

JM Asbestos Inc.



VIC KEIM

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Asbestos Fibre Handling Manual

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Introduction to Handling Asbestos

The prime object of this Association is to encourage and facilitate the endeavours of its members to eliminate risks to health, occupational and environmental, arising from the use of asbestos.

Many countries have official regulations and guide lines which producers, manufacturers and consumers are required to observe in order to prevent such risks occurring, and progressively the standards stipulated are being achieved. In the course of applying these requirements much practical experience has been acquired, and the interchange of such knowledge and the maximising of control techniques is seen as the principle means by which our members can attain our prime objective.

There are still areas where official guidance has not been provided, and others where the problems of applying statutory requirements are new and may appear formidable. The Asbestos International Association believes that it has an opportunity and a responsibility to provide what help it can to those concerned with this problem from the wide experience of its members, and has decided therefore to produce a series of advisory publications for this purpose.

We wish to remind readers of two important points:

First, in considering any recommendations in the AIA publications these should be related to the specific legal requirements in the country concerned. It is clearly not possible in such publications to relate the recommendations in every respect to the specific detailed regulations in each state. Nevertheless, the greater part of existing laws on the subject calls for similar forms of control and where no official regulation exists we advise that action should be based on the recommendation of the ILO meeting of experts on the safe use of asbestos, December 1973.

Secondly, the development of techniques of control is a continuous process, and we hope that the efforts we are undertaking will help to accelerate the process. Techniques which are recommended have reached their present stage as a result of interchange of ideas and practical experience between international experts in the asbestos industry, plant manufacturers, government agencies and many others. It will certainly be necessary regularly to up-date and amend these publications in the light of new ideas and criticisms. All such will be welcomed and will be given full consideration during revision stages.

**Publications by the Asbestos
International Association**

Recommended Control Procedures

- RCP1 The Control of Asbestos Dust.
- RCP2 Asbestos Cement Products.
- Insert Catalogue of Tools for working
with asbestos cement products
on-site.
- RCP3 Asbestos Waste Materials.
- RCP4 Asbestos Fibres, Packaging,
Handling and Transportation.
- RCP5 Asbestos Fibres, Bag Opening.
- RCP8 Asbestos Textile Products
Manufacture.
- RCP7 Asbestos Textile Products
Fabrication and Use.
- RCP8 Repair and Renewal of
Asbestos Insulation.
- RCP9 Protection equipment for use in
the manufacture and use of
Asbestos Products.
- RCP10 Asbestos Containing Friction
Material, Application and
Servicing.

Recommended Technical Methods

- RTM1 *Reference Method for the
determination of Airborne
Asbestos Fibre concentrations
at Workplaces by Light
Microscopy (Membrane Filter
Method).*

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**Recommended Control
Procedure No. 1**

**Recommended Control Procedures
Particularly for Countries Where No
Statutory Regulations Exist**

1. What Is Asbestos?

Asbestos is a broad term applied to a group of fibrous silicates falling into two chief varieties, chrysotile and the amphiboles.

1.1. Chrysotile asbestos (white asbestos) is a hydrated magnesium silicate found in serpentine rock. It is widely distributed in nature and accounts for some 93 per cent of the world's asbestos production and consumption.

1.2. The amphibole asbestos varieties include amosite, crocidolite, anthophyllite, tremolite and actinolite; the last two fibre types have few industrial applications but are sometimes found as impurities in talc.

2. Asbestos and Health

2.1. The possible effects of asbestos on health are of a somewhat complex nature, about which expert medical opinion is continuously evolving. The following explanation attempts to express in layman's terms the general consensus of expert medical opinion in sufficient detail for an understanding of the logic behind the control methods which this code of practice recommends.

2.2. Inhalations of dust can be harmful. Most of the dust breathed in from the atmosphere, whether general or in the workplace, is exhaled again when we breathe out. Only the finest respirable dust is small enough to reach the innermost areas of the lungs, where it can burden the lungs and reduce their efficiency. The greater the amount of such fine dust and the longer the period it is inhaled the greater will be the burden and the risk of damage to the lung.

2.3. Fine dusts from a number of materials have been identified as capable of producing such effects. Asbestos dust is one of these, together with such other materials as coal, beryllium, quartz. Inhalation of fine dusts from these materials, can, by a process known as fibrosis, impair the lungs' function by replacing normal lung tissue with scar tissue, thus reducing the capacity and elasticity of the lung. Conditions such as this are collectively known as pneumoconiosis diseases. There is some evidence that smoking may make some people more prone to develop these diseases.

2.4. The interaction of cigarette smoking and asbestos appears to be of great importance. Asbestos workers who smoke have a greatly increased risk of developing lung cancer compared with non-smokers. In most reported studies, non-smoking asbestos workers very rarely develop lung cancer. Cigarette smoking also increases the risk of lung fibrosis in asbestos workers.



2.5. A very rare type of cancer known as mesothelioma has also been particularly associated with asbestos, especially crocidolite which was in the past widely used for preformed thermal insulation and spray.

This type of cancer affects the membrane which lines the chest cavity and covers the outer surface of the lungs (pleura). It also lines the abdominal cavity and covers the abdominal organs (peritoneum).

It does not appear to be influenced by cigarette smoking and a certain number of cases are reported as occurring without any evidence of association with asbestos.

2.6. Cases of cancer of the gastrointestinal tract have been observed more frequently than expected among some heavily exposed workers, though the evidence for this is said to be less statistically significant.

2.7. There is also some suggestion that other types of cancer may be associated with exposure to asbestos dust but such evidence as is available as yet is insufficient to be conclusive.

2.8. These various effects are not usually apparent until many years after a first exposure to excessive quantities of respirable dust — asbestosis usually between 15 to 20 years. In a considerable number of reported cases where the exposed persons have been cigarette smokers associated lung cancer arises from 15 to 30 years after exposure. Mesothelioma usually only occurs 20 to 40 years after the alleged exposure.

3. Standards of Concentration and Measurement

3.1. Epidemiological studies throughout the world have demonstrated that pathological effects increase in relation to the amount of dust inhaled; exposure to high dust concentrations over a relatively short period of time may involve similar risks to exposure over a long period of time to lower levels of dust. This is generally described as a dose response relationship. Since bronchial cancer may result from similar conditions with the multiplicative effect of cigarette smoking as a co-factor, this may also be said to be related to the dose.

3.2. Environmental hygienists have tried to calculate at what dose level no excess risk will occur, so that manufacturing processes and conditions can be measured and the need and extent of remedial action assessed.

In many countries working standards have been established on the basis of the number of fibres in the fine dust range present in a measured quantity of air; for example, in many countries a maximum acceptable concentration of two fibres per millilitre average concentration over a normal working period (four or eight hours) has been adopted.

3.3. Such standard concentration is used (1) to ascertain whether an operation or process requires some form of control in order to reduce the dust level to within the acceptable range, (2) to check that the control devices or work procedures have had the effect in reduction of dust levels for which they have been designed, (3) to monitor the continuing working situation by regular measurements.

3.4. The methods of dust sampling and assessment of the fine asbestos dust-content in the sample require a good standard of technical training and equipment. Details of the techniques of

the equipment required and of the strategy of monitoring are contained in more detail in specialised publications of the AIA.

4. Prevention of Risks

The variety of products based on or incorporating asbestos involves a considerable diversity of processes. Consequently there are a great many different forms of technical control which have been developed and adapted to the particular circumstances of the type of manufacture, the nature of the product and the manner in which it is used.

