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IMPACT OF PROPOSED OSHA

STANDARD FOR ASBESTOS

A Final Report to

THE UNITED STATES DEPARTMENT OF LABOR

by

[illegible]

April 30, 19[illegible]

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General Dynamics Corporation, Quincy

C. L. Daugherty
Ingalls Nuclear Shipbuilding

J. Samuel Stratton
Ingalls Nuclear Shipbuilding

J. H. Jones
Levingston Shipbuilding Company

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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W. H. Beasley
Cement Asbestos Products Company

A. E. Alpine
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GAF Corporation

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EXECUTIVE SUMMARY

This study was undertaken to identify the impact of proposed standards for asbestos. Data were obtained from a variety of sources, cross-checked, and interpreted in terms of potential benefits to workers and costs to industry. Attention was also given to the expected effect of proposed alternative standards on shipbuilding, the principal Federal impact area, and on the regions of the country most likely to be affected. Major findings are included here along with conclusions. Separate appendices contain data and descriptions of the methods employed.

CONCLUSIONS

(1) Reduction of the exposure of workers to asbestos dust from present levels to 5-fibers/cc will significantly reduce asbestos-related diseases and achieve more than 99% of the benefits attainable from the control of dust levels.

(2) Capital and operating costs for meeting a 5-fiber/cc standard represent important added costs to an industry that has a low rate of return on investment. Although the ability to absorb or pass on these costs is marginal, it seems likely that only the textile industry will find it difficult to continue operations. On-board ship repair will be severely curtailed if the 5-fiber level is enforced in this working environment.

(3) A 2-fiber standard, if uniformly enforced, would require capital investment on the part of industry that is at least twice that required to meet the 5-fiber standard. Capital requirements are very probably more than the industry can meet within a two-year period. Increased operating costs reflected in higher unit prices

will intensify foreign competition. The textile industry will be forced to shut down; workers in manufacturing along with those in application activities will be affected adversely by increased costs and some operational shut-downs. Shipbuilding costs will increase but the major impact will fall on repair operations. It will not be possible to achieve a 2-fiber level in on-board repair in private yards at any cost within the next two years. Strict enforcement here will certainly lead to intensified foreign competition and possibly to the reduction of an important capability. Navy yards face equally difficult problems and costly solutions in attempting to meet this level.

The major impact of the standard will occur in the following states: New Jersey, Pennsylvania, North Carolina, South Carolina, California, Illinois, Ohio, Connecticut, and Massachusetts.

(4) In view of the strong expectation that a 2-fiber level will have an economic impact at least twice that of a 5-fiber standard appears to be cost-effective at this time.

(5) Adopting a 5-fiber standard now will result in major benefits and produce the experience that may reveal, if reviewed within 30 months, that a 2-fiber standard can be achieved with an impact considerably less than is now believed and more precisely known than is possible at present. On the other hand, serious economic consequences can be expected throughout all segments of this industry unless the cost of compliance with recommended asbestos dust exposure levels can be spread over a longer time period, particularly the textile and ship repair/conversion operations.

I. INTRODUCTION: STUDY SCOPE AND APPROACH

Arthur D. Little, Inc. (ADL) was retained by the U. S. Department of Labor to assess the impact of the proposed Occupational Safety and Health Administration (OSHA) standard for asbestos. The impact was to be evaluated in terms of benefits and costs to both Federal and non-Federal activities. We were also to develop, apply, and evaluate techniques for use in subsequent impact determinations.

To provide an intensive study that would meet the OSHA deadline, an interdisciplinary team of professionals was formed, with access to other specialists. The team included a representative of OSHA, who was directly involved throughout the work; the participating ADL staff included individuals experienced in techniques such as the DELPHI process and its extensions, technical personnel who have worked with the materials studied, and industry experts familiar with the production methods for manufacturing them.

Working closely with industry (manufacturers, applicators, and private shipyards) and the various unions directly involved, the team identified panels of personnel with appropriate expertise and sought their responses to a series of questions regarding control of the asbestos hazard and the costs and benefits of alternative

standards. These panels represented the following groups:

(1) The medical and health professions, for determining benefits.

(2) The asbestos industry, for determining costs.

(3) Private shipbuilding and ship repair, for determining costs.

(4) U. S. Navy shipyards, for determing costs.

Shipbuilding was chosen because of the heavy use of asbestos in ships and the continuing need to replace this material in ship maintenance and repair, and also because it is the chief Federal impact area.

The responses of the panelists were supplemented and checked by a review of relevent published information, visits to a small cross-section of the industry, and examination of information in ADL's own files. Using all of these sources, the team developed estimates of the probable impact of the alternative standards. This report presents the study findings and resulting recommendations. A separately bound set of Appendices describes the methods employed in the study, including the instruction to panel members, and provides data in more detail than space permits here.

The responses of a few panelists were still outstanding at the time of this writing. It is not expected that these responses will materially alter the conclusions reached.

[illegible]

[illegible] adequate [illegible] be available [illegible]
[illegible] and the situation [illegible] which these will [illegible]
available [illegible] [illegible] be varied [illegible]
[illegible] about [illegible] and will [illegible] be [illegible],
[illegible] be [illegible] to December [illegible]
[illegible] items [illegible] Secretary's Advisory Committee on [illegible]
standard, as well as the testimony provided in public hearings by
the medical profession, industry, labor, and government, [illegible]
determined the key factors to be as follows:

1. Threshold Limit Value (TLV), represented as the [illegible]
   of levels [illegible] [illegible] average [illegible]
   [illegible] to which
2. The degree of confidence in results possible [illegible]
   monitoring and analysis methods employed.
3. Interpretation [illegible] instructions in the [illegible]
   [illegible] values for the [illegible]

(6) The anticipated direct costs, both initial investment and annual operating.

(7) The method of disposal of waste materials containing asbestos.

(8) Requirements for record-keeping—medical and industrial.

(9) Potential unemployment as a result of shut-down decisions.

(10) Potential impacts of the standard on foreign trade and the international balance of payments

(11) The effect of the standard on Federal agency budgets.

These factors were used as a guide in preparing questions for the panels and obtaining and analysis of other data. As work progressed, other factors affecting impact were identified and incorporated into the study.

III. CONSTRAINTS ON THE IMPLEMENTATION OF STANDARDS

There are important limitations to the effective implementation of asbestos exposure standards. We believe that it is essential to take these limiting factors into account in the formulation of a final set of standards.

A. Accuracy of Measurement

The measurement of fiber levels yields highly variable results under the best of circumstances. The many sources of error are neither adequately understood nor likely to be taken into account in the interpretation of fiber counts. We found few individuals responsible for making dust level assessments who were prepared to provide a statistical basis for confidence in their measurements; fewer still had any confidence at all in measurements of samples having 2 fibers or less per cubic centimeter. The inevitable result is lack of confidence in exposure measures. This will continue until the principal sources of variability are understood, statistically described, and translated into assessment strategies. These strategies must be expressed in measurement procedures and interpretative guidance. If widely disseminated, such procedures and guidance may make it feasible to interpret dust measures as the highly variable indices they are of hazards to workers.

by inadequate [illegible] user [illegible]

extremely serious. Controversies are certain to arise [illegible]

measures cast later [illegible] to be statistical artifacts. [illegible]

depends heavily on uncertain and "behind the scenes" measurement.

