for asbestos. Similar success has been achieved in the production of floor tile, where non-asbestos fibers and petrochemicals are being used, and in friction materials. Fiberglass has been used successfully as a substitute for asbestos fiber in many products. Roofing felts, pipeline felts, and asphalt coatings have all been produced using fiberglass in place of asbestos fibers.

In the past, the price of substitute materials has been much higher than the price of asbestos. The "full price" of using asbestos, which includes the potential cost of control methods, tort litigation, etc., however, has increased significantly in recent years. Consequently, the difference between the cost of using asbestos and the cost of using other substitute materials has diminished greatly and in many instances has disappeared entirely.

TABLE 10.—ESTIMATED NUMBER OF WORKERS EXPOSED AND ASBESTOS EXPOSURE LEVELS IN THE CONSTRUCTION INDUSTRY

Sector	Estimated No. of workers exposed	Mean 8-hour TWA exposure levels (f/cc)
New construction	29,320	0.13
Abatement	81,366	1.85
Demolition	24,455	0.81
General building renovation	133,700	2.8