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Asbestos-Containing Sheet Gaskets and Packing

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Synopsis

BIOGRAPHIES

Dr. James R. Millette is Executive Director of MVA, Inc., an independent analytical laboratory with offices in Norcross, Georgia and Chicago, Illinois. Dr. Millette has been involved in environmental/toxicology/asbestos studies since 1972 primarily using microscopy analysis techniques. He has a Bachelor's degree in Physics from the University of Dayton (1973), a Master's in Environmental Science (1975) and a Ph.D. from the School of Engineering, University of Cincinnati (1983). Previous work by Dr. Millette includes 11 years as a research scientist at the U.S. Environmental Protection Agency Research Center in Cincinnati, Ohio and five years at McCrone Environmental Services in Atlanta, Georgia performing and supervising analysis of particulates by microscopic techniques. Dr. Millette has over 60 publications which have appeared in a number of journals including Environmental Health Perspectives, Journal of Analytical Toxicology, Applied Occupational and Environmental Hygiene, Scanning Electron Microscopy, Journal of the American Water Works Association, Archives of Environmental Contamination and Toxicology, the Science of the Total Environment, Electron Microscopy, and The Microscope. He has presented reports of his scientific work at a number of national and international meetings, including conferences of the National Asbestos Council, American Industrial Hygiene Association, American Water Works Association, Electron Microscopy Society, and several Asbestos Symposia of the Georgia Tech Research Institute. Among other presentations were those given at an International Corrosion Forum 1984 and at the International Water Supply Conference held in the Netherlands, 1980. He has served as chairman or co-chairman of technical sessions at national meetings such as that of the Electron Microscope Society of America. Dr. Millette is an active member of American Society of Testing and Materials and American Water Works Association Technical

Committees, currently serving as vice chair of ASTM Subcommittee D22.07 on asbestos analysis. He has testified as an expert witness on asbestos for the State of Connecticut Department of Health. He has served as an Adjunct Professor, Department of Zoology, Miami University, Oxford, Ohio and as Co-Course Director, "Settled Dust Analysis," Georgia Tech Research Institute. He currently lectures for the ASTM Technical & Professional Training Course: "ASTM Standards for Asbestos Control." Dr. Millette may be contacted at MVA, Inc., 5500 Oakbrook Parkway, Suite 200, Norcross, Georgia, 30093, (telephone (770) 662-8509) or (EMail:MILLETTE@EWORLD.COM).

Michael D. Mount is an industrial hygienist with MVA, Inc., an independent consulting and testing laboratory with offices in Norcross, Georgia and Chicago, Illinois. Mr. Mount received his B.S. in Environmental Science from Troy State University in 1982. He has over 13 years of experience performing industrial hygiene surveys, lead sampling, indoor air quality investigations, Phase I property asessments and monitoring asbestos projects with MVA, Inc., McCrone Environmental Services, Inc. (MES) and with Azimuth, Inc., a Charleston based industrial hygiene consulting firm. Mr. Mount served as Field Project Manager for MES and as Manager of the Atlanta Operations for Azimuth. Mr. Mount is a Certified AHERA Inspector/Management Planner (1987), an Occupational Safety and Health Technologist (1990), a Certified Asbestos Abatement Supervisor (1992) and a Certified Industrial Hygienist in Training (1994). In addition to his field work in which he plans and performs the collection of air and material samples for contamination studies, he also provides analysis by phase contrast and transmission electron microscopy. He has co-authored several published papers. He is a member of the American Industrial Hygiene Association and Georgia Microscopical Society. Mr. Mount may be contacted at MVA, Inc., 5500 Oakbrook Parkway, Suite 200, Norcross, Georgia, 30093, (telephone (770) 662-8509).

Steve M. Hays graduated from Vanderbilt University, Nashville, Tennessee, in 1973 with a Bachelor of Engineering degree in Chemical Engineering. He became a registered professional engineer in April 1978, and was certified as an industrial hygienist in June 1990 by the American Board of Industrial Hygiene. He was employed by E.I. DuPont Company from June 1973 until 1978, and was a senior engineer when he left DuPont to join Gobbell and Associates in September 1978, now Gobbell Hays Partners, Inc. Gobbell Hays Partners, Inc. is an architectural/engineering/environmental consulting firm with offices in Nash-

ville and San Francisco. He served as President of The Environmental Information Association (formerly National Asbestos Council) during 1992–93. He served as President of the Consulting Engineers of Tennessee during 1991–92 and is a member of the National Institute of Building Sciences (NIBS) Board of Directors. He is also currently a member of the Tennessee Air Pollution Control Board.

Mr. Hays was a consultant to NIBS for the development of "NIBS Guidance Manual: Asbestos Operations and Maintenance Work Practices," and is currently serving as consultant to NIBS for the development of "Lead-Based Paint Operations and Maintenance Work Practices Manual." Mr. Hays served as a member of the NIBS Task Force Steering Committee for the preparation of "Asbestos Abatement Management in Buildings: Model Guide Specifications." He has also served on the NIBS lead-based paint and radon committees. He was a member of the Environmental Protection Agency's Policy Dialogue Committee which advised EPA on future regulation of asbestos-containing materials in public and commercial buildings and served as reviewer for EPA's Managing Asbestos In Place *("Green Book"), issued in July 1990, which provides guidance for the in-place management of asbestos-containing materials. Mr. Hays also served on EPA's 24-member negotiating committee that established the regulations for the Asbestos Hazard Emergency Response Act (AHERA), affecting all private and public school districts across the nation.*

Mr. Hays is a member of the seminar faculties at the University of California at Berkeley, Georgia Tech Research Institute and The Environmental Institute, where he conducts dozens of lectures each year on asbestos, lead, and other environmental topics. He is co-author of two books, Settled Asbestos Dust: Sampling and Analysis, *which was published in June 1994, and* Indoor Air Quality: Solutions and Strategies, *published in October 1994. Mr. Hays also wrote "National Institute of Building Sciences: Recommended Practices and Procedures for Operations and Maintenance," which was published in the November 1994 issue of* Applied Occupational Environmental Hygiene. *Appearing in the same issue, were three other articles co-written by Mr. Hays. They include, "Baseline Studies of Asbestos Exposure During Operations and Maintenance Activities," "Level of Effort Required for Operations and Maintenance Work Practices," and "Synthesis, Summary and Outlook." Mr. Hays may be contacted at Gobbell Hays Partners, 217 Fifth Avenue, North, Nashville, Tennessee 37219, (telephone: (615) 254-8500).*

EDITORS' COMMENTARY

The "releasability" of asbestos fibers from gaskets and other materials is an issue of considerable importance. This is particularly true where the material seems to have tightly bound asbestos (non-friable) and human contact is infrequent or just not considered in risk evaluations. The question is whether such materials could present a significant episodic or cumulative health risk during foreseeable installation, cleaning, abrasion, deterioration, wear, maintenance, damage, repair, disassembly, disposal, or other operations or events that could effect the material. The ultimate issue is: should there be a health risk, what special precautions need be taken to prevent harmful human exposure to the airborne asbestos released from the materials?

The authors of the following chapter have had considerable experience in asbestos control activities and related research. They summarize prior studies (including their own), discuss variation in results, and present more current data relating to the release of asbestos fibers during various operations. Their results and conclusions are important. Similar research is needed on other materials.

The reader will find, in this book series, chapters on related topics including Asbestos-Containing Building Materials (Chapter 8, Volume 9); Measurement of Airborne Asbestos Fibers (Chapter 2, Volume 9); Shipboard Asbestos Use: An Historical Perspective (Chapter 8, Volume 10); and Asbestos Abatement (all of Volume 5).

A. INTRODUCTION

The term 'gasket' is a general term for a number of sealing materials, including sheet gaskets and packing. Sheet gasket materials are used to seal pipe joint connections and prevent leakage of fluids between the solid surfaces of the pipe flanges. Packing is often found inside valve systems and has been used on boiler and furnace doors. This chapter provides information about the releasability of asbestos fibers from asbestos-containing sheet gaskets and packing. The term 'asbestos rope' is sometimes used to refer to the rope-like asbestos packing which comes on a spool.

B. SHEET GASKETS

As indicated in the introduction, sheet gaskets are used to seal joints where pipes are connected. Asbestos-containing gaskets are used in steam lines and in some water pipelines. Gaskets, often consisting of more than 70% chrysotile asbestos, are used against alkaline, neutral or weak acid solutions.[1] Crocidolite (blue asbestos) containing gaskets have been used against harsher acid solutions. Sheet gaskets are composed of chrysotile asbestos compressed into a sheet with styrene butadiene rubber or other binder.[2] Other organic binders used in making asbestos gaskets include natural rubber, buna-S and buna-N synthetic rubbers, or neoprene.[3] Sheet gasket material is sold in a form that is precut to fit a certain size flange or may be sold in sheets from which gaskets are cut to fit a particular flange assembly. In their original state, gaskets which are composed of asbestos in an organic binder are not considered friable. However, gasket material after service may be friable.