OSHA objective of fair and consistent enforcement cannot be achieved.

We therefore regard dependence on time-weighted averages (TWA) and [illegible]

sequently on fiber counts as a weak and undesirable basis for enforce-

ment at this time. Certainly, existing methods cannot distinguish

between asbestos fibers and [illegible] with desirable reliability. While fiber

levels are important as a guide to the evaluation of [illegible] practices

practices offer a more readily understood and enforceable means for

compliance.

[illegible] Variability in Skilled Personnel

Closely related to the measurement constraints of the Asbestos Fiber

Counting Technique are the [illegible] of highly experienced individuals available. Few of the many factors affecting

and interpreting fiber counts. At present, the public health [illegible]

ory at Salt Lake City Utah, and the private industry [illegible] counting

fibers; samples are mailed to [illegible]. It seems inevitable that [illegible]

minimal enforcement procedures based primarily on fiber counts will

tinely produce a backlog in the Salt Lake City laboratory. [illegible]

pacity of this facility were to be increased, [illegible] could still [illegible]

[illegible] the expected demand [illegible] the application of [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

industry with its own requirements for monitoring fiber counts in order to comply with the standards.

To react responsibly to a standard based on fiber counts, the asbestos industry and the applicators will need to make frequent counts. Since these groups lack the organizational integration of a Federal agency or even a labor union, their utilization of limited personnel resources will inevitably be inefficient.

In any event, we foresee a demand for people. Until larger numbers of trained and experienced technicians are available to make and interpret fiber counts, implementation of a standard relying strongly on TWA will be impractical.

C. Lack of Work Practice Standards

An appealing alternative to reliance on TWA's that would do much to avoid the limitations discussed above is to apply work practice standards. In fact, the Secretary's Asbestos Standard Committee recognized the need for work practice guidelines as an important element of the standards package. However, under the pressure of a fixed deadline, the committee could not investigate the adequacy of available work practice standards. The problem is that no adequate standards exist--they remain to be developed. Unless a full set of practices is developed for protecting workers from asbestos dust hazards, enforcement will have to depend solely on fiber counts, with their disadvantages of poorly understood reliability and

insufficiently trained hygienists, and compliance will be difficult since work practices are an important determinant of worker exposure to asbestos dust hazards. We therefore believe that the development of work practices, and their interpretation for use by affected employees and OSHA, should be given high priority in the effort to establish and enforce standards.

D. Time

Neither measurement difficulties nor the lack of qualified people and work practices guidelines are permanent constraints. They can and no doubt will be corrected in time as developments now under way gain momentum. With strong support, that time can be shortened. Even with support, though, it must be recognized that the processes of developing and disseminating improved measurement and interpretation methods, obtaining more trained people, and establishing adequate work practice standards will take time--up to three years.

Similarly, it will take time for industry to develop and implement ways to remove health hazards. Data from the asbestos industry and the shipyards make this clear. Table 1 summarizes responses on this issue from the panel of experienced representatives of the asbestos industry and similar groups from the private shipyards. Median estimates of when each industry as a whole (all companies employing 20 or more workers) can meet each of three fiber levels show at a first glance that only a 12-fiber standard can be met immediately--and only in private shipyards engaged in new construction. The

TABLE 1

ESTIMATED TIME TO MEET STANDARDS

Standard Fiber Level		Private Shipyards		Asbestos Industry
		Building	Repair	
2	Median	1975	1991	Not feasible
	Range	1980 ⟷ 1973	Never ⟷ 1976	Never ⟷ 1977
5	Median	1973	1977	1975
	Range	1977 ⟷ 1972	Never ⟷ 1975	1990 ⟷ 1974
12	Median	1972	1974+	1973
	Range	1977 ⟷ 1972	1997 ⟷ 1972	1983 ⟷ 1973

asbestos industry believes that it cannot meet the 12-fiber standard until 1973, while private shipyards cannot bring fiber counts to this level on board ship (repair activities) until mid-year 1974. Some representatives maintain that the time for achieving this level will extend to 1983 for industry and 1997 for on-board ship repair.

Even allowing for the reluctance of industry to change and the fact that the panels were directed to take "...into account competing requirements for capital and realistic increases in operating costs," compliance will require time. Our own observations of processing activities support the general conclusion that not all elements are able to meet the 12-fiber level instantly. We are further persuaded of this by the fact that the panel responses reflect only the larger industrial units. The companies with fewer than 20 employees—49% of all companies—will very probably require more time still if they are to meet a 12-fiber standard.

Turning now to the estimates of when each industry (companies with 20 or more employees) can meet 5-fiber and 2-fiber standards, we find, as one would expect, that longer intervals are anticipated. In addition, the estimates range more widely for these than for the 12-fiber standards. On the basis of the median estimates, however, it is clear that in both private shipbuilding and the asbestos industry a change from a 5-fiber to a 2-fiber standard will take longer than the change from present levels to the 5-fiber standard. It is also clear from the number of respondents who state that the

2-fiber level can "never" be met or that it is "not feasible" in the foreseeable future, that the estimates reflect considerable uncertainty over how [illegible] the lower level. The one favorable prospect is in shipbuilding, where the shortest estimate given for full compliance is 1973 and the median value is only two years longer, 1975. Even here, though, the estimates range as high as 1980.

Thus, the industry with the most favorable prospects for reducing dust levels will still take three years to achieve a 2-fiber goal. Again, our own assessments from direct observation confirm the expectation that it will take longer to change from a 5-fiber standard to a 2-fiber standard than to achieve the 5-fiber level. Even an extreme discounting of the panel estimates suggests that as much as five or more years will be required in certain portions of the asbestos industry to meet the 2-fiber level and that ship repair will take even longer to achieve that level—if it can be achieved at all. The requirement for time to introduce changes seems unlikely to be overcome entirely by strong enforcement, maximum will, or even appealing incentives. The economic consequences of ignoring this time constraint are described in Section V of this report.

The Navy shipyards illustrate time constraints for compliance with various standards in a special situation. In addition to the fact that they constitute the principal Federal activity involving asbestos, the Navy shipyards are of interest because they have been making a concerted effort for several years toward the reduction of dust levels. Expectations concerning the time to comply therefore

reflect a "running start" on the part of the Navy, in light or the showcase dust control program at Puget Sound Naval Shipyard.

Responses from the Navy shipyards on time to comply are incomplete at the time of this writing. A Navy survey, incorporating questions addressed to this study is now under way with data arriving daily. The incomplete responses, however, indicate that the earliest time by which all Navy onshore building activities can comply with the 5-fiber standard is 1974, although approximately half the planned effort to reach this goal has been expended. A 2-fiber level appears not to be achievable until 1975 or later. These estimates are in agreement with our informed judgment concerning planning, funding, and implementation lead times. Work aboard ship is another matter. As in the case of private ship repair, achievement of a 2-fiber level does not seem to be possible in the foreseeable future. It is not expected that even a 5-fiber standard can be met in the foreseeable future for repair work. Thus, the Navy, where a strong effort is well under way, can meet the 5-fiber standard, but for construction only and not immediately. To achieve 2 fibers will take longer and again will be possible only for new construction.