Much emphasis has been placed on the use of substitutes for asbestos, but in practice it has not been possible in most cases to find technically suitable or economically feasible alternatives. Moreover, it is not as yet known whether the proposed alternative materials are themselves free of risk. The effects of inhalation of asbestos dust have only become well understood after many years' experience in manufacture and use. It will be many years before such experience is gained of the effects of newly developed substitute materials. There is some suspicion that similarly fine fibres may produce health effects of the same kind as asbestos.

5. Technical Prevention

In any process involving the use of asbestos fibres or in the use of any materials containing asbestos, where dust in excess of the stipulated standard may be given off, technical measures should be devised to prevent the emission of asbestos dust into the atmosphere of the workplace. The generally accepted methods of achieving this are as follows:

5.1. Suppression of dust at source. This may be achieved by the design or redesigning of the process or operation so that the possibility of dust exposure is reduced below a specified level. This can sometimes be achieved by wetting or the processing of the asbestos component in association with dust-suppressing materials or compounds.

Many asbestos-containing products in the course of their manufacture, made virtually dust free. For example rubberised asbestos gaskets, lubric packings and dust-suppressed text and millboard are products which, because of a bonding effect of the materials of which they are compounded or treated, do not release harmful quantities of dust when handled or fabricated.

5.2. Enclosure and mechanisation.

Where it is not possible to prevent dust occurring during a process, every effort should be made to localize or enclose the dust-producing part of the process so that the dust does not escape into the workplace, or to devise mechanical means to avoid handling which would create dust involving personal exposure.



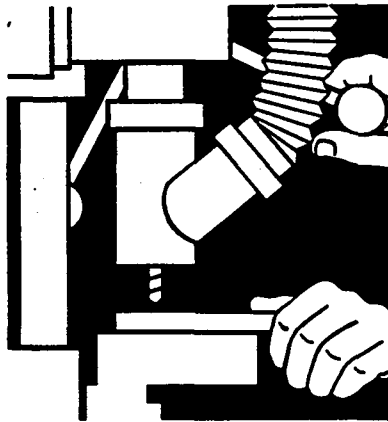
5.3. Partial enclosure with exhaust ventilation (dust extraction). Often total enclosure is not practicable. In such cases partial enclosure, together with exhaust ventilation, can be used. Even with totally enclosed systems, sufficient exhaust ventilation is necessary in order to provide negative pressure and avoid dust leakage from joints in the system.

5.4. Design of hoods. There are many varieties of enclosure hoods, booths, etc., which experience has shown to be effective for control; particular care is necessary in the design, which must take into account the capacity, air-speed and ventilation equipment used to avoid turbulence and the effect of operators' movements, as well as to provide adequate and safe access to the work.

Hoods should be fitted as near as possible to the source of the dust.

5.5. Exhaust ventilation. Extraction systems associated with the hoods or enclosures must be capable of removing all the dust that the process is delivering to the hood. High-volume, low-velocity systems are usually suitable for in-plant processes where a high degree of enclosure can be achieved.

When access to the work makes enclosure difficult or virtually impossible, expertly designed and tailor-made receptor hoods, combined with low-volume, high-velocity extraction, are usually found most suitable, and such systems are also most suitable for portable tools for site operations.



The design of extraction systems is a highly technical skill, and it is recommended that such work should be entrusted to specialists of sound professional standing.

5.6. Dust-collectors and filters. Exhaust ventilation systems should incorporate filters which separate asbestos dust from the air before the air is emitted to the atmosphere. The filtration should be so effective and reliable that harmful emissions of asbestos dust cannot be transmitted to the general environment or returned to the workplace. It is usually accepted that filtered air should not be readmitted to the workplace unless it can be ensured that the asbestos content of the returned air is not more than one tenth of the stipulated maximum dust concentration for the working environment.

5.7. Service and maintenance. Dust extraction equipment must be regularly checked and serviced to ensure that it continues to operate at its designed efficiency.

5.7.1. Dust control equipment should be inspected at regular intervals (but certainly not less than once a year) by a properly qualified technician, and a certificate of the effectiveness of the equipment should be obtained. It is often found convenient for such inspection to be included in the contract of the installers, ensuring that the equipment continues to operate in the manner and to the standard required in the original installation contract. At the same time it should also be a part of the general management of the plant that the departmental supervision is responsible for ensuring that the equipment is at all times operating in the manner intended. Continuous monitoring of large installations is recommended.

5.7.2. Asbestos dust collected by a unit must be regularly removed under strictly controlled hygienic conditions and disposed of in impermeable containers as described under the heading of waste disposal (paragraph 9).

6. Personal protection

6.1. Where it is impracticable by available techniques to control the emission of dust so as to prevent the possibility of inhalation (e.g. during maintenance, repair of exhaust equipment, removal of old asbestos lagging), personal protection must be provided by means of suitable respiratory protective equipment and protective clothing.

It should always be acknowledged that the use of such equipment should be regarded as a temporary solution to the problem of dust control or as an emergency measure.



6.2. Respiratory protective equipment. Many types are available. Competent authorities in different countries have different standards for classifying the range of concentrations for which a type of respirator is suitable. The following ranges are recommended:

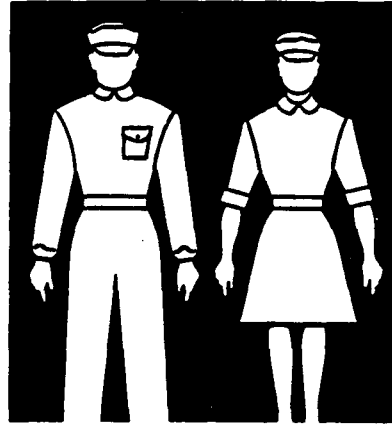
6.2.1. Concentrations up to 20 times the specified level; well-fitted respiratory equipment of the half-face-mask type are generally found to be suitable.

6.2.2. Where concentrations exceed the above level (as examples in 6.1.) more sophisticated equipment such as positive pressure respirators (where the fresh-air supply is fed by a small portable electric pump through a filter into the face-piece) should be used.

6.2.3. In very heavy concentrations direct airline breathing apparatus may be considered necessary.

6.3. When respiratory equipment is provided, it is essential that this should be individually fitted, that operatives are properly trained in the use of the equipment and understand the reasons why, and the occasions when, the equipment must be worn.

6.4. Such equipment should be issued to individuals for their exclusive personal use, and exchanged at regular and suitable intervals for cleaning and maintenance by suitably qualified personnel. Equipment when not in use should be stored in hygienic containers.

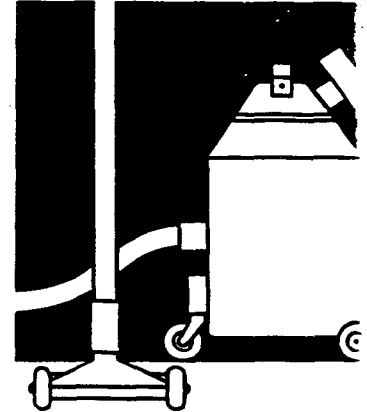


6.5. Protective clothing provided in situations where personal protection is necessary should be designed to prevent the deposition of asbestos dust on the personal clothing of the wearer. A variety of materials have been used successfully; the best type and design will depend on the nature of the operations.

6.6. Such clothing should be issued for the exclusive personal use of the wearer and exchanged for cleaning at such intervals as conditions of use necessitate.

6.7. Change rooms. Accommodation should be provided for changing into and out of the protective clothing, so that asbestos dust collected on the clothing does not in itself accumulate or contaminate the workers' own clothing.