Although replacement gaskets may be found in a storage closet, in-service gaskets are generally located between two pipe flanges and are not readily accessible for disturbance. The concern over asbestos-containing gaskets comes from the fact that periodically a pipe connection must be broken at the flanges and the old gasket removed. This effort may require a simple scraping with hand tools or may need the assistance of power tools to clean the flange. Possible fiber release from both cutting new gasket material and from the removal of after-service gasket material as well as from the debris resulting from these activities must be considered.

1. Regulations Concerning Asbestos Gasket Material

In the U.S. Occupational Safety and Health Administration (OSHA) regulations, asbestos-containing gaskets are included under Class II asbestos work which pertains to activities involving the removal of ACM which is not thermal system insulation or surfacing material.[4] According to the OSHA rules and regulations, when removing gaskets containing ACM, the employer shall ensure that the following work practices are followed: (A) if a gasket is visibly deteriorated and unlikely to be removed intact, removal shall be undertaken within a glovebag. (B) the gasket shall be thoroughly wetted with amended water prior to its removal. (C) the wet gasket shall be immediately placed in a disposal container. (D) any scraping to remove residue must be performed wet. Gaskets would also be covered in Class IV asbestos work. Class IV work includes maintenance activities during which employees contact ACM and custodial activities in which employees clean up waste and debris containing ACM. Under the Class IV activities, dry sweeping, shoveling or other dry clean-up of dust and debris containing ACM is prohibited, regardless of measured levels of asbestos exposure or the results of initial exposure assessments.

Under the U. S. Environmental Protection Agency (EPA) NESHAP regulations of 1992, gaskets are included in Category I nonfriable asbestos-containing material (ACM) along with packings, resilient floor covering, and asphalt roofing products.[5] In most cases the asbestos NESHAP does not require their removal prior to demolition. Removal prior to demolition would be required if the gaskets or other Category I nonfriable ACMs became regulated asbestos-containing material (RACM) because they have been subjected to sanding, grinding, cutting, or abrading. Removal would be necessary before demolition if the gaskets (Category I nonfriable ACM) were located in a structure which was to be demolished by burning.

Under the U.S. Asbestos Hazard Emergency Response Act (AHERA), the Local Educational Agencies (LEA) must conduct reinspections every three years of all "friable and nonfriable known or assumed ACBM." Among the materials that the LEAs are to consider for reinspection are "other materials such as . . ., gaskets, . . . which may have been missed". If an inspector overlooked a suspect material during the original AHERA inspection, there is no specific requirement that it be included in the reinspection. However, any missed actual or suspect ACBM present in the school represent a violation of AHERA for which both the LEA and the original inspector could be liable.[6]

2. Hazard Communication Labels

In accordance with OSHA's Hazard Communication standard, labels shall be used to identify asbestos-containing material. The labels shall contain a warning statement against breathing asbestos fibers. However, labels are not required when asbestos fibers have been modified by a bonding agent, coating, binder, or other material, provided that the manufacturer can demonstrate that, during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation; no airborne concentrations of asbestos fibers in excess of the permissible exposure limit and/or excursion limit will be released.[7] While some manufacturers of gaskets represent that the asbestos is completely bound or encapsulated in their gaskets and therefore need no hazard label, others have put warning labels on their gaskets as shown in Figure 6-1.

3. Releasable Fibers in Sheet Gaskets

The question of whether or not all asbestos fibers are completely bound or encapsulated in gasketing material is one that has been studied by microscopy.[8] A close examination of the surfaces of four unused gaskets showed that although most of the asbestos was bound within an organic binder, uncoated asbestos fibers were present on the surface and on the edges of the gaskets which would be released as free fibers with mild abrasion. Additional work examining gaskets from a number of manufacturers showed similar results. Figures 6-2–6-8 show sheet gaskets from Garlock, Chesterton, Anchor Packing, John Crane, Crane Packing Company, and Sepco. Magnified views obtained with a scanning electron microscope of asbestos fibers found on the surface of the top of each gasket are shown in Figures 6-9–6-15. Chrysotile fibers are uncoated and protruding from the surface of each manufactured gasket. The x-ray spectrum shown in Figure 6-16 is typical of those obtained for chrysotile fibers on the surface of each gasket.

A gasket manufactured by Flexitallic is shown in Figure 6-17. It is a metal-jacketed gasket which consists of asbestos-filler material held within two metal pieces. If the metal-jacketed gasket remains intact there is little chance for abrasion of the asbestos material. However, if the metal pieces come apart as shown in Figure 6-17, the exposed asbestos material is very friable and easily dislodged. Figure 6-18 shows a magnified view obtained with a stereo light microscope of the asbestos material in the Flexitallic gasket. Figure 6-19 shows an SEM image of the fibers pulled from the surface with a Post-it Note™.

4. Published Literature on Asbestos Fiber Release from Sheet Gaskets

A U.S. government-sponsored report on the exposures from gasketing operations was compiled by the GCA Corporation in 1982.[9] They summarized their findings on gaskets as follows:

> Secondary processing of compressed sheet gaskets can result in comparatively high workroom fiber concentrations, on the order of 3.0 to 5.0 f/cc during hand and machine punching, if control measures are not employed. When dust control procedures are implemented, which is usually the case, fiber concentrations resulting from various hand and machine processing steps and materials handling operations range from less than 0.01 to 1.3 f/cc. Measured airborne fiber concentrations resulting from the installation of compressed sheet gaskets were less than 0.03 f/cc as reported by one study. Removal of these materials, however, can result in higher concentrations, up to 0.4 f/cc during hand scraping of material adhering to a bearing surface. In this latter case, fiber release is related to the physical exertion required to remove the material and to the high asbestos content (equal to or greater than 75%) of compressed sheet gasket.

The information in the GCA report is apparently based primarily on a U.S. Naval Regional Medical Center report commonly referred to as the Bremerton study.[10] Air samples were collected during gasketing activities including gasket handling, installing, removal and disposal at the Puget Sound Naval Shipyard. In addition to the summary provided by the GCA Corporation, data on cleaning of gasket debris showed less than 0.05 f/cc in one cleanup following removal with no controls and 1.2 f/cc and 1.67 f/cc during shearing and punching activities which included cleanup.

Data published in the scientific literature on asbestos exposures during use and handling of asbestos gaskets in the oil and chemical industries showed a range of fiber levels depending on the activity.[11] Long-term samples (over 300 minute sampling periods) during gasket fabrication with knives, power shears, and a wheel cutter showed levels ranging from 0.001 to 0.017 f/cc. Short term samples (30-55 minutes) collected while the gaskets were cut with a saber saw or power shear and wheel cutter showed concentrations ranging from 0.33 to 0.49 f/cc. Short-term exposures during dry removal of gaskets varied between 0.11 and 0.33 f/cc when surface cleaning was done with a scraper and/or with a wire brush. One air sample, collected during dry polishing of pipe flanges with a power sander, showed 1.4 f/cc for the task. A wet-work method for the removal of after-service gaskets which called for the spraying of a solvent-based wetting agent such as an oil to wet the gasket and seating surfaces before removing and cleaning showed workers short-term asbestos exposures to be below detection (detection limit = 0.06 f/cc). Other published results of simulated gasketing operations showed personal exposure to fiber levels ranging from 0.049 to 0.44 fibers/cc for removal and 0.13 to 0.19 f/cc for installation.[12] In the same study, TEM analysis of air samples collected during gasket removal and installation showed asbestos fiber levels ranging from 0.86 to 18.44 structures/cc (s/cc) for removal and 0.40 to 74.32 s/cc for installation. Some observational data on air levels during the changing of asbestos gaskets in a gasket plant/factory with some offices was included in the data considered by the Literature Review Panel of the Health Effects Institute-Asbestos Research report.[13] There was no ACM reported in the building, which was located in the southeastern U.S., other than the gaskets. Samples were taken on one day in 1988. Although no PCM data were collected, the concentration from 2 area samples based on TEM analysis for fibers longer than 5 μm was 0.002 f/cc. For structures of all sizes, the TEM result was 0.0012 s/cc. No asbestos fibers longer than 5 μm were detected in 2 personal samples collected during the changing. The detection limit was not given. Although *not* included in the HEI-AR report, other air samples collected during gasketing operations in an associated project showed significant levels of asbestos fibers released.

Two additional studies were performed by the authors to study the potential for exposure from asbestos from gasketing activities.[14] In the first study, air samples were collected before and during the removal of asbestos sheet gasket material and wire-brushing of the pipe flange. Special precautions were taken to isolate the removal activity from other activities that might have contributed airborne asbestos from other sources. The study was conducted in a warehouse in Norcross, Georgia. An asbestos abatement type enclosure was built for the study to isolate the testing from any other source of asbestos and to prevent any fiber release from contaminating the building.