E. Lack of Data on Small Businesses

Because small businesses are so numerous and widely scattered, any data collection and analytic effort aimed at them is very time-consuming. Thus, in determining the impact of asbestos standards, our study schedule restricted us to larger companies (20 or more

employees, as noted earlier), which account for the larger portion of activity in the industry and for which information can more readily be developed and analyzed. This excludes most applicators and installers of asbestos insulation.

We believe that the responses of industry panelists representing the larger units provide useful indications of the economic impact on applicators. On the other hand, lack of data on small businesses prevents an assessment of enforcement problems. If the requirements for enforcement staff and effort posed by small businesses are proportionately greater than those for the larger firms, there is the risk of underestimating the size and range of these requirements. Where a large number of small businesses are involved, care must be taken to allow for adequate resources and probably to simplify enforcement procedures.

Another limitation resulting from inadequate data on small businesses is the difficulty this poses for estimating whether or not these units can obtain adequate capital for meeting standards. We understand that financial relief is available to small businesses which are affected by new OSHA standards through the long-term, low-interest guarantee program of the Small Business Administration. Such relief could reduce some of the risks associated with the application of new standards to small businesses.

IV. BENEFITS FROM ASBESTOS EXPOSURE CONTROL STANDARDS

The case against asbestos dust is firm and unquestioned by those familiar with available research data. Selikoff and others have amply demonstrated an association between exposure to asbestos fibers and increased morbidity. It follows that reduction of the hazard will provide increased freedom from disease and longer life for those working with or near asbestos.

The question of how closely the goal of zero risk to asbestos-related diseases can be approached requires further exploration. The removal of this hazard requires changes that inevitably involve the expenditure of time and money, and in the world of business (including working men when jobs are at stake) the relationship between benefits and costs is an important issue. Numerous examples of the refusal of people individually and collectively to pay even modest inconvenience costs to completely remove risks demonstrate that eliminating a hazard at any cost is not always feasible. However, those who must pay the price for removing the hazard may be willing or able to do so within limits. Finding these limits usually involves comparing less than the maximum obtainable benefits with associated costs. This, of course, is the familiar cost/benefit framework for evaluating alternative courses of action. While we do not believe a purely quantitative cost/benefit

[illegible] is feasible or desirable here, the conceptual [illegible] In the next section, we examine the probable [illegible] fiber levels, in the hazard of asbestos [illegible] in a perspective that may be useful in setting [illegible] attempt to estimate the benefits associated with each of [illegible] [illegible].

The crucial data for evaluating benefits [illegible] the relationship between exposure (as defined by exposure standards [illegible] which [illegible] are identified) to asbestos and the biological response. [illegible] we are interested in excess morbidity or disease attributed to exposure to asbestos. We find, however, that no such relationship has been established empirically because of the extreme difficulty of obtaining adequate data on a response that occurs long after exposure. Readily available, however, is the experienced judgment of those associated with asbestos and the related diseases. To capture this experience systematically, we employed an adaptation of the DELPHI process. The procedures, described in the Appendices, yielded a consensus-of-experts exposure-response curve that describes how benefits improve with the reduction of the hazard in terms of fiber levels. Data on benefits attainable from medical examinations were developed in the same manner.

Table [illegible] shows the median estimates and their range for the eight* panel members who had responded by the time this report was being written. [illegible] estimated the number of [illegible] among 100 workers exposed [illegible]

[illegible]

TABLE 2

ASBESTOS-RELATED DISEASE STATUS OF 100 WORKERS
(EXCESS MORBIDITY AND MORTALITY)
AT THE END OF 40 YEARS OF EXPOSURE TO ASBESTOS
(PREDOMINANTLY CHRYSOTILE)

Exposure: Fibers per cc if average exposure is:	Judgments Concerning Number of Instances of Excess Disease*			
	No Excess Disease	Asbestosis	Bronchogenic Cancer	Mesothelioma
2	99.9** (100-80)***	0 (20-0)	0 (1-0)	0 (0.1-0)
5	99 (100-40)	1 (55-0)	0.3 (5-0)	0 (0.2-0
12	69 (93-20)	9 (70-6)	1.5 (10-.05)	0.1 (1-0)
30	78 (90-9)	19 (75-9)	3.4 (15-1)	0.1 (2-0)

*(Columns 2 + 3 + 4 + 5 = 100 for estimates of panel members. Use of median values results in some rows that do not sum to 100.) Numbers in parentheses indicate full range of data.

**The median value is the middle number when all values are ordered from the largest to the smallest. For example, of the eight estimates, 100, 100, 100, 99.9, 99.9, 98.9, 94.0, 80.0, the midpoint falls at 99.9.

***The range is the spread between the largest and smallest estimates. In this case, 100 and 80

40 years, of asbestosis, bronchogenic cancer, and mesothelioma. Column 2, "No Excess Disease," shows [illegible] presumably [illegible] exposure to asbestos dust. Thus, decreasing exposure, from a 30-fiber level to 2 fibers, is associated with a decreasing incidence of disease attributable to asbestos dust. It is apparent from this set of judgments that relatively large benefits correspond to the reduction of exposure from 30 to 12 fibers and from 12 to 5 fibers. The judgments suggest, however, that a further reduction of the exposure level to 2 fibers is attended by very small benefits—on the order of less than one percent. Even if the data are taken as rough estimates only, they still indicate that relatively little incremental benefit is obtainable through reduction to the 2-fiber level. The objective of removing all risk is very nearly reached once workers are assured of an exposure level no greater than 5 fibers. The costs of further reduction to 2 fibers should be examined carefully, since such costs will yield few additional benefits.

Data on bronchogenic cancer and mesothelioma suggest that these diseases are also related to the degree of exposure. The numbers are small, however, and experience more limited than that available for asbestosis. The only inference we are prepared to draw from these data is that their explicit consideration by the panel members very probably yields better estimates than if they had not been included. Continuing studies of these diseases among asbestos workers should contribute to estimates that better justify interpretation and speculation than these.

As an extension of the assessment of benefits, panel members were asked to estimate the "percentage change" in mortality and period of disease associated with various frequencies of medical examination. Here both cost and benefit were involved. Responses thus far received from the panel members indicate that only for bronchiogenic cancer does a beneficial change result from periodic examination. For other diseases, the course of events is not significantly changed by scheduled examinations that do not respond to first symptoms. The desirable frequency of examination in the one beneficial instance is once each year. Annual examinations, as included in the proposed standard, appear to be confirmed and justified. Additional responses from the panelists concerning specific examination procedures are provided in the Appendices.