Vacuum cleaning equipment should be made available so that dust collected on the overalls can be removed at the end of the work period before such clothing is taken off. On no account should this be done by the use of compressed air or dry brushing.



6.8. Laundering. The cleaning of protective clothing should be carried out under such conditions that the cleaners are not exposed to risk from any asbestos dust collected on the garments.

7. Cleaning of Premises and Plant

7.1. Wherever asbestos processes are being carried out, particular attention should be paid to regular cleaning of premises and plant, so that deposits of asbestos-containing dust do not accumulate.

7.2. Cleaning should be carried out with vacuum cleaning equipment of types which have been shown to be suitable for use with asbestos. In the absence of any official directives, industrial vacuum cleaners designed by well-established manufacturers may usually be considered suitable for asbestos, provided that they have filters of an adequate standard and have disposal bags which avoid the necessity for emptying the collected material.

7.3. Where such equipment is not available, or not suitable, cleaning can be carried out by wet methods which prevent the creation of dust during collection.

7.4. If such methods are not possible, cleaning should be arranged at times when other workers are not present and the cleaning personnel should be provided with suitable personal protective equipment.

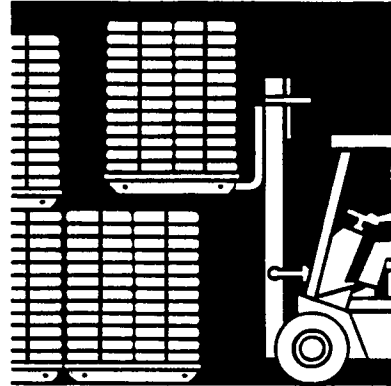
7.5. Every effort should be made to ensure a high standard of hygiene and general tidiness of the plant. Suitable receptacles should be provided for the collection of waste and scrap material and its regular removal to prevent accumulation and dust creation in the workplace.

8. Storage and Distribution of Asbestos Fibres and Asbestos- Containing Materials

8.1. Asbestos fibres, mixtures of fibrous materials, process waste and materials in process and in transit, should be contained in such a way that harmful quantities of asbestos dust cannot be emitted during storage and distribution.

8.2. Containers, such as impermeable bags, and/or methods of packing should be such as to prevent the escape of asbestos dust and to facilitate handling in such a manner that the risk of damage to the package and consequent spillage would be reduced to a minimum.

8.3. Wherever possible, asbestos fibre should be transported in containers and palletised to avoid the use of hooks in unloading and handling.



8.4. Containers of asbestos fibre or asbestos-containing materials of a dusty nature, and dusty waste materials, including empty bags previously containing asbestos fibres, should be identified so that persons handling the material are informed of the nature of the contents and of the need for taking suitable precautions.

Packaging, Handling and Transportation

**Recommended Control
Procedure No. 4**

**1. Products and Operations Covered
by These Recommendations**

- 1.1 Chrysotile asbestos fibre
- 1.2 Amosite asbestos fibre
- 1.3 Crocidolite asbestos fibre
- 1.4 Fibrous anthophyllite
- 1.5 Any other asbestos fibre or mixtures thereof

These recommendations cover the handling during loading and unloading consignments of fibre at port or other despatch or receiving depot, storage on ship, road vehicle or railway wagon, transport between mine and point of ultimate consumption, storage and disposal.

2. Basic Requirements

2.1 Today it is known that the inhalation of fine asbestos dust may — under certain circumstances — cause serious bodily harm. Many asbestos fibre producers therefore draw attention to the need for suitable precautions with a distinct warning label on each bag; some draw attention to the responsibility for proper control in their sales contracts.

2.2 Consumers of asbestos fibre (i.e. manufacturers of asbestos products) become responsible for control of harmful asbestos dust emission as soon as the asbestos fibre comes into their possession. (This may be at any stage from leaving the mine onwards according to the conditions of purchase.) Handling consignments of fibre in a dockyard, on ships, in transit and in store can result in dust hazards from spillage unless good packaging and handling methods are employed. The problem of dust control at a factory during the initial stages of most manufacturing processes can be greatly relieved by well-designed packaging of the unprocessed fibre.

2.3 Asbestos fibre producers have developed a number of methods of packaging to ensure the safe and spillage-free arrival of asbestos fibre at its final destination. These methods of packaging are designed to permit various techniques of handling, transportation and storage which minimise the possibility of damage to bags and consequent spillage.

2.4 The disposal of empty asbestos fibre bags so that they may not be reused for other purposes is a feature of control which must not be overlooked.

3. Packing — Initial Packing of Fibre

3.1 Type of bag. Asbestos fibres should always be packed in impermeable bags. The following materials are used:

- Woven and coated polyethylene or polypropylene.
- Multiwall impermeable paper and multiwall water-soluble paper.

3.2 Polyethylene or polypropylene are recommended because of their much greater resistance to damage during handling. The coated exterior surface of the woven plastic bags is less inclined to slip when stacked than paper bags.

3.3 Multiwall, water-soluble paper bags are not recommended because of their vulnerability to tearing. They are used in special situations where the bags are fed into a wet process without opening them. Because the bags are water soluble they are consumed in the end product. However, this system is not acceptable unless the bags are carefully transported in closed railway wagons, containers or vans without transhipment.

3.4 The plastic used should preferably be polyethylene, this material being more convenient for recycling than polypropylene. However, polypropylene is the best second choice depending on availability.

3.5 An ultraviolet inhibitor should be added to the plastic material, which allows some exposure to sunlight without protective cover, and ensures that the plastic bags retain their strength even though they may be exposed to sunlight during transhipment or temporary storage at ports. However, once a shipment has been delivered to its final destination it is essential that the bags be protected from further exposure to sunlight. This can be accomplished by storage in a proper warehouse or by the use of such protective devices as tarpaulins, rubber or black plastic sheeting.

3.6 Closure of bags may be by stitching or heat sealing. Stitching at approximately two stitches per centimetre is recommended. Where plastic bags are recycled, the cotton thread may cause problems; in such cases polyester thread should be used for sewing if the bags cannot be heat-sealed.

3.7 Bags are usually pressure packed or partially pressure packed for subsequent press-baling, or 'high density' blocked. This latter method, developed by a Canadian producer for chrysotile fibre, consists of compression of the fibre into a solid block (about half the volume of a normal pressure-packed bag), individually wrapped in water-soluble paper for subsequent shrink — or stretch — wrapping with plastic film onto pallets.

3.8 Bags should be printed with a health warning label incorporating the 'a' symbol recommended by AIA. (See Fig. 1.)

Figure 1



4. Packaging for Consignment

The prime aim of all types of packaging for consignment is to eliminate individual handling of bags wherever possible and to minimise damage to bags which would result in spillage.

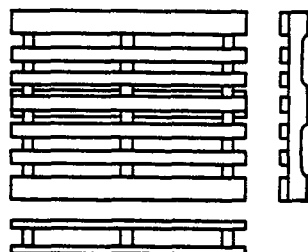
4.1 Pallets

4.1.1 For the transport of small tonnages in break bulk vessels (i.e. those carrying mixed cargoes) the bags should be palletised in an interlocked fashion. This does not apply to bags of amphibole asbestos which are normally too large to permit interlocking on standard pallets. Furthermore, the bags should be securely attached to the pallet by using such techniques as strapping, glue locking and shrink — or stretch — wrapping.