A valve that had been used in a steam line onboard a ship was used for the experiment. The valve assembly had two sets of flanges with a gasket between each set of flanges. According to the retired steam fitter performing the gasket removal the valve assembly probably carried 40 to 75 pound steam through it. The temperature in the valve could have reached about 160° C. Gaskets were removed from both sides of the valve. The flanges were first scraped with a putty knife or screw driver to remove the majority of the gasket material (Figure 6-20). The flanges were then

wire brushed with an air powered drill to remove the residual gasket material adhering to the flanges (Figure 6-21).

The person doing the gasket removal was fitted with two personal air sampling devices. Air samples were analyzed by the standard phase contrast microscopy (PCM) method NIOSH 7400 using the "A" counting rules. Some of the samples were prepared for further study by transmission electron microscopy (TEM). The samples were prepared and analyzed using the International Standards Organization (ISO) direct preparation counting procedure. This TEM analysis method identifies asbestos fibers on the basis of morphology, crystal structure and x-ray elemental analysis. All asbestos fibers longer than 0.5 μm were counted by TEM so that a total asbestos concentration could be determined.

Polarized light microscopy (PLM) was used to determine the type of asbestos in the sheet gasket material. A friability test was performed on the samples of gasket material removed from the flanges.

The results of air sampling during the first gasket removal showed levels of 0.14 f/cc (3.9 s/cc by TEM) during hand removal and scraping with hand tools and 6.8 f/cc (62 s/cc TEM) during power wire brushing of the residue on the flanges. During the removal of the second gasket the air level was 2.1 f/cc (20s/cc TEM) for the period of time involving both the hand scraping and power wire brushing. Polarized light microscopic analysis showed both the sheet gaskets to be approximately 80% chrysotile. The gasket materials removed from the valve flanges were dry and friable.

The second study consisted of the collection of air samples during a cleanup of asbestos dust and debris following a cutting of a gasket material with a band saw. Air samples were also collected before and during the cutting of the gasket material. The study was conducted in a warehouse area in Norcross, GA in an enclosure similar to that used for Study 1. As in the previous study of gasket removal, the person doing the cutting and sweeping was fitted with two personal air sampling devices. All samples were analyzed by phase contrast microscopy (PCM) and some by transmission electron microscopy (TEM).

Polarized light microscopy (PLM) analysis showed the gasket to contain approximately 80% chrysotile asbestos. As received, the gasket material was not friable. However, it produced dust when scratched. The residue materials from cutting contained dust.

During sweeping with a broom, the airborne fiber level in the vicinity of the breathing zone of the person sweeping was 1.7 fibers/cc. TEM analyses of the airborne fiber concentration during sweeping showed a level of 5.9 s/cc for asbestos fibers of all widths over 5.0 µm in length. During cutting with a band saw, the air monitoring showed that the asbestos fiber level for the operator was 11 fibers/cc. TEM analyses of the airborne fiber concentration during band sawing showed a high level of chrysotile asbestos of all widths over 5.0 µm in length. The high number of long, thin asbestos fibers prevented an accurate TEM count. It was estimated that the concentration was over 30 f/cc for asbestos fibers of all widths over 5.0 µm in length.

Table 6-1 Summary of Air Sampling Results for Gasket Activities

Activity	PCM* (f/cc)
Cutting	
Hand punching (no controls)[9]	3.0-5.0
Hand & machine processing (controls)[9]	0.01-1.3
Cutting with knives, power shears, wheels[11]	0.001-0.017
Cutting with saber saw/ power shear and wheel cutter[11]	0.33-0.49
Cutting a gasket with a band saw[14]	11
Installation	
Installation[9]	<0.03
Installation[12]	0.13-0.19
Removal	
Removal[12]	0.049-0.44
Hand scraping[11]	up to 0.4
Hand Scraping[14]	0.14
Dry removal with scraper/wire brush[11]	0.11-0.33
Dry polishing of flange[11]	1.4
Hand Scraping and Power Wire Brushing[14]	2.1
Power Wire Brushing[14]	6.8
Wet removal[11]	<0.06
Cleaning	
Cleaning of debris following removal (no controls)[10]	0.05
Broom Sweeping of Area After Removal[14]	5.5
During Sweeping of Dust & Debris after gasket cutting[14]	1.7
Shearing and punching activities with cleanup[10]	1.2 & 1.67
Changing of Gaskets[13]	0.002

5. Conclusions about Asbestos Sheet Gasket Materials

The results of various tests suggest that asbestos sheet gasket material can release asbestos fibers into the breathing zone of the person working with them especially if cutting or abrasive tools are used in the work. Gaskets should be wetted during removal. Powered brushing should be done in a glovebag because even if wetted, the action of the power brush will dry out the material. Sweeping dry asbestos-containing dust and debris following cutting or removal of gaskets can release significant levels of asbestos fibers into the air and should be avoided.

C. ASBESTOS PACKING MATERIAL

According to the U.S. Environmental Protection Agency (EPA), asbestos packing means an asbestos-containing product intended for use as a mechanical seal in circumstances involving rotary, reciprocating and helical motions, and which are intending to restrict fluid or gas leakage between moving and stationary surfaces.[1] In a valve, the packing is compressed against the bore of the box by a gland which is tightened down on the packing. The packing is forced against the throat of the valve box and the packing conforms to the valve shaft surface forming a tight seal. Compression packings are manufactured from various types of fibers, such as vegetable, animal, mineral (asbestos) or synthetic, twisted or braided with binders and lubricants.[15] One of the most commonly used in valves is a graphite-impregnated packing material which has the appearance of a shiny, stiff rope. EPA states that products such as packing may release asbestos dust if cut or torn.[16] Most piping systems use valves to regulate the flow of liquids or gases within them. The valves, especially in industrial and maritime facilities, may contain asbestos packing material which acts as a seal to prevent fluid or gas leakage as the valve is turned. Periodically, the values must be repaired or routinely maintained by removing the packing and replacing it with new packing. In some facilities a number of valves are repacked at one time.

1. Releasable Fibers in Packing

The question of whether or not all asbestos fibers are bound or encapsulated in packing material is one that can be studied by microscopy. A close examination of several pieces of packing showed that uncoated asbestos fibers were present on the surface of the packing which would be released as free fibers with mild abrasion. Figures 6-22, 6-23, and 6-24 show representative types of packing materials. Figure 6-22 shows a twisted packing in contrast to the braided packings shown in Figures 6-23 and 6-24. Figure 6-23 shows a round form of the braided packing; Figure 6-24 shows the square form. Magnified views obtained by scanning electron microscopy of the cut ends of the pieces of the different types of packing are shown in Figures 6-25–6-27.

2. Published Literature on Asbestos Fiber Release from Packing

The GCA Corporation Report of 1982 reported on one 1979 study of packing material where six different packings were tested over a 4-day period.[9] Two (one area, one personal) samples were collected during installation and two during removal of the same packing material in water circulating pumps. Of the 28 samples collected, 5 had a fiber concentration of 0.0 f/cc (PCM), 10 had a concentration of "less than 0.1" f/cc, 12 had a concentration of 0.1 f/cc and one sample had a concentration of 0.2 f/cc. In general, the installation activity samples showed slightly higher concentrations than the removal activity samples.

Published results of simulated valve packing operations showed personal exposure to fiber levels ranging from 0.05 to 1.01 f/cc (PCM) for removal and 0.04 to 0.52 for installation.[12] The TEM analysis results for them were 0.52 to 19.57 s/cc for removal and 0.07 to 4.05 s/cc for installation.

In a published study by two of the authors of this chapter (JRM & MDM), asbestos fibers were found to be released into the air during valve packing removal operations.[17] The study was conducted in an unused steam power plant in Manchester, New Hampshire. Air samples were collected before and during removal of asbestos packing material from valves that had been used at the plant. The results of this study showed that asbestos fibers can be released into the air during the generally used procedures for the removal of asbestos packing material. Air concentrations were measured by PCM in the range of 0.2 to 1.3 f/cc and by TEM in the range of 1.5 to 4.2 f/cc for all diameter fibers greater than 5 μm in length.

In a second study the authors performed a similar operation in which air samples were collected before and during removal of asbestos packing material from a valve which had been used on board a ship. To determine the possible contribution of valve packing only, special precautions were taken to isolate this material from other activities that might have contributed airborne asbestos from other sources. The study was conducted in a warehouse in Norcross, Georgia. An asbestos abatement type enclo-

sure was built for the study to isolate the testing from any other source of asbestos and to prevent any fiber release from contaminating the building. The containment barriers in the area consisted of three layers of 6-mil polyethylene plastic sheets on a wooden frame and three layers of 6-mil polyethylene plastic on the floor. A containment area (8 ft by 8 ft) around the valve was completely contained within a larger containment area. The study area had two High Efficiency Particulate Absolute (HEPA) air filtration devices (AFD) used to clean the area of particulate including asbestos before the valve packing removal activity. In the outer area the AFD operated throughout the test.