V. COSTS

A. Industry Categories Studied

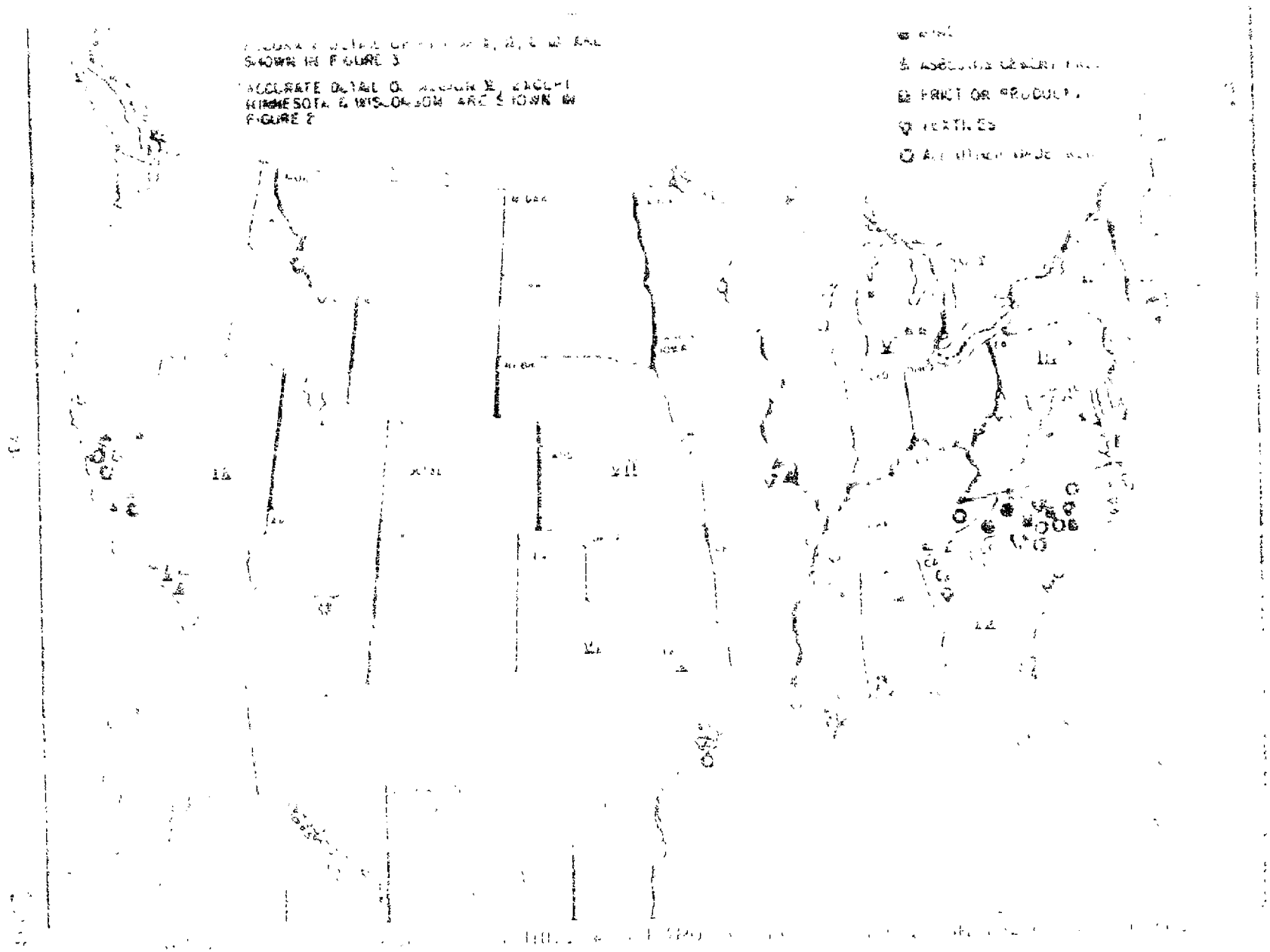
For purposes of analyses, we have divided users of asbestos into the following categories:

(1) Manufacturers of asbestos-containing products which include:
   (a) Asbestos cement products, high- and low-pressure pipe, corrugated and flat board products
   (b) Resilient flooring--vinyl asbestos floor tile
   (c) Friction materials including brake linings
   (d) Packing and gaskets
   (e) Asbestos insulation
   (f) Asbestos pipes--flooring underlay, pipeline, felt, roofing paper, sheet gasket materials, and electrical insulating papers
   (g) Asbestos textiles
   (h) Molded plastics, asbestos-reinforced
   (i) Paints, roof coatings, caulking compounds, and miscellaneous materials
(2) Applicators and installers of asbestos insulation
(3) Private shipyards
(4) U. S. Navy shipyards.

The manufacturers of insulation and roofing products [illegible] have been [illegible] value of shipments [illegible] and [illegible] locations of [illegible] locations in the United States having 20 or more employees employ [illegible] of all companies in the base of the manufacturing [illegible] majority of the smaller companies have fewer than 10 workers. For the purpose of our analysis, we have used 31,000 as the total number of workers in the manufacturing sector, of whom 1000 are associated with asbestos manufacturing, an area which has a special problem [illegible] because of the nature of the manufacturing process. The textile sector has been static in growth and in the employment of capital for improvement of facilities.

The application and installation of asbestos insulation is a widely scattered industry sector, with locations in essentially every major population center in the country. The industry is made up of a large number of small service companies having fewer than 20 workers. The 1971 statistics show that approximately $370 million in gross sales were attained by between 1000 and 1200 firms, both union and non-union. For purposes of our study, we used 36,000 workers.

Figure [illegible] is a map showing the locations of most of the [illegible] in the country and [illegible] value of shipments. [illegible] are employed in [illegible] of the [illegible] of the country [illegible]