4.1.2 By using containers it is possible to design the loading so that 100 per cent of each shipment is on pallets. It is undesirable to double-stack small units in the container because the top pallets can cause damage to the lower units during transport. Depending on bag size, weight and container capacity, this will generally mean forming pallet loads to consist of seven to nine interlocked layers. The addition of plastic stretch or shrink wrapping is sufficient to avoid bag movement.

4.1.3 In general the size and design of the pallet is made to suit the asbestos bags and the type of shipment involved. For example, small tonnages in break bulk vessels should be on pallets similar to the sketch shown at Fig. 2. The actual dimensions of the pallet should be such that the bags slightly overhang the pallet on all sides. If the pallet protrudes beyond the bags it can easily damage bags in an adjacent pallet load. It should also be a 'wing' style as shown at Fig. 2. This is to permit easy lifting with slings and to assist in anchoring shrink or stretch wrapping.

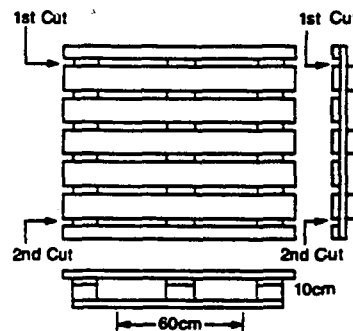
Figure 2



4.1.4 The afore-mentioned pallet is also suitable for loading in containers, vans and railway wagons, because it can be picked up from all four sides with a lift truck.

4.1.5 Another style which is also suitable for containers and has gained wide acceptance is shown at Fig. 3

Figure 3



4.1.6 This pallet should have the following dimensions:

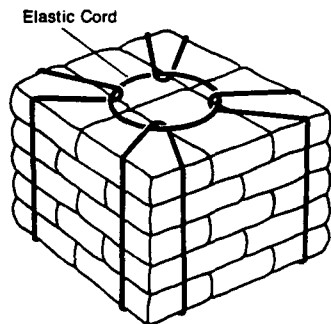
- Four entries, 10 cm high
- Min. 60 cm width of opening on each side allowing the lifting by any forklift

The two wings may be cut easily to suit for the re-use of the pallet for finished products. For example, a pallet of size 100 x 120 cm can be altered with one cut to 90 x 120 cm or with two cuts to 80 x 120 cm (standard European size). Thus, the rather high pallet costs are offset and the disposal problem of the one-way pallet presently in use is solved.

4.2 Marino slings

4.2.1 For charter shipments where several thousand tons of asbestos are stowed in a vessel, experience has shown that pallets should not be used because the wood may damage bags during loading and unloading or through the movement of cargo during the voyage. These problems can be overcome by the use of disposable marino slings (see Fig. 4). A design which has been found very satisfactory for use with chrysotile asbestos (but which is not generally recommended for use with amphibole asbestos) incorporates the use of webbing straps and has a plastic sheet embedded in the bottom to create a platform on which a unit of bags is placed. These units must be made up of interlocked bags and not exceed five layers high. Each unit should then be stretch wrapped to ensure maximum stability.

Figure 4



The four corner straps should be held together by an elastic cord to keep them available for lifting. Otherwise stevedores may have to search for them, which delays unloading.

4.2.2 For the most efficient handling of these units, spreader devices of particular design have been created. These permit the handling of multiple units at one time, thereby greatly reducing the time required to load and unload from the vessel.

4.2.3 It is also important to understand that once the units in marino slings are removed from the ship they are placed on pallets for further handling by fork-lift truck.

4.3 Plastic cover

4.3.1 In order to further protect the bags against damage and to bring stability to the unit, a plastic cover should be added. It should be used for units on wooden pallets as well as for units in marino slings.

4.3.2 There are two basic types of plastic covers, namely shrink-wrapping and stretch-wrapping. The shrink-wrapping has the advantage of being a complete cover for the top and four sides of the unit. It is heated causing it to shrink and tighten around the unit ensuring very good stability. However, the heat may in some cases cause the cover and bags to stick together. To avoid this a satisfactory alternative is stretch-wrapping. This form of wrapping generally covers only the four sides of the unit. If it is important that the top be protected (in case of double stacking), a top cover can be added and held in position by the stretch-wrapping.

4.3.3 An ultra-violet inhibitor should be added to both types of wrapping to increase their outdoor resistance further. However, this will only prolong their resistance to sunlight for a short period of time (e.g. a few months). Neither the stretch- nor the shrink-wrapped units are weather proof and they should therefore be covered if outside storage is necessary.

4.3.4 An alternative form of cover recommended for use with palletised units of amphibole asbestos is a heavy-gauge plastic cover which fits over the top and four sides of the unit and is strapped in position.

4.4 'Big bags' and 'tank trucks'

Two methods have been developed to handle asbestos in bulk form. These are 'big (balloon) bags' and 'tank trucks', which have a limited application; they are only capable of handling short

asbestos fibres and are only economical for transporting short distances. It is also necessary that the receiving plant is suitably equipped to handle each delivery in a controlled manner.

5. Transportation

5.1 Closed vehicles

5.1.1 The ideal methods of transporting asbestos are palletised and plastic-wrapped units loaded in either closed road vehicles or railway cars for overland and closed containers for overseas shipment. As the doors are closed at the asbestos mine or port and opened only when the shipment arrives at the user plant, any spillage of asbestos during transport is completely avoided.

5.1.2 The direct unloading of these vehicles by fork-lift truck may not be possible unless a ramp is available. If not, a satisfactory alternative is to put the palletised units to the doorway with a *trans-pallet* where they can easily be picked up with a fork-lift truck. More expensive solutions are the use of mobile ramps or special trailers which lift the containers to the ground.

5.2 Alternatives

5.2.1 Small overseas shipments which cannot be made in containers should nevertheless be palletised and plastic covered and loaded in break bulk vessels. (See 4.1.1.)

5.2.2 Large overseas shipments which cannot be transported in containers should be unitised in marino slings and stretch-wrapped. However, this method of transport can only be successful by choosing the proper type of vessel. The ideal ship is box type single-decked, having vertical sides and full-width hatches. Whilst the units are being loaded aboard ship, all significant empty spaces must be filled by using disposable inflatable dunnage.

5.2.3 All vehicles used for the transport of asbestos must be properly cleaned after the unloading process. The recommended procedures are by dry vacuuming or wet sweeping, and personnel concerned should be provided with suitable protection when harmful dust emission cannot be avoided.

6. Warehousing

The following preparations must be completed before final storage:

6.1 All bags should be palletised.

6.2 All units must be carefully inspected for damage and cleanliness.

6.3 All damaged bags must be immediately repaired. (See 7.)

6.4 All units having loose asbestos or other debris on them must be cleaned by dry vacuum and the worker should be provided with suitable protection.

6.5 The final storage ideally should be in a dry warehouse. If outside storage cannot be avoided the units must be protected by such devices as tarpaulins, rubber or black plastic sheeting.

7. Bag Repair

It is very important to instruct workers who handle asbestos units in ports or warehouses that they should repair any damaged bag immediately with appropriate adhesive tape. Otherwise the asbestos spilled during handling will defeat the efforts which are described in these recommendations.

8. Bag Opening

This is a complex subject covering a multiplicity of methods of opening of the several different forms in which asbestos is packaged and will be the subject of a Recommended Control Procedure to be published separately.