The study consisted of the collection of air samples before and during a valve packing removal activity. Prior to the study, the valve had been thoroughly washed and the flanges which contained gaskets were sealed with duct tape. A spray encapsulant was also used on the valve. The valve packing removal was performed by a retired pipefitter using his own tools and performing the removal of packing in the same way that he had in his previous years of work on valves (Figure 6-28). Although some lubricating oil was used to loosen the bolts on the valve, the work was generally done in a dry manner. One packing removal test was performed. Pieces of the removed packing were placed in plastic bags and stored for analysis. The packing removed from the valve appeared to be graphite-impregnated packing material with a wire insert. It had a shiny gray-black appearance. The packing removal activity occurred for approximately 62 minutes. The study site was cleaned after the work. After the valve stuffing box had been cleaned thoroughly and vacuumed with a HEPA vacuum, the valve was repacked with an asbestos-containing packing. The repacking test period was 7 minutes.

Prior to starting the study, three (3) area air samples were collected to determine the background level of asbestos in the air of the study area. The sampling cassettes were located on the walls at the breathing zone, five feet from the floor. A volume of 1100 liters of air was passed through each cassette at a flow rate of 10 liters per minute. During the background sampling, the valve and area were swept vigorously with a broom. One (1) area air sample was collected during the valve packing removal in the same locations as one of the background air samples, approximately five feet from the gasket removal activity. It was collected at 5.0 lpm. The person doing the packing removal was fitted with two personal air sampling devices and a person helping and photographing the activity was fitted with one personal monitor. These personal air samples were collected at a rate of 2.2 liters per minute. Personal air samples were also collected on the person repacking the valve.

All personnel inside the study area were protected by air purifying respirators and complete head and body coverings. The decontamination system consisted of a changing room outside the testing area, and a clean suit-up room. The decontamination system was used each time a person exited the study area and the overall containment area.

3. Analytical Methods

Air samples were analyzed by the standard phase contrast microscopy (PCM) method using the "A" counting rules.

Although the phase contract microscope enhances the analyst's ability to see fibers over other types of light microscopes, the standard procedure does not involve identification steps which specifically determine how many of the fibers counted are actually asbestos. Because packing material is known to contain other types of fibers, some of the samples were prepared by transmission electron microscopy (TEM) following the AHERA preparation procedure. They were analyzed using the International Standards Organization (ISO) direct procedure. The TEM analysis method identifies asbestos fibers on the basis of morphology, crystal structure and x-ray elemental analysis. Asbestos fibers longer than 0.5 μm were counted.

Polarized light microscopy (PLM) was used to determine the type of asbestos in the samples of packing material removed from the valve. A friability test was performed on samples of packing material that had been removed from valve.

4. Results of the Second Valve Packing Removal Study

The results of this study show asbestos fibers can be released into the air during the generally used procedures for the removal of asbestos packing material. Air concentrations were measured by phase contrast microscopy to be 0.14 fibers/cc and by transmission electron microscopy in the range of 0.4 to 1.4 fibers/cc for asbestos fibers of all sizes. A personal sample on the person nearby the packing remover was 0.09 f/cc. The area samples collected in the vicinity of the packing removal activity showed levels of fibers elevated over the background levels. During the 7 minutes it took to repack the valve with a single short piece of asbestos-containing packing, the levels of fibers in the vicinity of the worker were below the detectable limit of 0.17 f/cc. No cutting of the packing was done during the repacking.

The used packing, removed from the valve, was friable. Polarized light microscopic analysis showed it to be approximately 80% chrysotile. Scanning electron microscopy examination of the removed packing showed chrysotile asbestos fibers uncoated by any binder.

5. Conclusions

Asbestos packing, although not considered friable in original, unused condition, can become friable after use in valves and can release asbestos fibers into the air during valve packing removal operations. The amount of fiber release appears to depend on the condition of the after-use packing. That which is compressed and requires considerable effort to remove may release significant levels of asbestos into the air. Operations such as installation which do not include cutting the packing do not appear to release asbestos in levels over 0.2 f/cc. Packing should be wetted with water or oil before it is cut and torn with packing tools such as hooks and screwdrivers during the procedures for removing old packing.

EDITORS' POSTSCRIPT

Additional information on the releasability of asbestos, from floor tile, has resulted in the following recommendations (as listed in a project summary of the National Risk Management Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA/600/SR-95/121, dated August 1995). The recommendations resulted from using a criterion of the (OSHA) P.E.L. of 0.1 f/cm^3 (8-hour TWA). This was compared to measurements of airborne asbestos concentrations resulting from low-speed spray-buffing, ultra high-speed burnishing, and wet stripping of asbestos-containing resilient floor tile (under pre-existing and prepared levels of floor maintenance.) It is important to note that the vinyl floor tile tested was in good condition and contained a low percentage of asbestos (3 to 5% chrysotile), but that floor tile generally ranges form 3 to 25%. The recommendations were as follows:

1) Floor-care treatment systems that include the use of a sealant over which the wax or finish costs are applied should be used on asbestos-containing resilient floor tile. Two or more layers of sealant should be applied as a base coat. The use of multiple layers of sealant on asbestos-containing floor tile can significantly lessen airborne asbestos concentrations during the mechanical removal of the wax or finish from the floor.

2) Two or more layers of wax or finish should also be applied to asbestos-containing resilient floor tile. Although to a lesser extent, multiple layers of floor finish may also provide additional protection against asbestos release during low-speed spray-buffing and

ultra high-speed burnishing of asbestos-containing resilient floor tile.

3) The results of this study further support the original U.S. EPA Recommended Interim Guidance for Maintenance of Asbestos-Containing Floor Coverings issued on January 25, 1990. Machine stripping of asbestos-containing resilient floor tile should be conducted only when necessary. Wet-stripping of floors tends to result in higher increases in airborne asbestos concentrations than routine buffing procedures. Floors should be kept adequately wet during stripping. The floor machine should be equipped with the least abrasive pad possible to strip the wax or finish coat from asbestos-containing floor tile.

4) Workers responsible for the maintenance of asbestos-containing floor tile should be trained on the proper use of the floor machines used for low-speed spray-buffing, ultra high-speed burnishing, wet-stripping, the appropriate buffing and stripping pads, and the selected floor care treatment system. Workers should also be informed of and follow appropriate operations and maintenance (O&M) work practices and procedures for the maintenance of asbestos-containing resilient floor tile.

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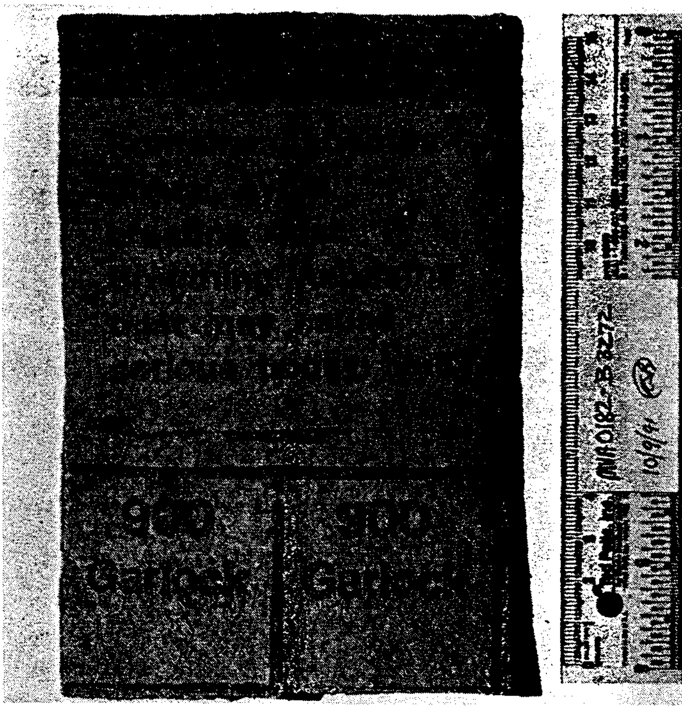

Figure 6-1. Warning Label on a piece of asbestos-containing sheet gasket material.

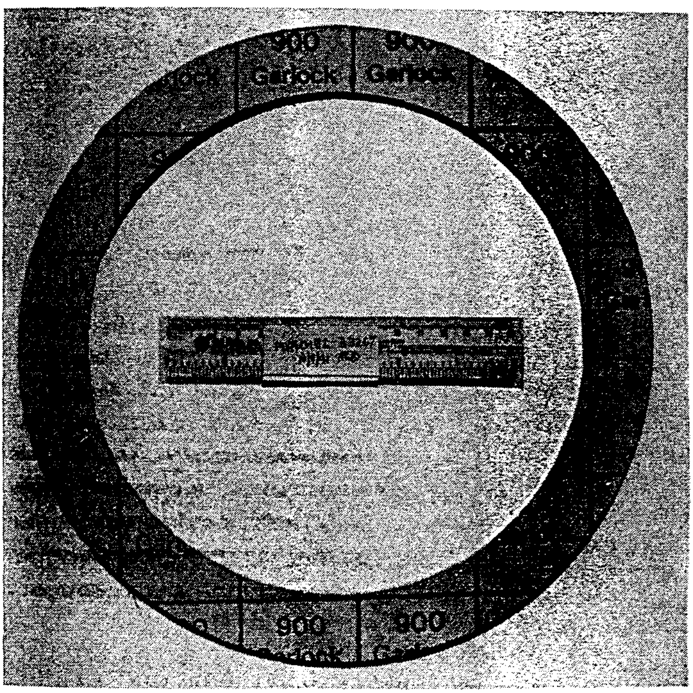

Figure 6-2. Pre-formed asbestos-containing sheet gasket material manufactured by Garlock.