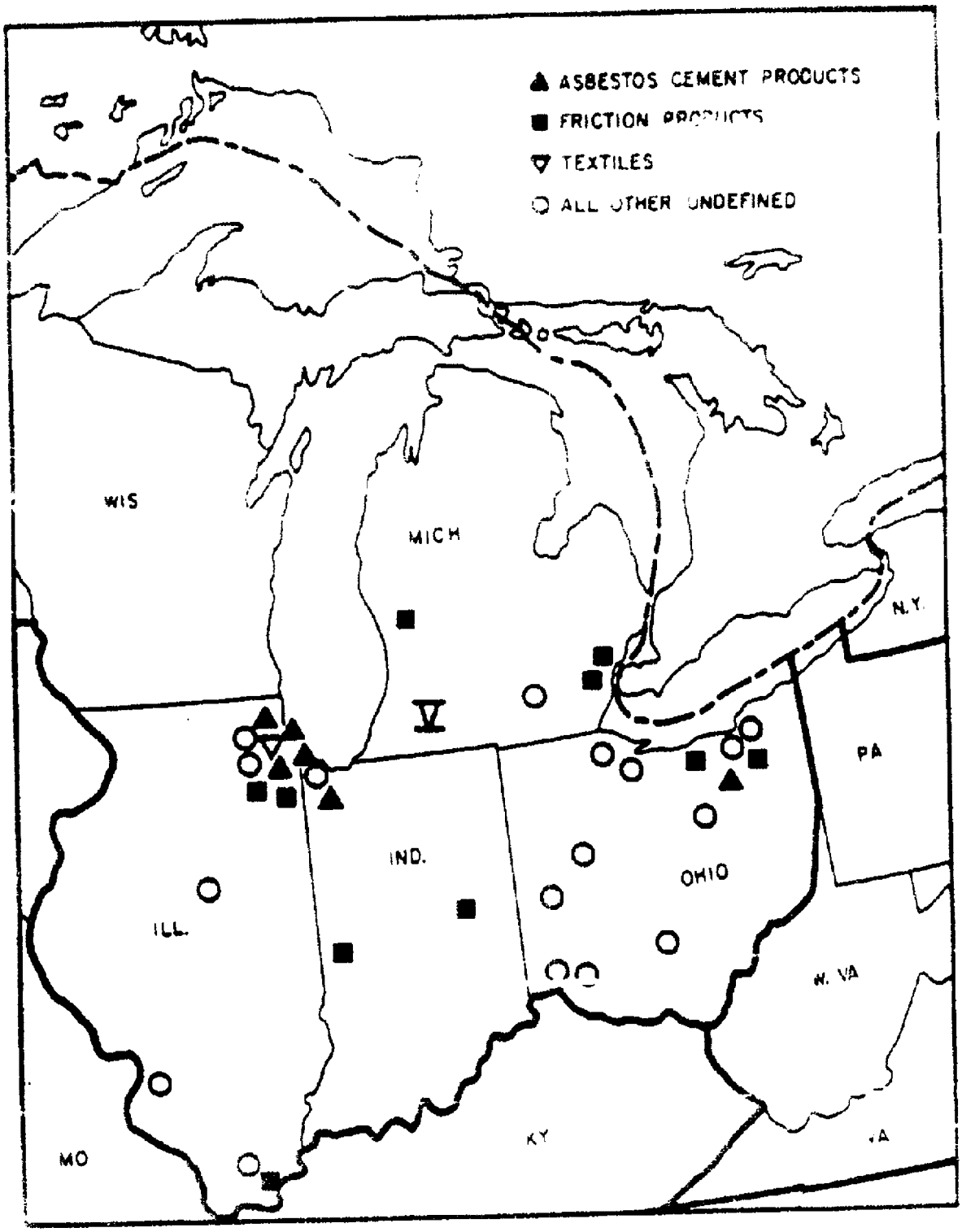


FIGURE 2 - ASBESTOS MANUFACTURING FACILITIES: REGION 5

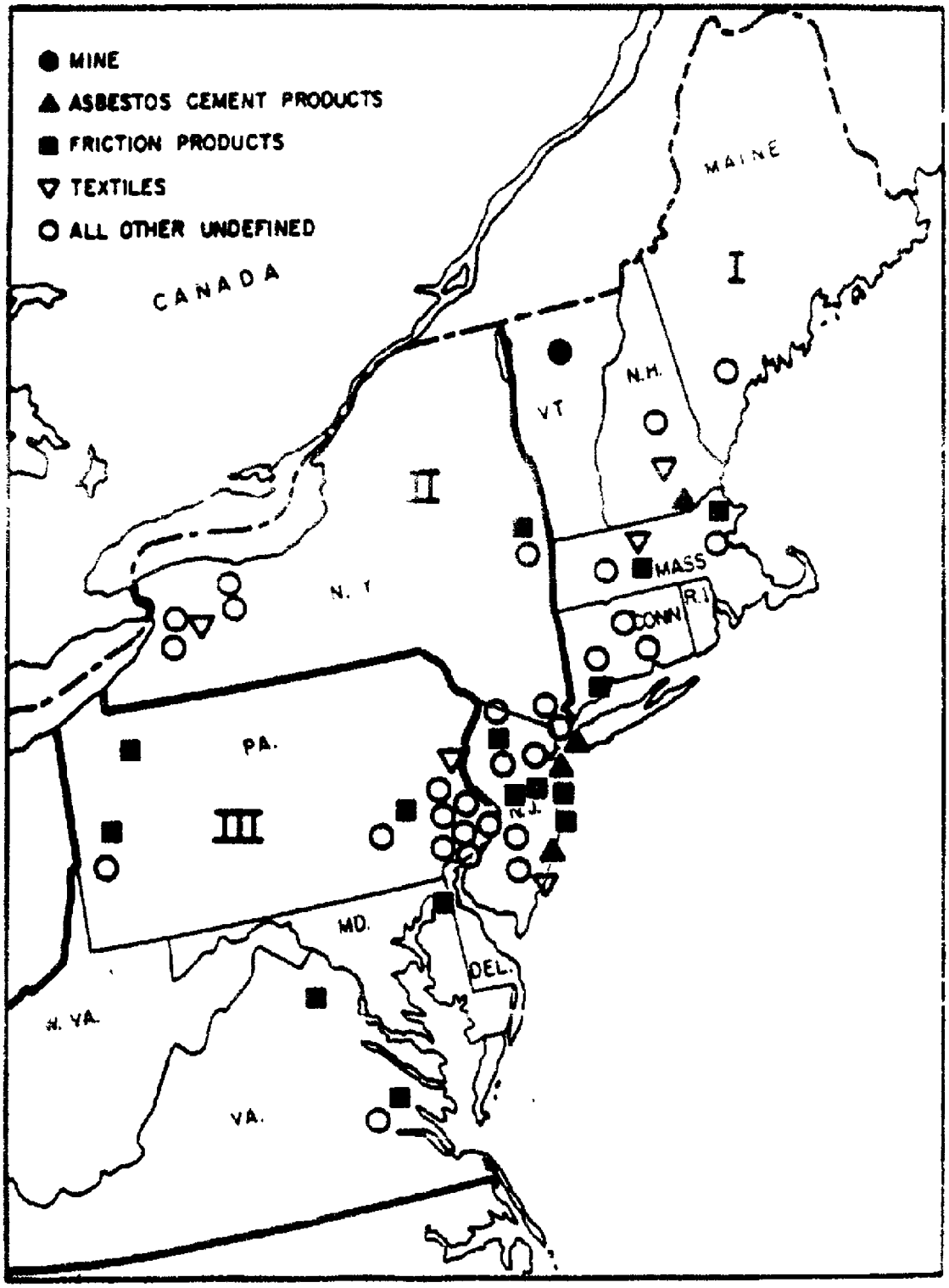


FIGURE 3 - ASBESTOS MINING AND MANUFACTURING FACILITIES: REGIONS I, II, AND III.

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TABLE

1971 SALES OF ASBESTOS-CONTAINING PRODUCTS*

Asbestos-Cement Products		$218 MM
Vinyl Asbestos Floor Tile		190
Friction Materials		179
Packing and Baskets		100
Asbestos Insulation		41
Asbestos Paper and Felt		110
Molded Plastic		12
Miscellaneous		105
	Subtotal	$955 MM
Textiles		38
	Total	$993 MM