9. Disposal of Packing Materials

9.1 It is important to recognise that empty asbestos bags and wrapping contain a small residue of loose asbestos. Therefore they must be carefully handled in a manner to avoid creating dust, and disposed of by one of the methods listed below:

They are:

9.1.1 Grinding for inclusion in the end product.

9.1.2 Melting for safe disposal in normal waste-dumps.

9.1.3 Recycling into secondary plastic products.

9.1.4 Bagging.

9.2 Grinding

Chopping equipment has been developed which can cut the plastic materials into particles small enough to permit their inclusion in some end products. It is important to note that the empty bags and wrapping material amount to about 0.5 per cent of the asbestos. If the end product, such as asbestos cement sheets, contains 10 per cent asbestos, the plastic then becomes only .05 per cent of the final product. Two criteria are important for this concept to be successful. The plastic must be compatible with the process and other ingredients in the end product, and the plastic particles must be cut fine enough to ensure that they disperse properly.

9.3 Melting

If the end product cannot accept the plastic, an alternative is to melt it. By melting the empty plastic bags and wrappers, the asbestos residue becomes embedded in the melted plastic. As a result of the asbestos being 'locked in', it should be possible to dispose of this material in any normal waste dump. Specific low-volume melting equipment, which can be employed at individual bag-opening stations, is in development.

9.4 Recycling

Work has now been completed which demonstrates that the melted plastic material can also be incorporated into secondary plastic applications. For example, it can be added as an ingredient in the manufacture of certain plastic pipe or moulded parts where recycled plastic is permissible. It is recognised that the cost of the moulding equipment is quite high and would require a large usage of asbestos bags to justify the installation of equipment at the asbestos-using plant. Therefore, the final choice of whether to re-use the plastic in this manner will depend on the economics of the specific situation.

9.5 Bagging

Unless one of the above three methods can be adopted, used packing materials should be collected under suitable dust control conditions into an impermeable container (such as new, unused plastic bags) immediately after being emptied. Such containers should be properly sealed and despatched for disposal at authorised waste dumps. In no case should bags which have contained asbestos fibre be re-used in any other manner than described above. (See also AIA RCP3 — Asbestos Waste Materials.)

10. General

Further information on any aspect of safe working with asbestos will gladly be supplied by the Asbestos International Association or by any of the Associate members whose addresses are contained elsewhere in this publication.

October 1979

Dust Control

Introduction

Asbestos fibre is a remarkable and useful material in modern-day technology. Long exposure and relatively high concentrations cause various diseases. Process changes, leaktight equipment, industrial exhaust systems and dust filters are used to control dust exposures in mining and milling and manufacturing. Examples from asbestos mills, asbestos-cement pipe plants and textile operations are given. Belt conveyors, vibrating screens, bag opening stations, machine hoods, and textile cards are discussed. Duct design and filter selection are discussed.

Asbestos Fibre

Asbestos fibre is a remarkable material. It is literally a fibrous form of rock. It has the chemical composition of the rock with which it is associated. Table I lists some of the physical properties of the three most important types of asbestos fiber as well as those of the more common natural and man-made fibres. The greater surface area and the remarkably small fibre diameters of asbestos fibre are apparent. Two other properties that render asbestos fibres unique are their temperature resistance and their relative inertness to some types of chemical attack.

Asbestos fibres, although rocklike in chemical composition, are flexible enough to be spun into yarns and woven into cloths with heat stability known to the ancient Egyptians and Greeks.

Of the three forms of asbestos listed in the table, chrysotile is the most valuable economically in the United States, where it represents 95% of the asbestos fiber used annually. In Quebec, Canada, where most of the fibre imported into the United States is mined, the asbestos is graded by numbers from 1 through 7. Group 7 represents the shortest fibre lengths and the lowest price; both length and cost increase with each group to group 3, which is suitable for spinning into yarn. Groups 1 and 2 are hand-cobbed fibres, produced in such small quantity as to have small economic importance.

Health Hazards

The first reports of asbestos-related disease were described as early as 1907. However, it was not until 1930, when Merewether and Price published an epidemiological study that showed a relationship among years of exposure, dustiness of the environment, and lung fibrosis, that authorities in England acted to institute control measures. Increasing years of exposure and increased dust concentrations both contributed to increased lung disease. Measures were instituted at that time to reduce dust exposures by means of exhaust ventilation and enclosures.

Merewether in 1947, Cloyne in 1951, and Doll in 1955 published studies that purported to show the relationship between exposure to asbestos dust and lung cancer. Finally, in 1960, Wagner reported a relationship between crocidolite exposure in South Africa and a rare cancer known as mesothelioma.

All the risks of disease caused by exposures to asbestos fibre and disease appear to be related to length of time of exposure or time after first exposure and degree of exposure. Although the general population is exposed to extremely small (compared to occupational exposures) concentration of the ubiquitous asbestos fibre, the National Academy of Sciences in their study, *Biologic Effects of Atmospheric Pollutants — Asbestos*, has concluded that "at present there is no evidence that the small number of fibres found in most members of the general population affect health or longevity."

The mechanism by which asbestos fibre cause disease is not well understood. There are unsupported theories that synergistic effects due to cocarcinogens are responsible. A relatively new theory postulates that the shape and size of fibres — critical diameters and lengths are responsible.

Unfortunately, owing to changing test methods, errors in test methods, and the long period between exposure and the onset of disease symptoms, it is extremely difficult for an engineer to

Table I

Properties of Asbestos Fibres
Compared with those of Organic Fibres

Type	Color	Surface Area (sq cm/gm)	Tensile Strength (psi)	Fibre Diameter (μ m)
Chrysotile	White	130,000-220,000	80,000-100,000	0.02
Crocidolite	Blue	—	100,000-300,000	0.03
Amosite	Yellowish brown	—	16,000 ^a -90,000	0.03
Common natural and man-made fibers		3,000-10,000	80,000 ^a	10-20

^aCotton.

correlate control methods with the environment required to reduce health effects to a minimum. In England, dust counting was done by thermal precipitator methods. In the United States, the Greenburg-Smith impinger method was used. In recent years, the membrane filter method of dust counting has taken over in the asbestos industry. Controversies rage as to whether acceptable limits are 5, 2, or 1 fibre per cubic centimeter. Since it is postulated that certain health effects take as long as thirty years to develop, any engineering improvements developed today must wait for thirty years to be fully evaluated. It is extremely difficult to look back for guidance. In no case with which the authors are familiar have workers in the present asbestos industry been living in an environment that has been stable. There has been a constant series of improvements. We know that control methods of twenty and thirty years ago are unacceptable. How about methods of ten and fifteen years ago? How about today's methods? Only time, and long periods of time, will tell.

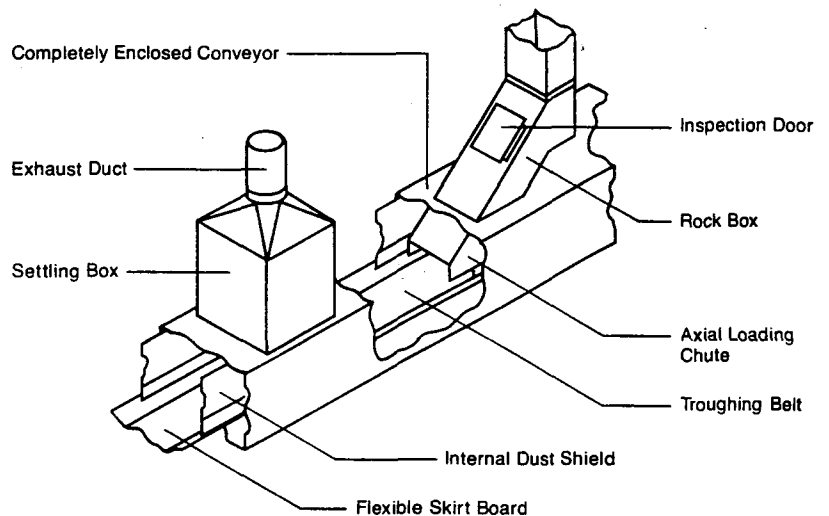
In such an atmosphere, the only moral stance is to use the best methods of control available to us and to constantly seek to improve those methods.