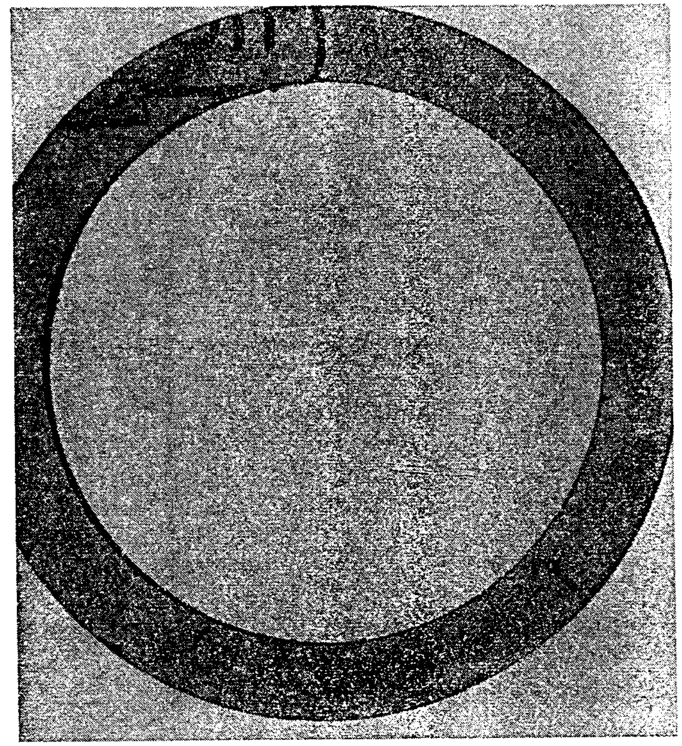

Figure 6-3. Pre-formed asbestos-containing sheet gasket material manufactured by Chesterton.

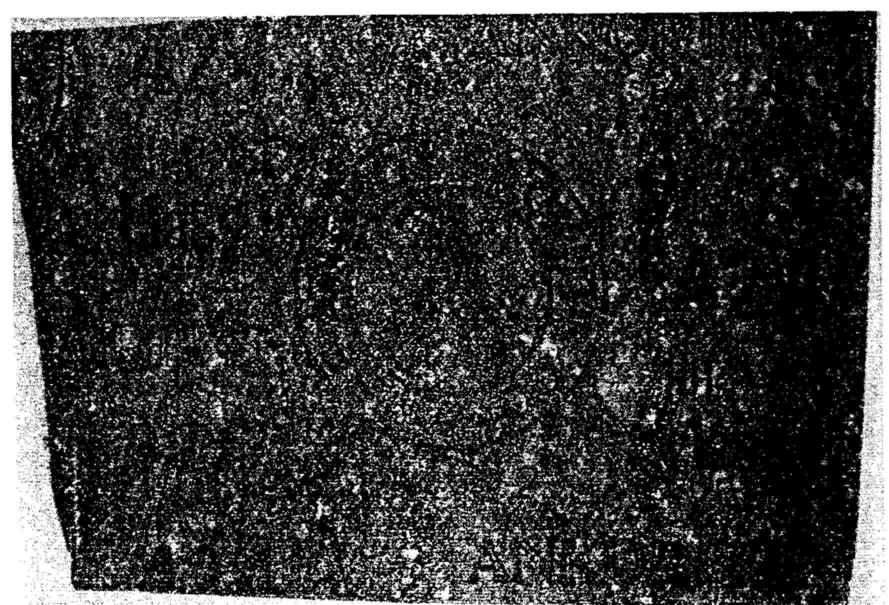

Figure 6-4. Asbestos-containing sheet gasket material manufactured by Anchor Packing Co.

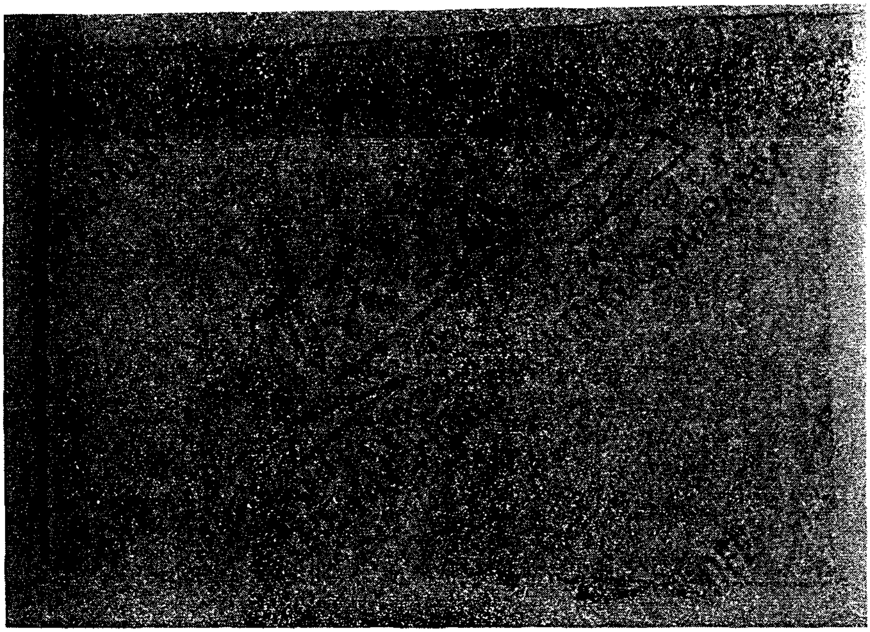

Figure 6-5. Asbestos-containing sheet gasket material manufactured by Anchor Packing Co.

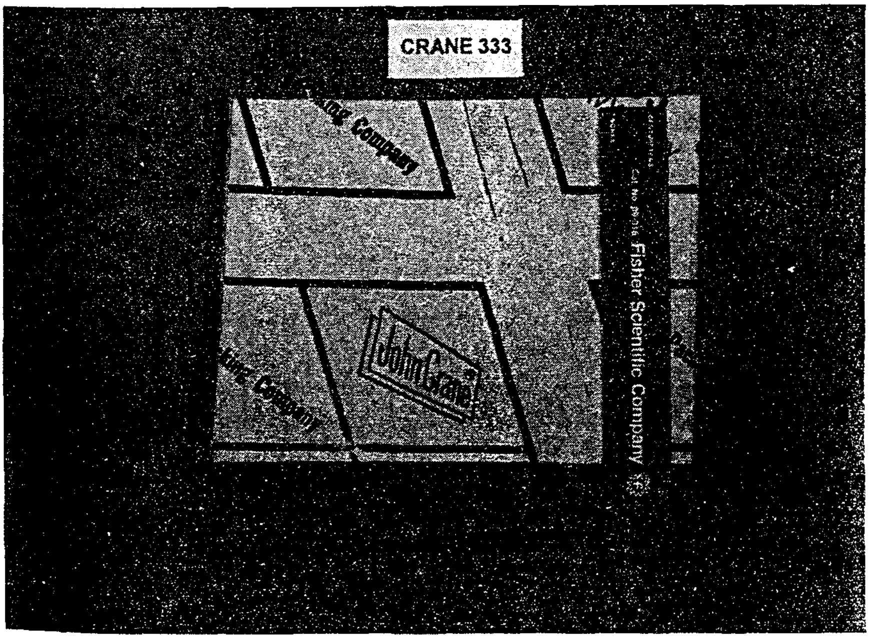

Figure 6-6. Asbestos-containing sheet gasket material manufactured by John Crane, Crane Packing Co.

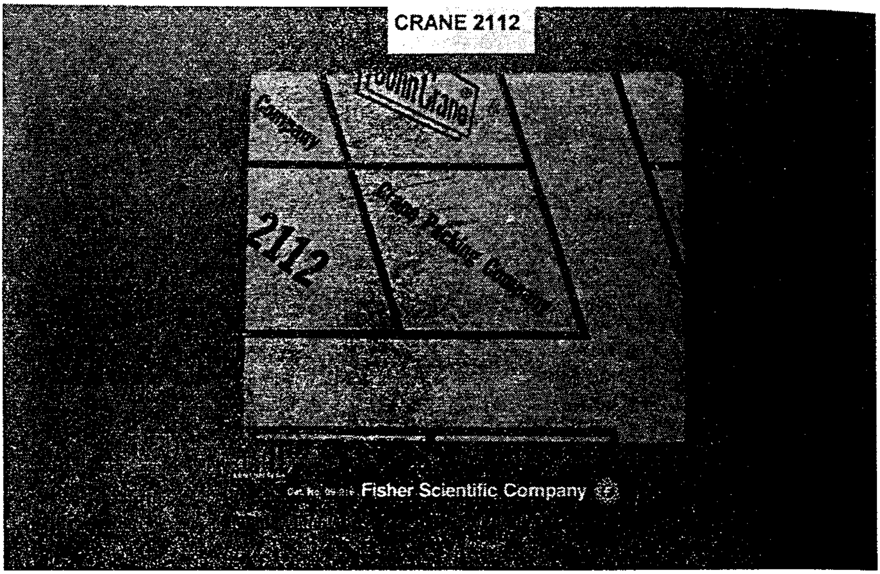

Figure 6-7. Asbestos-containing sheet gasket material manufactured by John Crane, Crane Packing Co.