*Source: Asbestos Information Association

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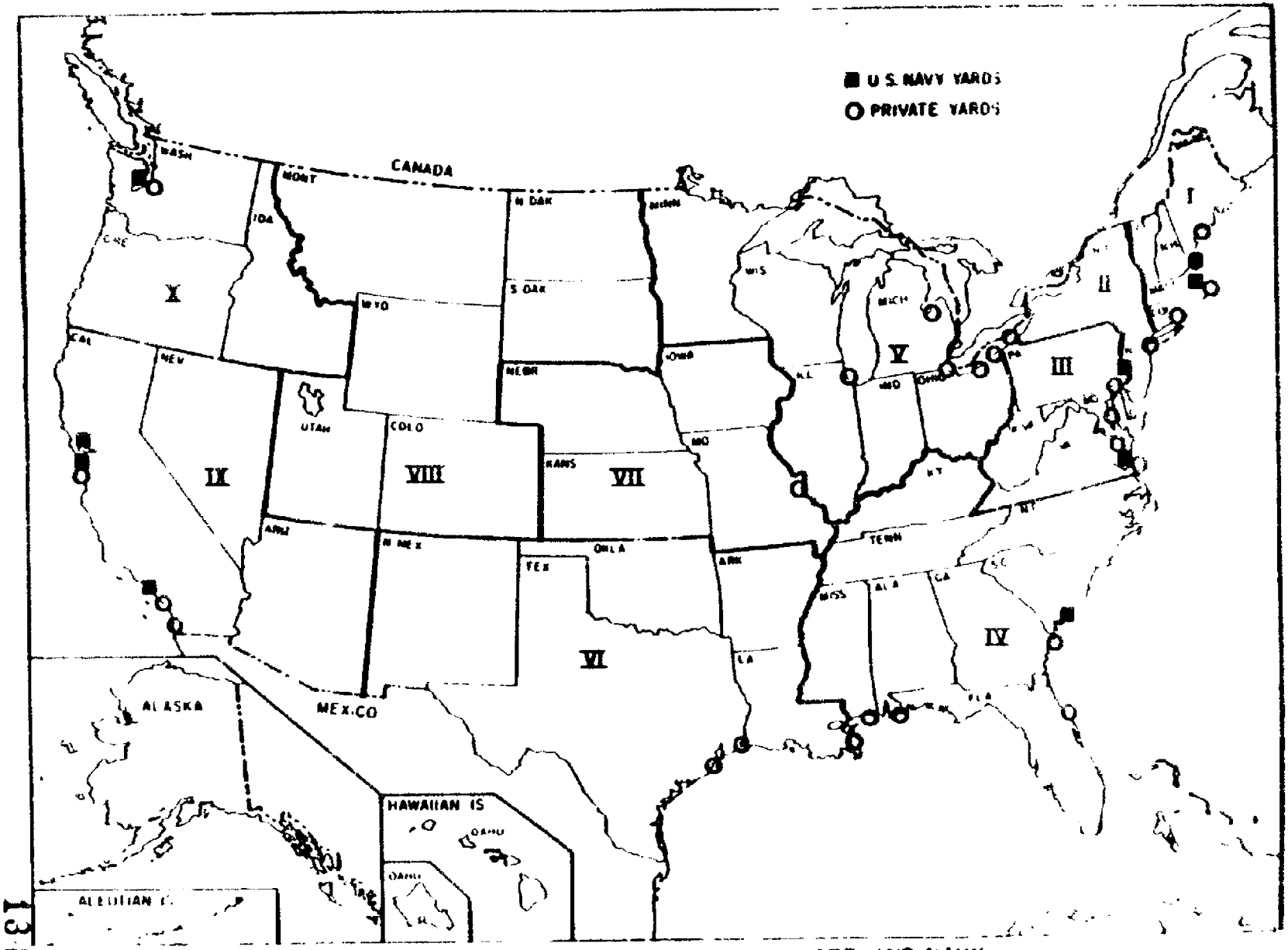

FIGURE 4 - U. S. SHIPYARDS, PRIVATE AND NAVY

asbestos. Working with the Navy, we have ascertained that there are 10 shipyards in the country and approximately 1000 men directly involved with asbestos insulation.

B. Economic Impact on Shipbuilding and Repair

Shipbuilding and repair have a different economic and operational environment from that of other asbestos users. The primary difference is the fact that any impact on shipbuilding and repair will have Federal implications. For the Navy shipyards, this is obvious; defense costs are directly affected. But the private shipyards are almost equally dependent on government support (although some of it is indirect), and in addition asbestos standards could conceivably have an important impact on the U. S. position in maritime trade.

To anticipate the costs of compliance and identify specific impact issues, we obtained data from the Navy and the Shipbuilders Council. The latter provided a representative panel whose members supplied data in two phases of a DELPHI process.* Information from the Navy on its shipyards comes from the incomplete returns of a survey mentioned earlier. All results of that survey which are applicable to the present study are included in the Appendices.

The impact (cost of compliance) of various asbestos standards in private shipyards is shown in Table 4, which contains the second-phase DELPHI

* The DELPHI technique provides for initial and subsequent estimates in separate phases; the Appendices include a description of this technique.

results. Protection at the 2-fiber level appears to be attainable at an estimated capital cost in two years of $6.6 million. This represents approximately 0.2% of the annual gross of all private shipyards--an amount that very probably can be absorbed without serious consequences. There are, however, several warning signals. One specialty shipyard believes that the 2-fiber level will result in foreign competition that could mean the loss of 1200 jobs. Another panel member maintained with 90% confidence that "vigorous enforcement" of a 2-fiber standard would "shut down 20% of the insulation work." In each case, the potential impact is a serious matter to the company concerned. Whether or not these effects will occur depends on the actual cost increases experienced and their effect on competition. The interpretation of such possibilities and the assessment of the ability of the industry to accept compliance costs are aided by other data from the panel.

The panel reported estimates of the "portion of annual gross" that could be applied to meeting standards while other requirements for capital are also being met. The allocation of 0.01% shown in Table 5 for meeting asbestos standards is well below the estimated capital cost of 0.2% of gross to meet the 2-fiber standard. The total capability for meeting all health and safety standards, however, is more than twice this amount, or 0.5%. This suggests that for the industry as a whole, a 2-fiber standard conceivably could be met without disturbing other capital commitments but only at the expense of effort devoted to meeting other standards.

TABLE 4

PRIVATE SHIPBUILDING: PANEL ESTIMATES OF DOLLAR COST FOR COMPLIANCE WITH STANDARDS
(amount/production worker [102,000 workers in 1971])

Standard Fiber Level	Shipbuilding (65,000 production workers)			Repair and Conversion (36,700 production workers)			Industry Total (102,000 production workers)	
	Capital to Meet in 2 Years		Annual Operating	Capital to Meet in 2 Years		Annual Operating	Capital to Meet in 2 Years	Annual Operating
	Per Worker	Total (MM)	Per Worker (MM)	Per Worker	Total (MM)	Per Worker (MM)	(MM)	(MM)
2	45	2.9	[illegible] 2.7	100	3.7	70 2.6	[illegible]	[illegible]
5	40	[illegible]	[illegible] 2.6	50	1.8	[illegible] 2.0	4.4	[illegible]
12	25	[illegible]	[illegible] 1.4	28	1.0	[illegible] 1.8	[illegible]	[illegible]

Workers	Gross 1971 Sales	Cost as Percent of Gross					
		2 Fibers		5 Fibers		12 Fibers	
		Cap. 2 yrs.	Oper.	Cap. 2 yrs.	Oper.	Cap. 2 yrs.	Oper.
Shipbuilding	65,000	$ [illegible]MM		.15	.14	.13	.13	[illegible]
Repair & Conversion	36,700	[illegible]		.42	.30	.21	.21	[illegible]
Total	102,000	2,820MM		.23	.18	.16	.16	[illegible]

[illegible] Annual Report, Shipbuilders Council of America.