Elements of Dust Control

The methods used in the asbestos industry for the control of asbestos are the classical methods used by dust control engineers in all industry:

- Enclose any dust source as fully as possible.
- Place all dust-producing equipment under negative pressure by connecting to exhaust ventilation of adequate capacity.
- Design and install a properly designed duct system.
- Filter the dust-laden air adequately.
- Move the air with fans of the proper types, having adequate volume and pressure capabilities.
- Where normal principles of dust control are difficult or expensive to apply, process changes must be considered.

Figure 1. Conveyor Belt Enclosure.



Describing how all the principles of dust control are applied to the field of asbestos mining and manufacturing is a massive job beyond the scope of one paper. Examples illustrating the principles given will be described. Some of the methods are unusual and may be fruitfully applied to other industries.

Mining

The two most widely used pieces of equipment in asbestos mills are troughing belt conveyors and vibrating screens. In early milling operations, before about thirty years ago, these pieces of equipment were not covered to prevent dust generation in the mills.

The dust problems caused by belt conveyors are as follows:

- Dry materials carried on the belt conveyor, at high speed, generate dust in the mill.
- Chutes feeding either from one belt to another, or from other equipment onto the belt, generate dust.

- The return belt is a serious source of dust contamination in asbestos mills. Dust carried on the bottom of the return belt is engraved on every idler carrying the return belt. Each idler becomes a source of dust generation.

Conveyor Enclosures

Figure 1 shows an enclosure that is often used to enclose the top portion of a troughing conveyor. It is particularly used at the location of chutes feeding either from one belt to another or from other equipment onto the troughing conveyor. This enclosure normally has sheet metal section that encloses the belt on three sides. Rubber skirting on the two vertical sides bears against the surface of the belt. This skirting is adequate to prevent dusting from the material that rides on the belt. Of course, the belt width and the speed of the belt must be adequate to carry the material load within the skirt boards; otherwise the value of the skirting is negated by material forcing its way under the rubber skirting and out of the conveyor enclosure.

Chutes feeding the conveyor should feed axially onto the belt. The material should not be forced against the skirting. If possible, the chute should also be arranged so that a rock box may be placed at the base of the chute. Long, vertical chutes must be avoided. Chutes should be run at angles so as to reduce the velocity of material feeding onto the conveyor.

The return belt must be cleaned by scrapers or by rotating brushes that bear against the head pulley, as shown in Figure 2. However, in spite of all cleaning equipment on the market, the return belt often carries dust to the idlers. In extreme cases, it is necessary to enclose the return belt with a complete leak-tight enclosure and to clean that enclosure by means of scraper conveyors.

Dust connections are used at strategic points on belt conveyor enclosures. These dust connections should always be attached to the conveyor enclosures by means of a settling box, which reduces the velocity so as to minimize the exhaust of material and especially valuable products. These dust connections should generally be installed in areas where conveyors feed from one to the other or where several chutes feed onto the conveyor. The movement of material at the feed points generates windage and air pressure that must be relieved. Dust connections should also be installed at points where the conveyor enclosure ends, as serious dust pumping into the mill can be caused by material exiting from the enclosure.

Screens

Vibrating screens have been notorious dust generators. Considerable progress has been made in enclosing screens with leak-tight enclosures and installing flexible connections, generally made of nylon cloth, which attach the vibrating screen to the feed chute. Similarly, the chutes carrying away the various screen products, including undersize and middlings, are also attached to their respective chutes by means of similar

Figure 2. Conveyor Belt Scraper.

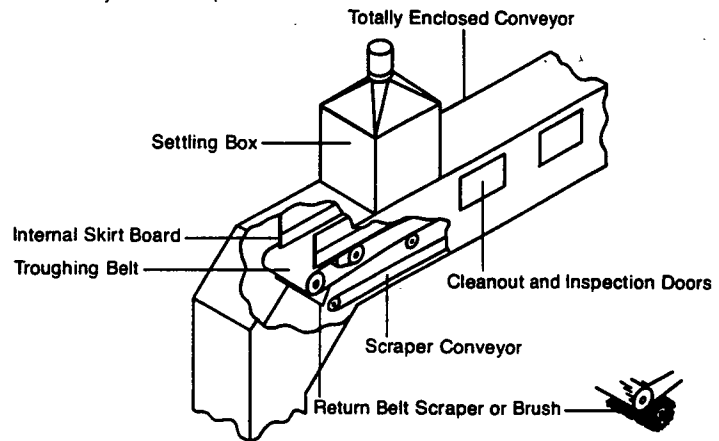
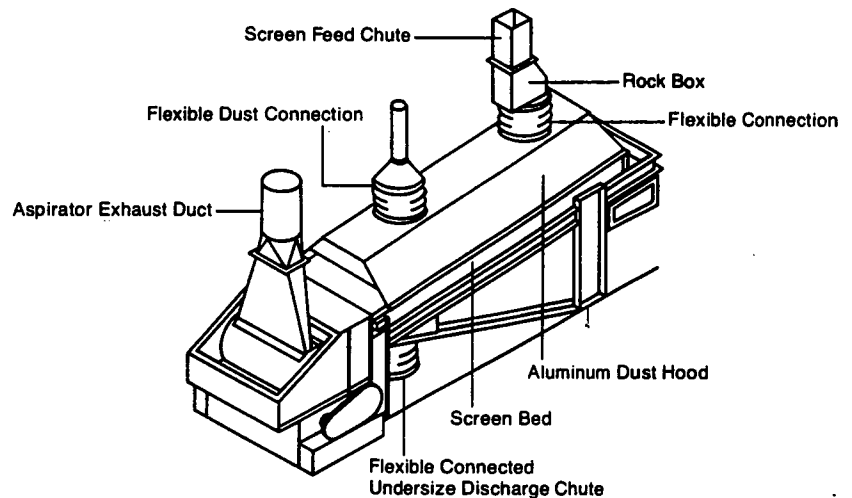


Figure 3. Gyrotory Fiber Screen and Rotary Aspirator.



flexible nylon cloth. The dust connection to the screen cover may be a 6-inch or 7-inch (15.2 or 17.8 cm) pipe exhausting about 800 to 1000 cubic feet per minute (22.7 to 28.3 m³/min) from screens about 4 feet by 10 feet (1.2m by 3.0m). The pipe is connected by means of a large, flexible connector, reducing the velocity at the connector to approximately 200 to 300 feet per

minute (61.0 to 91.4 m³/min). Figure 3 shows a typical screen cover.

Chutes

Asbestos mills are frequently multistoried buildings in order to take advantage of gravity flow in the movement of the ore and finished products. Literally miles of chutes carry the material in process.

The design of the chutes is critical in determining the cleanliness of an asbestos mill. First and foremost, they must be designed to carry the required quantities without plugging. This specification requires that the chutes be adequate in cross section and be run at angles that cause material flow and minimize hang-ups. Long, straight drops must be avoided because a change of direction at the base of such a run will cause plugging or will pump large quantities of dust-laden air that will contaminate the mill.

Finally, the chutes must be free of leaks yet allow ready access in case of blockage. Access doors and poke holes must be provided but must be leak-tight in initial construction and remain so in use.