Figure 6-8. Asbestos-containing sheet gasket material manufactured by Sepco.

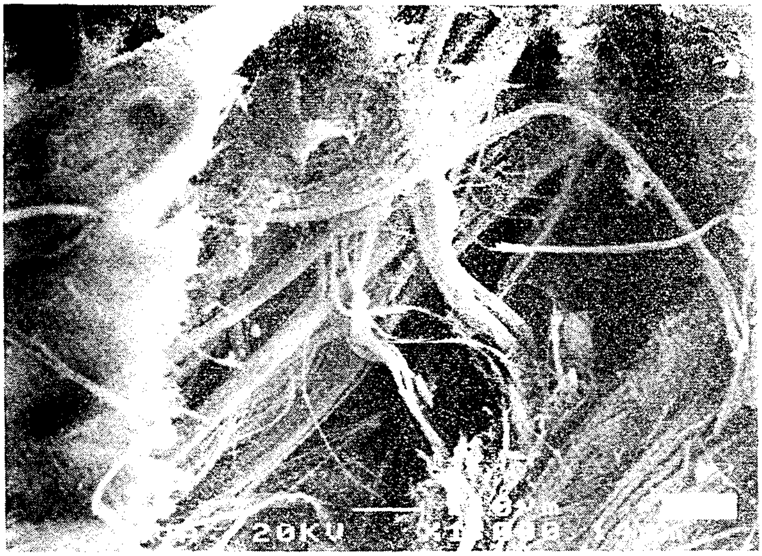

Figure 6-9. Close-up view of the surface of the gasket material shown in Figure 6-2 showing uncoated chrysotile asbestos fibers protruding.

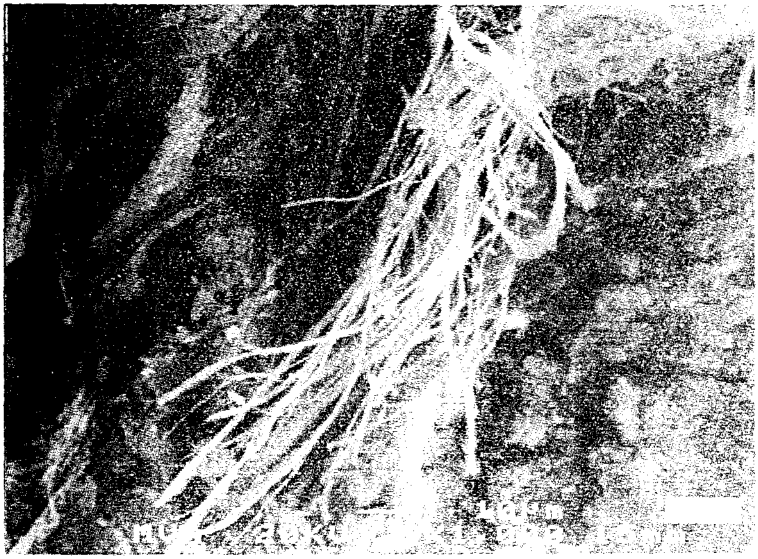

Figure 6-10. Close-up view of the surface of the gasket material shown in Figure 6-3 showing uncoated chrysotile asbestos fibers protruding.

Figure 6-11. Close-up view of the surface of the gasket material shown in Figure 6-4 showing uncoated chrysotile asbestos fibers protruding.

Figure 6-12. Close-up view of the surface of the gasket material shown in Figure 6-5 showing uncoated chrysotile asbestos fibers protruding.

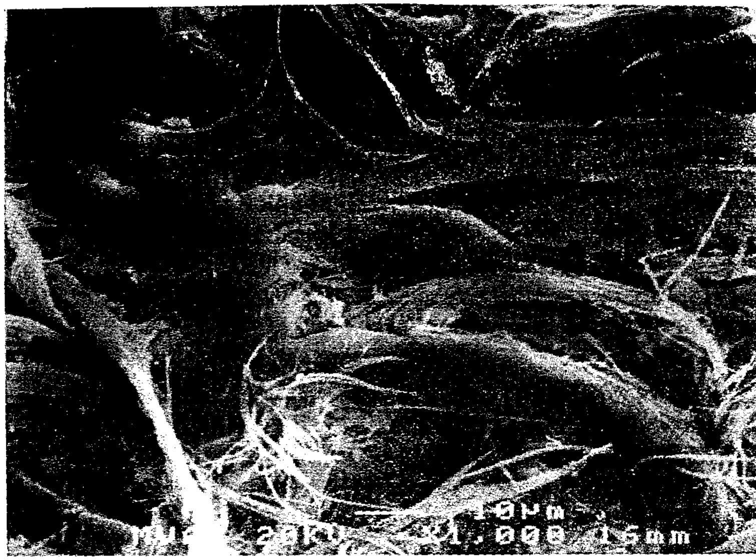

Figure 6-13. Close-up view of the surface of the gasket material shown in Figure 6-6 showing uncoated chrysotile asbestos fibers protruding.

Figure 6-14. Close-up view of the surface of the gasket material shown in Figure 6-7 showing uncoated chrysotile asbestos fibers protruding.

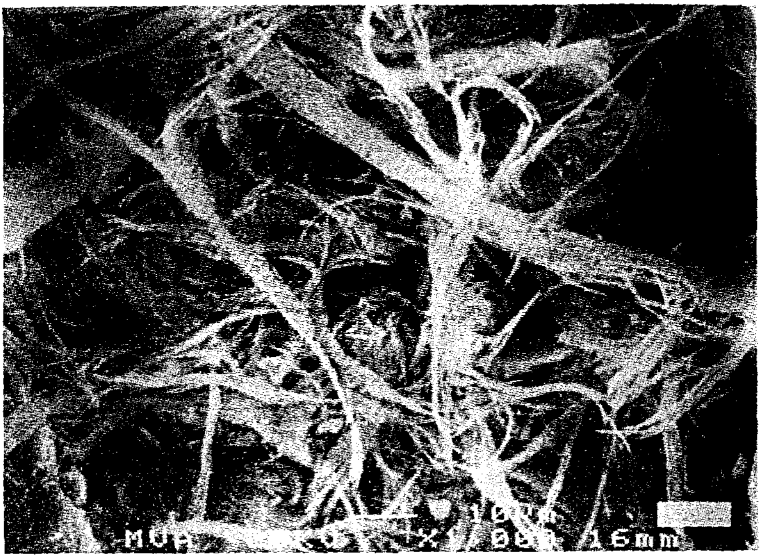

Figure 6-15. Close-up view of the surface of the gasket material shown in Figure 6-8 showing uncoated chrysotile asbestos fibers protruding.

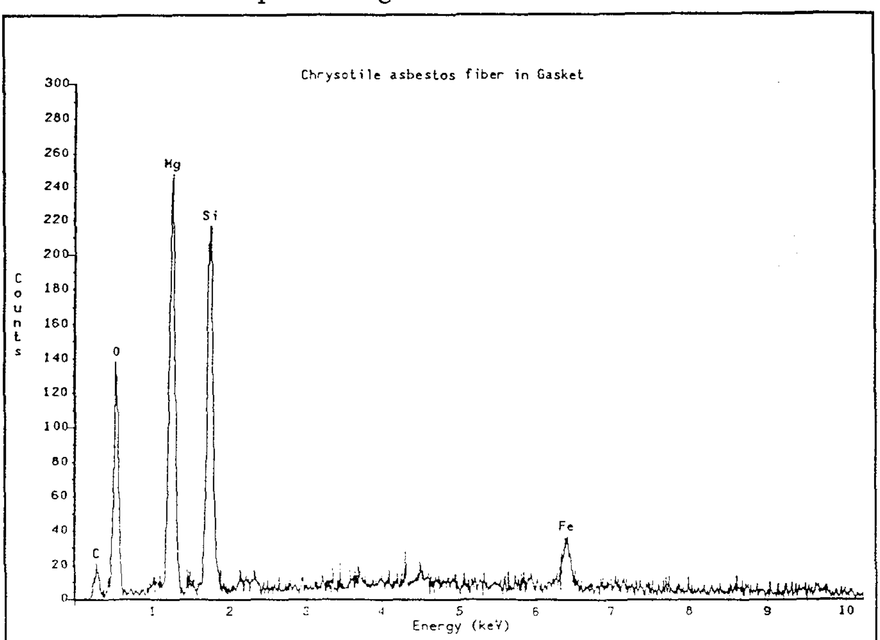

Figure 6-16. X-ray spectrum of chrysotile on the surface of gasket shown in Figure 6-5. The major components of chrysotile—magnesium, silicon, oxygen are evident.