TABLE 5

PRIVATE SHIPYARDS: MEDIAN PANEL ESTIMATES
OF POSSIBLE RESOURCE ALLOCATIONS
FOR COMPLIANCE

(Delphi Process, Phase II)

		Percent of 1971 Gross		
Each Year for:		Asbestos Standards	Other Standards	Total
Two Years	Median	0.01	0.24	0.50
	Range	0.001-0.10	0.001-2.00	0.01-2.0
Five Years	Median	0.01	0.24	0.38
	Range	0.001-0.40	0.001-1.40	0.01-1.50

TABLE 6

MANUFACTURING: PANEL ESTIMATES OF DOLLAR COST FOR COMPLIANCE WITH STANDARDS
(cost increment per worker/per industry segment)

Fiscal Years 197

Standard Fiber Level	Capital in 2 years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 years	Annual Operating
2	70,000 / 10MM	1,500 / 1.5MM	2,860 / 86MM	1,573 / 47MM	1,000 / 30MM	2,000 / 72MM	19?MM	121MM	12	
5	4,100 / 4.1MM	750 / .8MM	1,634 / 49MM	970 / 29MM	750 / 27MM	1,000 / 36MM	80MM	37MM	5	4
12	1,?70 / 1.8MM	450 / 5MM	1,115 / 34MM	500 / 1.5MM	500 / 18MM	500 / 18MM	54MM	.8MM	3	1

Workers — Gross 1971 Sales

Textiles	1,000	9 .8MM
Other Mfg	20,000	9?4MM
Applicators	36,000	5 0MM
	67,000	$ 1,562MM

Cost as Percent of Gross

2 Fibers Cap. 2yrs	2 Fibers Oper	5 Fibers Cap 2 yrs	5 Fibers Oper	12 Fibers Cap. 2 yrs	12 Fibers Oper
184	4	11	2	5	1
9	5	5	3	4	2
6	13	5	6	3	3

TABLE 6

MANUFACTURING: PANEL ESTIMATES OF DOLLAR COST FOR COMPLIANCE WITH STANDARDS
(cost increment per worker/per industry segment)

Percent of Sales for

Standard Fiber Level	Capital in 2 years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 Years	Annual Operating	Capital in 2 years	Annual Operating
2	70,000 10MM	1,500 1.5MM	2,860 86MM	1,573 47MM	1,000 30MM	2,000 72MM	192MM	121MM	12	
5	4,100 4.1MM	750 .8MM	1,614 49MM	970 30MM	750 27MM	1,000 36MM	60MM	37MM	1	4
12	1,770 1.8MM	450 .5MM	1,123 34MM	500 1.5MM	500 18MM	500 18MM	54MM	.8MM	1	1

Workers		Est. 1971 Sales	Cost as Percent of Sales					
			2 Fibers		5 Fibers		12 Fibers	
			Cap. 2 yrs.	Oper.	Cap. 2 yrs.	Oper.	Cap. 2 yrs.	Oper.
Textiles	1,000	$ 8MM	184	4	11	1	5	1
Other Mfg	30,000	9.4MM	9	5	5	2	4	2
Applicators	36,000	5.0MM	6	13	5	6	3	3
	67,000	$ 1,542MM						

The economic impact on private shipbuilding promises to be modest, even for a 2-fiber standard, and we therefore do not foresee a significant impact at the Federal level for the capital investment requirements of this activity. Operating costs for shipbuilding are expected to increase by less than 0.2% annually. While this impact will result in some price increases and a worsening of the U. S. competitive position in shipbuilding, these effects will probably be small. They are unlikely, in our opinion, to result in more than minor and temporary changes in employment levels.

Repair and conversion, however, present special problems. The increases in both capital and operating costs associated with a 2-fiber versus a 5-fiber standard are greater here than in building operations. In fact, one major shipyard maintains that a 2-fiber standard would make it necessary to discharge 1000 employees engaged in repair and conversion work. Others question the feasibility of reducing exposure to the 2-fiber level at any cost. Most assume that respirators will be needed during rip-out operations aboard ships being repaired or converted. Since older ships containing much asbestos will continue to require work for many years, it is clear that these difficult-to-control hazards will be a problem for a long time to come. In view of these special circumstances, it seems unlikely that ship repair operations can be made to conform to the 2-fiber standard in the near future, if at all. The consequence of enforcing a standard at this level is very likely to result in a loss of conversion business, and in time much of the capability for conversion, in U. S. yards.

Preliminary indications* of the probable impact of standards on Navy shipyards parallel those reported above for the private yards. Little difficulty will be encountered in meeting a 5-fiber standard for onshore operations. A program currently under way to meet this objective has cost approximately $85,000 per yard to date and is 90% complete. At least this level of expenditure will be necessary to complete the program by 1974. For the Navy to meet a 2-fiber standard will cost approximately $200,000 per yard, with a completion date of 1975, under favorable funding, planning, and approval conditions. This estimate, however, applies only to onshore work. We are persuaded that it is not feasible for the Navy to meet either a 5-fiber or a 2-fiber standard for on-board work. This conclusion has also been reached by the Department of Defense.

Shipyards, both private and governmental, can meet the 5-fiber standard within the next several years, but not for on-board work. Although costs of building operations will increase, with a consequent risk in the loss of business to foreign competition, we expect this impact to be modest and acceptable. Even a 2-fiber standard probably can be met in the near term for building operations, but possibly never for repair and conversion. The effect of enforcing this standard would be to reduce employment through some loss of demand to foreign competitors and greatly limit the nation's capability for repairing ships in its own yards. Observations reported above on time constraints add support to our view that compliance within two years to a 2-fiber standard is not feasible for shipyards.

* Based on incomplete data from the Navy survey mentioned earlier.

C. Economic Impact on Manufacturers

We assessed the impact on the manufacturing sector of the industry via two distinctly separate routes. First, we used the responses of the industry panel, with 10 members representing various manufacturing subsectors. Because of time constraints, only one phase of questioning was possible. Second, we analyzed costs at several plant locations to check the validity of the estimates submitted by panelists.

Table 6 presents the findings of the panel. The upper figure represents the cost increment per worker, while the lower figure represents the total costs per segment of industry (textiles, other manufacturing, and application and installation), based on multiplying the cost increment per worker by the number of workers. The percent of gross is based on 1971 gross sales. We find that the predicted capital cost ranges from $54 million for meeting the 12-fiber limit to $80 million for meeting the 2-fiber limit. Our own assessment, after visiting selected plants, is that to meet the 5-fiber limit would cost from $740 to $1770 per worker, depending on the size of the operation. The panel estimated a range of $550 to $5000 with a median of $1634 per worker to achieve the same result. These estimates seem reasonably consistent with our own.

With regard to technical feasibility, we judge that the 5-fiber level is achievable. Even with the best available techniques, however, we do not know whether a 2-fiber limit could be met. (In fact, we cannot be completely certain about the 5-fiber limit until the best available equipment has been installed and evaluated.) Thus, a reliable assessment

of the validity of the 'gues[illegible]es put forth in the body of [illegible]-
ances to the 2-fiber [illegible] [illegible]eally possible until technic[illegible]-
bility has been established. [illegible]he meantime, he estimates sh[illegible]
Table 5 are the best that ha[illegible]n developed.