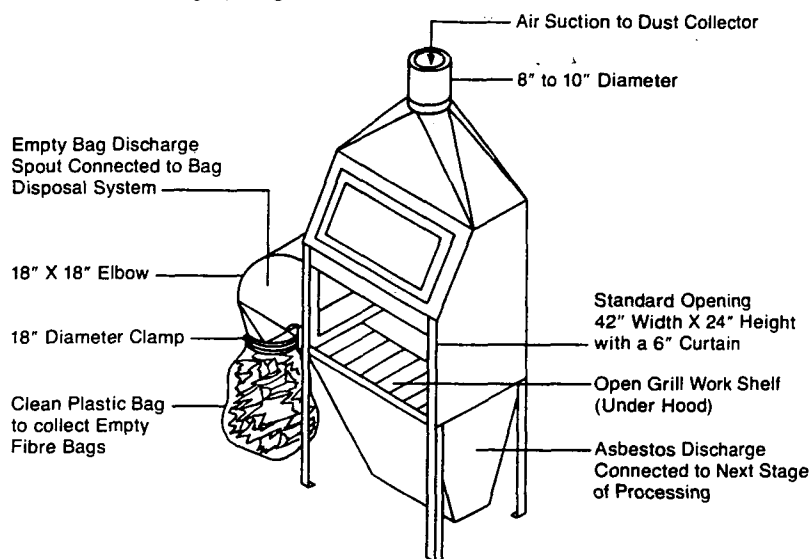
Where only asbestos fibre is handled, chutes may be of 10-gauge, all-welded steel, on the bottom and sides. The top cover can be even lighter gauge. However, the seams must be leak-tight. Cloth tape may be used for this purpose.

Where ore-containing rocks must be handled in chutes, they may be 3/16-inch or 1/4-inch (.48 or .64 cm) plate bolted and gasketed. For abrasion resistance, Ni-Hard liners may be required, since dust leakage may be due to holes worn in the chutes, as well as other leaks.

Packers

Most of the mill operations in the separation, grading, and mixing of asbestos fibres are done without human aid. However, the packing of the finished fibre used to be a manual operation. The pressure packer, developed by Johns-Manville, eliminated most of the human handling. The fiber is weighed, compressed, and forced into a paper bag for shipment with a minimum of human effort.

Figure 4. Asbestos Fiber Bag-Opening Station



Manufacturing

Most manufacturing operations receive pressure-packed bags of asbestos fibre in 45 or 50 kg bags that are palletized and shipped in boxcars or containers. Dust control starts with the unloading operation of the boxcar or container. Care in shipment and unloading is required to eliminate bag breakage and contamination of the boxcar or container. Dirty bags should be repaired and vacuum cleaned before storage in warehouse areas.

The pressure-packed bags are brought to manufacturing areas and opened in bag-opening stations, as shown in Figure 4. The pressure-packed bag must be put in the bag-opening stations before the paper or polyethylene bag is slit. An in-draft of approximately 200 feet per minute (61.0 m/min.) is maintained in this station by the dust pipe.

The fibre cake may be fed into an opening machine or into the boot of an elevator. The opened bag may be charged into a clean bag, a shredder, or a large (16-inch-diameter) (40.6 cm)

bag-conveying pipe. Machines may be necessary to break up the pressure-packed cake so that it can be handled in the manufacturing process. This machine may feed into a large ventilated opening such as the boot of an elevator, or into a low-pressure pneumatic conveying system which controls the windage from the machine

Elevators of the normal belt type, used to convey solid materials in a manufacturing plant, are suitable in asbestos manufacturing. The elevator must be of leak-tight construction. Special attention should be paid to access doors and shaft seals. Normal practice in asbestos manufacturing is to install dust connections at the point where the material is fed into the elevator. A dust connection at the top of the elevator, connected to a settling chamber which avoids loss of material, maintains an in-draft into the elevator. Opened fibre is often conveyed to "live-bottom" bins, to avoid manual handling. Automatic weighing may be used to feed fibre from these bins to the process.

In asbestos-cement pipe plants, a negative-pressure conveying system carrying fibre from willows to "live-bottom" bins maintains a negative pressure in the system to avoid leaks into the plant.

Finishing machines of various types are enclosed with hoods and connected by dust pipes to dust collecting systems. Figure 5 shows a hood enclosure on a pipe lathe. Figure 6 shows a similar enclosure on a coupling lathe.

In the manufacturing of asbestos textiles, blending and carding operations have been serious sources of asbestos dust. Through process modifications, blending may be eliminated and pressure-packed fibre fed directly into double Bramwell-type feeders at the card. Figure 7 shows the enclosures and the dust pipes normally installed on a typical asbestos card.

The organic lap is fed in the form of rolls into the card, avoiding the difficult problem of conveying blends containing organic fibre to the feed box at a card machine. Scraper conveyors, installed below the card, carry accumulations of asbestos fibre blend back into the card operation.

Wetting

In mining operations, particularly in ore processing and crushing, wet ore causes much less of a dust problem than dry ore. This observation has been applied to manufacturing. In textile manufacturing, wetting the yarn reduces dust generated in twisting and in weaving.

Wet cutting and fibre opening have been applied to reduce the dust generated in manufacturing operations.

Figure 5. Pipe Lathe Dust Hood.