Figure 6-17. A view of a Flexitallic Gasket from which the metal jacket covering the asbestos has come off.

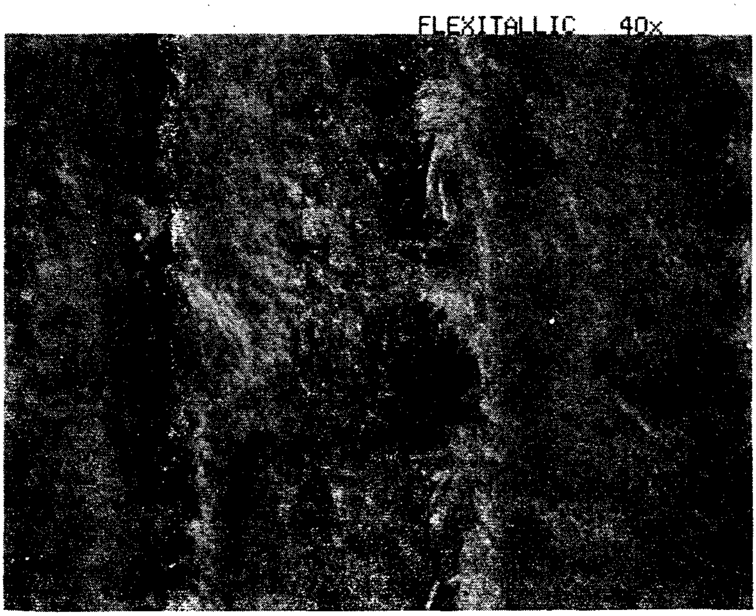

Figure 6-18. Light microscope image of the surface of the asbestos in the gasket shown in Figure 6-17.

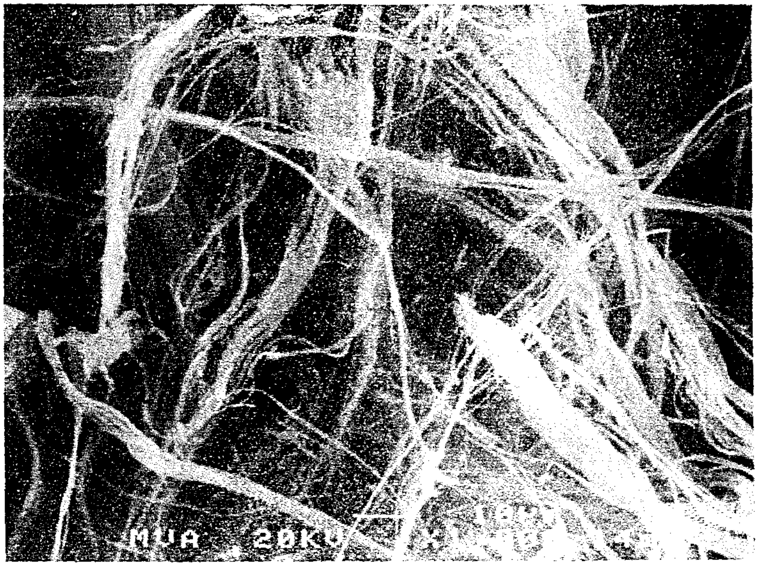

Figure 6-19. Close-up view of the asbestos removed from the gasket material shown in Figure 6-18 on a Post-it Note showing uncoated chrysotile asbestos fibers protruding.

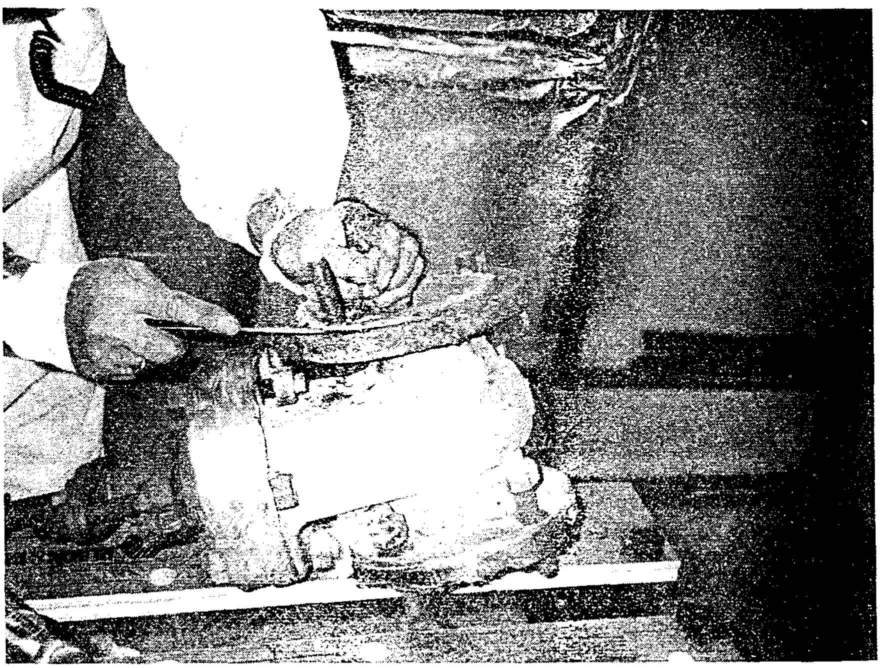

Figure 6-20. Removing an after service asbestos-containing gasket from a pipe flange by hand-scraping.

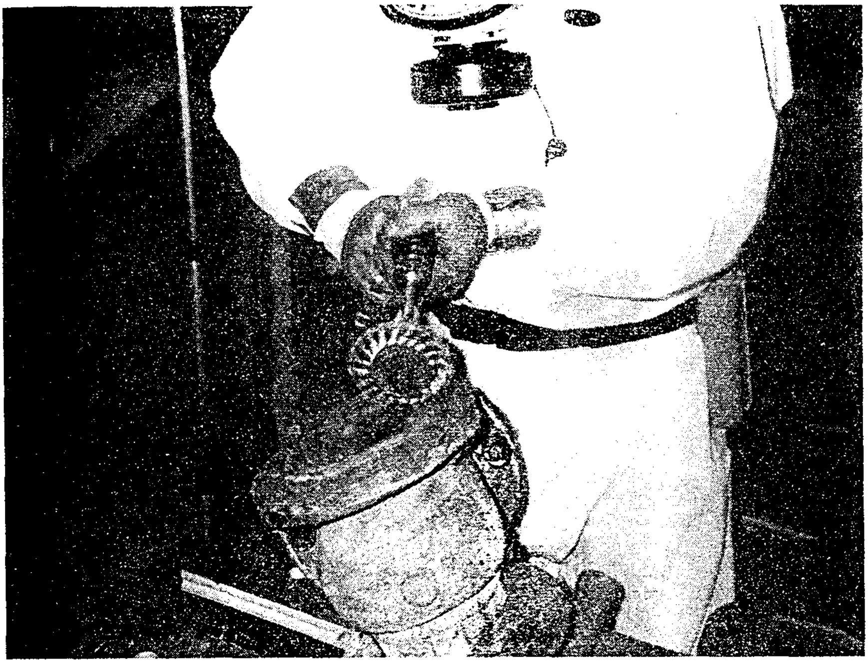

Figure 6-21. Power wire brushing of a pipe flange after the removal of the gasket during Study 1.