Specifically analyzing the c[illegible]nts of the manufacturing indu[illegible]
we find that textile manufac[illegible] receives the biggest impact [illegible]
asbestos standards in terms [illegible]ital cost. With the increasi[illegible]-
sure from substitute product[illegible] imports and the price sensiti[illegible]
the product, it is doubtful [illegible]his segment of the industry w[illegible]ain
in business very long, regar[illegible]of the level at which the fib[illegible]t
is set. The increased press[illegible] capital spending and attenda[illegible]
creases in operating cost wi[illegible]all likelihood eventually cau[illegible]
asbestos textile producers t[illegible] down their facilities. This
result in loss of employment [illegible]n estimated 1000 workers (a ma[illegible]y
in OSHA Region IV, and the re[illegible] Regions I, II, and V).

The other manufacturing indust[illegible] have the capacity to handle ex[illegible]di-
tures to meet the 5-fiber level and to pass on to the customer their
increases in operating costs. If the 2-fiber level is pushed, the need
for capital, which may have been estimated on the low side, will be
great and may force corporate managements to reconsider their positiou
in the industry. The manufacture of asbestos-containing products is a
low-rate-of-return business, and the requirement for large sums of money
beyond [illegible] normal [illegible]e-of-return capabilities will probably cause many
[illegible]locations within the industry. [illegible] [illegible] some [illegible]

standards allows the industry to make the appropriate expenditures over a period of time with full assurance of technical success, then the industry can cope with the situation. From an operating cost standpoint, the increase in costs would not materially affect the position of asbestos in the markets it serves.

We have investigated the possibility of substitute materials replacing asbestos in products now in use and find that there is no major threat to the use of natural asbestos in the end-use market. As long as the current price structure is not completely destroyed, the consumption pattern of the industry will probably not be adversely affected by price increases resulting from added operating costs to meet any of the standards.

Work practices, disposal techniques, medical examination programs, and respirator programs in most cases can be treated as an operating expense, and these costs could be passed on to the customer without affecting the position of the products in the industry.

D. Applicators

Applicators and installers of asbestos insulation are almost entirely employed by small companies. The workers in this group handle asbestos only part of the time, estimated on the average at 25% of their working time.

Referring to Table 6, we find that the capital investment required for compliance in this sector is 3% of gross revenues for a 12-fiber level.

5% for a 5-fiber level, and 6% for a 2-fiber level. Operating costs are estimated at 3% of gross revenues for a 12-fiber level, 6% for a 5-fiber level, and 13% for a 2-fiber level.

Since most of the applicators are small businesses, a 5-fiber standard would probably cause some dislocations of companies; however, the principal effect is likely to be reluctance on the part of the applicators to handle asbestos, forcing the substitution of higher-cost materials for asbestos. This would have the secondary effect of diminishing sales of asbestos insulation, now $41 million, or about 4% of the 1971 gross sales of asbestos products. Some unemployment could result, but quantitative estimates are difficult to make. A 2-fiber standard would increase this impact.

E. Implications for Other Standards

In assessing the impact of the asbestos standard, one must determine its effect on compliance with other future OSHA standards and with regulations put forth by other Federal agencies such as EPA and by state agencies. Through our industrial panel, we inquired about capacities for resource allocations to meet asbestos and other standards. The results of this analysis are presented in Table 7 for industry, paralleling Table 5 shown earlier for private shipyards.

We note that the manufacturing sector, excluding textiles, estimates that it can allocate 1.0% of gross sales to meet standards of all types within the next two years. Of this allocation, 60% or 0.6% of gross

TABLE I

ASBESTOS INDUSTRY: MEDIAN PANEL ESTIMATES
OF POSSIBLE RESOURCE ALLOCATION
FOR COMPLIANCE

(Delphi Process, Phase I)

		Percent of 1971 Gross		
Each Year for:		Asbestos Standards	Other Standards	Total
Two Years	Median	0.60	0.40	1.00
	Range	1.8-0.00	1.4-0.00	3.2-0.00
Five Years	Median	0.48	0.28	0.75
	Range	1.25-0.00	1.10-0.00	2.10-0.00

sales, is available for the asbestos standard. Yet, as Table 6 has shown, to meet the 5-fiber level within that period will require a capital investment estimated at 5%. Thus, the industry is in a bind because of time constraints for capital expenditures. If the individual companies were allowed to invest over longer time periods, then this constraint would not hold.

In principle, the problem of private shipyards is similar, as shown by Table 5 and the accompanying discussion; an allocation of 0.01% of annual gross is available toward meeting a capital requirement of 0.2%, and the difference would have to be made up from the allocation for standards other than asbestos.

It must be noted that early standards will bear the brunt of costs for changes that will facilitate compliance with some future standards. The cost of cleanup for asbestos, for example, will improve the ability of the asbestos industry to comply with silica standards. Initial standards will also set a pattern with respect to compliance. To the extent that initial standards prove unenforceable, compliance with future standards will be jeopardized.

VI. CONCLUSIONS

(1) Reduction of the exposure of workers to asbestos dust from present levels to 5-fibers/cc will significantly reduce asbestos-related diseases and achieve more than 99% of the benefits attainable from the control of dust levels.

2) Capital and operating costs for meeting a 5-fiber/cc standard represent important added costs to an industry that has a low rate of return on investment. Although the ability to absorb or pass on these costs is marginal, it seems likely that only the textile industry will find it difficult to continue operations. On-board ship repair will be severely curtailed if the 5-fiber level is enforced in this working environment.

(3) A 2-fiber standard, if uniformly enforced, would require capital investment on the part of industry that is at least twice that required to meet the 5-fiber standard. Capital requirements are very probably more than the industry can meet within a two-year period. Increased operating costs reflected in higher unit prices will intensify foreign competition. The textile industry will be forced to shut down, workers in manufacturing along with those in application activities will be affected adversely by increased costs and some operational shut-downs. Shipbuilding costs will increase but the major impact will fall on repair operations. It will not be possible to achieve a 2-fiber level in on-board repair in private yards at any cost within the next two years. Strict

enforcement here will certainly lead to intensified foreign competition and possibly to the reduction of an important capability. Navy yards face equally difficult problems and costly solutions in attempting to meet this level.

The major impact of the standard will occur in the following states: New Jersey, Pennsylvania, North Carolina, South Carolina, California, Illinois, Ohio, Connecticut, and Massachusetts.

(4) In view of the strong expectation that a 2-fiber level will have an economic impact at least twice that of a 5-fiber standard while yielding minute additional benefits, a 5-fiber standard appears to be cost-effective at this time.

(5) Adopting a 5-fiber standard now will result in major benefits and produce the experience that may reveal if reviewed within 30 months, that a 2-fiber standard can be achieved with an impact considerably less than is now believed and more precisely known than is possible at present. On the other hand, serious economic consequences can be expected throughout all segments of this industry unless the cost of compliance with recommended asbestos dust exposure levels can be spread over a longer time period, particularly the textile and ship repair/conversion operations.