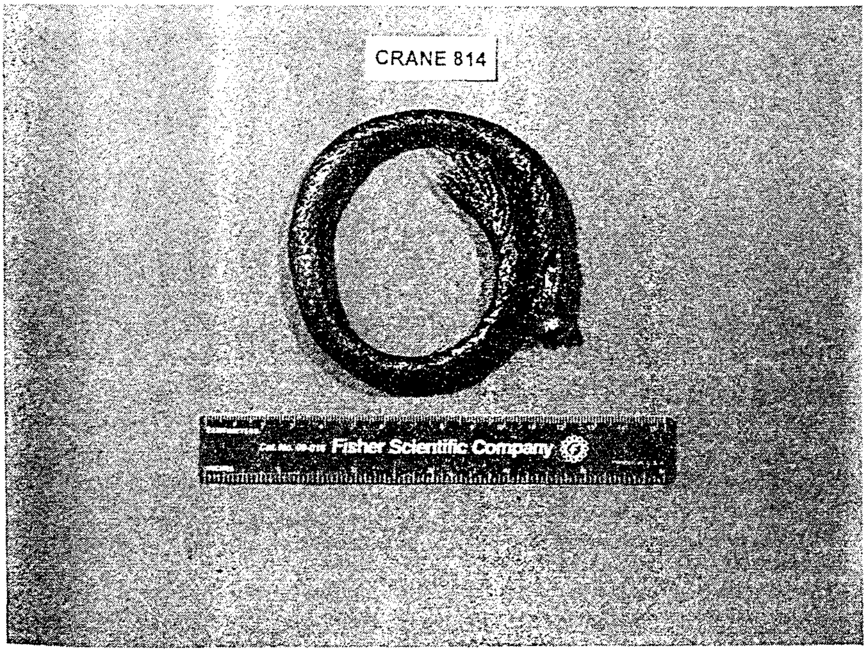

Figure 6-22. Example of twisted asbestos packing. Crane Style 814

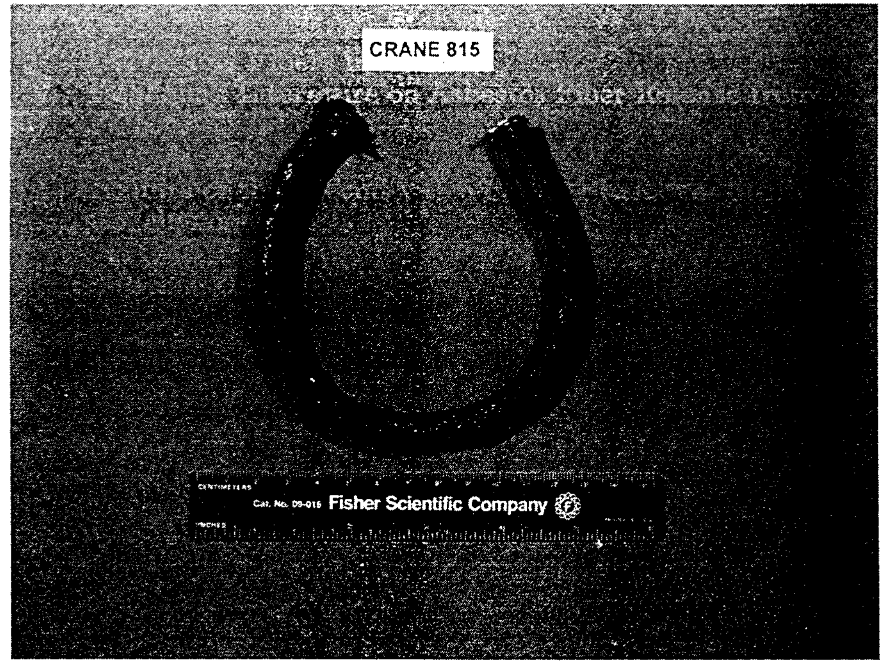

Figure 6-23. Example of braided round asbestos packing. Crane Style 814

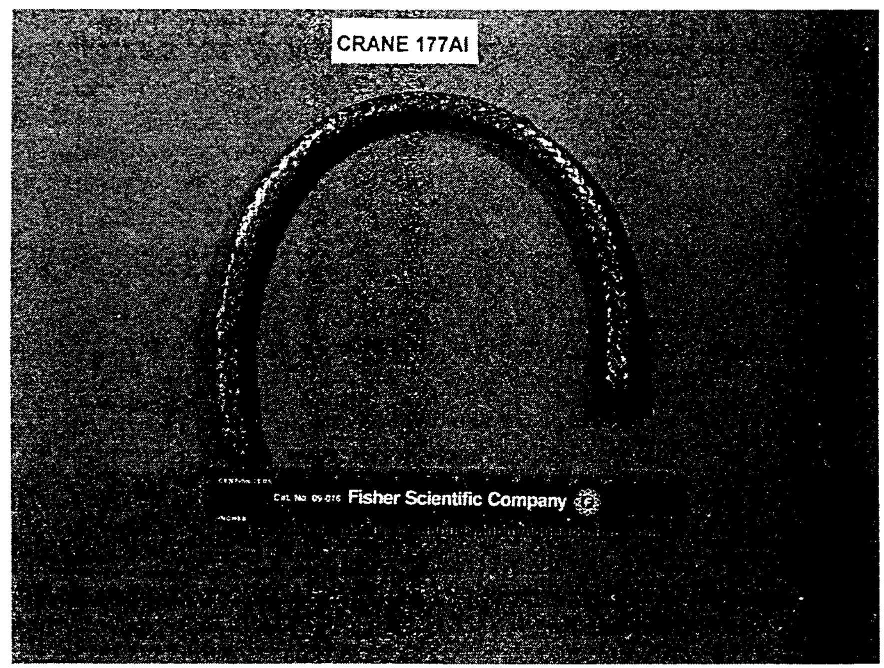

Figure 6-24. Example of braided square asbestos packing. Crane Style 814

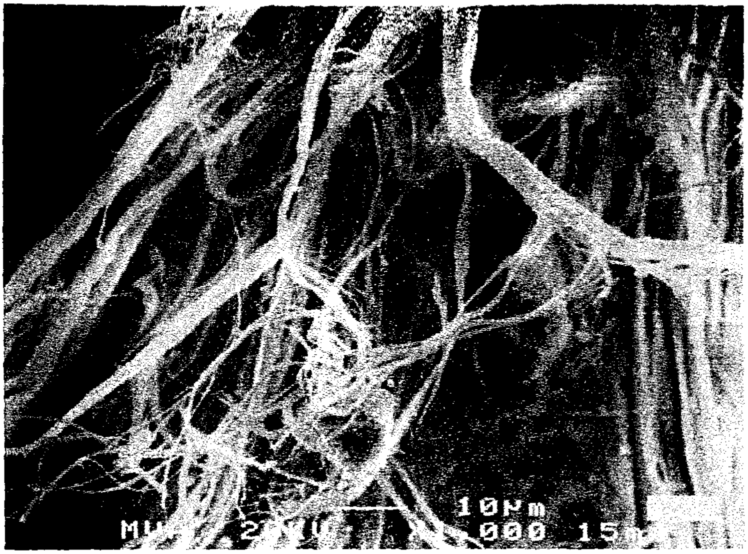

Figure 6-25. Close-up view of the surface of the packing material shown in Figure 6-22 showing uncoated chrysotile asbestos fibers protruding.

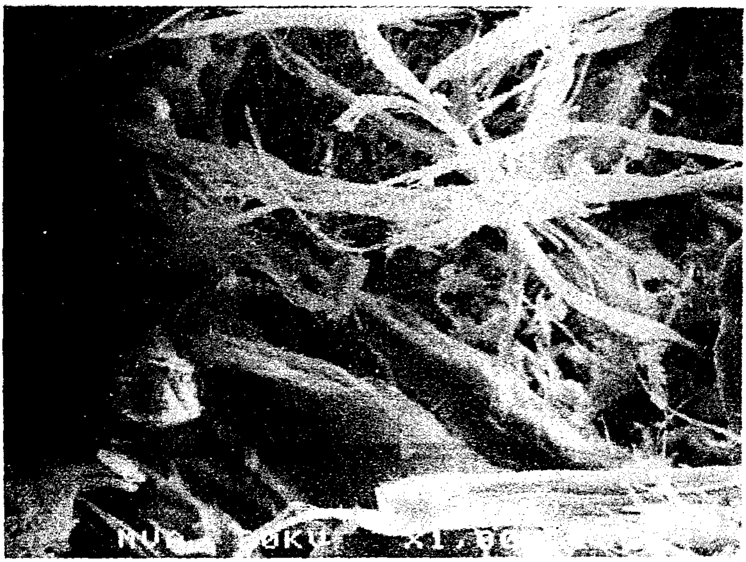

Figure 6-26. Close-up view of the surface of the gasket material shown in Figure 6-23 showing uncoated chrysotile asbestos fibers protruding.

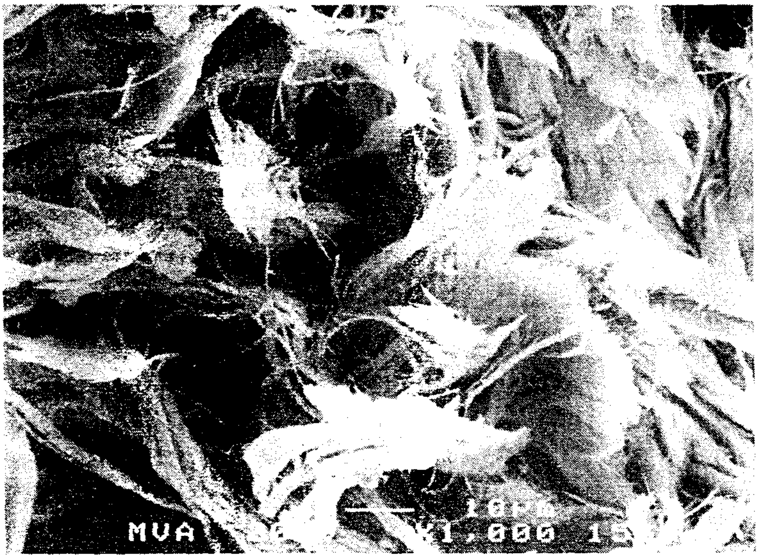

Figure 6-27. Close-up view of the surface of the gasket material shown in Figure 6-24 showing uncoated chrysotile asbestos fibers protruding.

Figure 6-28. Removal of valve packing.