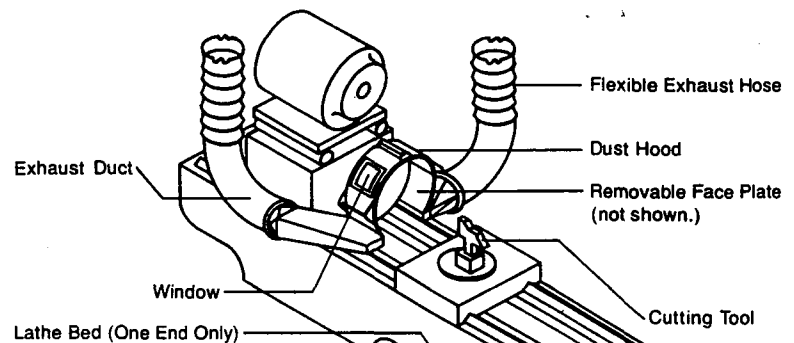


Figure 6. Coupling Lathe Dust Hood

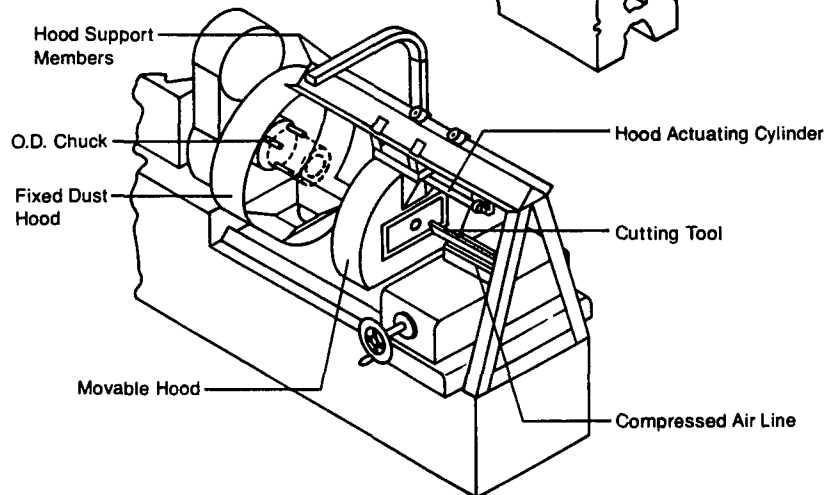
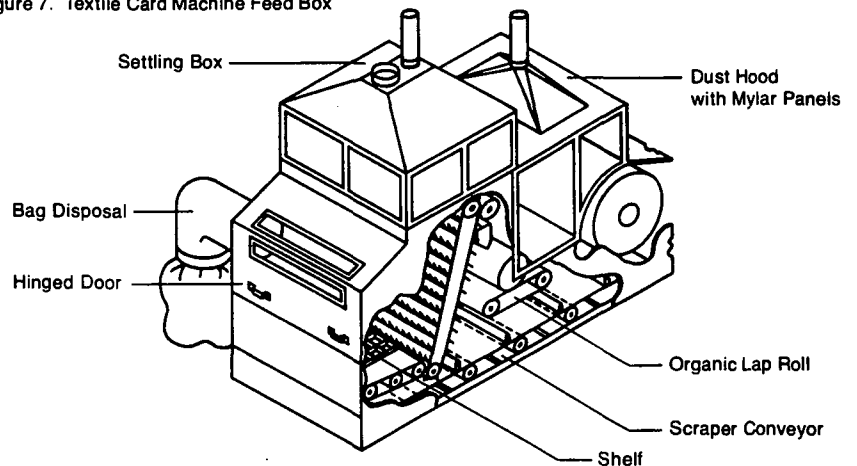


Figure 7. Textile Card Machine Feed Box



Exhaust Ventilation

Equipment that handles asbestos fibre must be designed as leak-tight as possible. This includes bins, elevators, conveyor enclosures, screen covers, screw conveyors, chutes, and conveying ducts. However, it is impractical to design equipment that is leak-tight at installation and from then until the end of the useful life of the equipment. Exhaust connections are therefore installed to maintain all leaks and openings under negative pressure so that room air may leak into the asbestos system instead of dust leaking out.

The number of variables affecting the amount of air to be exhausted is so great that only experience can indicate the amount of exhaust to be applied to each of the dust producers in the industry. However, the principle is an important one. It is desirable to maintain all parts of asbestos control systems under negative pressure. It is more desirable to carry air under negative pressure than to pressurize an asbestos dust system.

Duct Design

Velocities. Ducts are designed to carry air at velocities ranging from 3800 to 4200 feet per minute (1158.2 to 1280.2 m/min.) to 5000 to 5500 feet per minute (1524.0 to 1676.4 m/min.). The lower velocities are used for dust control ducts where relatively small concentrations of well-opened fibre must be carried, such as the dust control systems at textile plants. The highest velocities are used where space is restricted and where large chunks of material must be carried, as in dust systems for the machines that cut and shape asbestos-cement pipe.

Most systems, including low-pressure pneumatic conveying systems, function well at duct velocities of 4000 to 4500 feet per minute (1219.2 to 1371.6m/min).

Dust Risers. In multistoried asbestos mills, a practice has developed where vertical risers that have no carrying velocity are installed. The main value of these risers is to allow flexibility in the mill. Duct connections may be added in future years with no concern for settlement or overloading the riser. At the base of the riser, a rotary valve must be installed to remove settled material.

Materials of Construction. Ducts are generally built of sheet steel, black or galvanized. Table II shows the sheet metal gauges commonly used for most duct sizes. These gauges are suitable for most average-duty dust systems. For heavier duty and more abrasion resistance, elbows may be made of 14-gauge welded construction. They may be square, with a removable back plate, sometimes protected by suitable rubber linings.

Since ducts are generally round for dust control work, transitions are needed to connect the square elbows with removable back plates to the ducts. The transitions and the duct following the transitions must be rubber-lined. Fittings, including branch entries, will wear rapidly in abrasive service and must also be rubber-lined.

Where abrasion is a problem, all-welded steel ducts of 14-gauge and 12-gauge steel are used.

Table II
Sheet Metal Gauges
for Duct Handling Asbestos Fibre

Diameter Straight Duct	U.S. Standard Gauge Steel Duct
4-8	20
9-18	18
20-30	16
31-40	14
41 & over	14

Details of Construction and Design.

Although many specifications for duct construction and design may be found in standard reference books such as *Industrial Ventilation*, issued by the American Conference of Governmental Industrial Hygienists, some of the most common specifications that are violated and cause field problems bear repeating here.

Main ducts should be sized so that the area of the main is 10 to 20% greater than the sum of the area of branches connected to them. Main ducts should be laid out with a minimum number of bends and offsets — preferably none. Bear in mind that the flow of air does not follow the wishes of a designer but rather the following principle: The pressure drop between every opening in a system and the fan shall be equal. Thus, a long run of small-diameter duct will have less air than designed flowing in it, while short runs of large-diameter ducts will have more air than designed.

Blast gates are of limited utility in correcting unbalanced systems. They are misused more often than they are helpful.

No branch entry to a main shall be installed at an entry angle greater than 45 degrees. Entry angles of 90 degrees should never be used. Branch entries shall enter mains at the side or top, never at the bottom.

Elbows shall have a center-line radius of two times the duct diameter. They shall be made of five, seven, or more pieces.

Seams of ducts must be made leak-tight by soldering, tape, flanges or welding.

Air Filtration

Cyclones, wet collectors, fabric filters, high-energy scrubbers, and electrostatic precipitators have all been used to filter asbestos fiber discharges from mines, mills, and manufacturing plants. Cyclones or centrifugal separators are installed today in asbestos mills and manufacturing plants. They are widely employed both in ore-drying installations and in product-conveying systems, in asbestos mills. In general, they are used for the collection of relatively large quantities of product. The fibres passing out of such collectors are of little commercial value. Cyclones are not considered to be adequate in efficiency as a final filter. As a prefilter, they help to reduce the material concentration entering more efficient filters.

Low-energy scrubbers have been used in dust systems in asbestos cement plants and on ore dryers in asbestos mills. In both applications they are more efficient than cyclones, but not efficient enough to prevent visual dust discharges. In addition, they suffer from plugging, freeze-up, and corrosion problems. At present, low-energy scrubbers are not widely used for asbestos fiber filtration, nor are they considered adequate in efficiency.

Fabric filters are widely used in asbestos fiber filtration. They are found in asbestos mills and in manufacturing plants. A separate report on fabric filters for asbestos fibre filtration was presented at the Air Pollution Control Association National Convention in Denver in June, 1974. Fabric filters have been successfully applied to ore dryers where corrosion problems, due to combustion gases and sulfur dioxide, had to be solved. Moisture problems, due to condensation, also had to be minimized to make this application work.

Data have been collected to show that fabric filters made of cotton sateen cloth are more efficient than filters made of various synthetics. Where possible, cotton cloth should be used in asbestos dust filters. Of course, temperature and corrosion problems will dictate the use of various synthetics despite reduced efficiency.

High-energy scrubbers are used today only where moisture problems preclude the use of fabric filters. There are few examples of such applications. Scrubbers may become somewhat more prevalent, but it is not believed that they will be competitive with fabric filters.

There are few instances of electrostatic precipitators in the asbestos field. In general, small electrostatic precipitators are much more expensive than fabric filters. In the old Johns-Manville Jeffrey Mills, there was a high-voltage electrostatic precipitator that filtered about 1,400,000 cfm (39,648 m³/min). Its efficiency was poor, about 70%. At present, a fabric filter is filtering about 5,000,000 cfm (141,600 m³/min). Its efficiency exceeds 99.99%. In addition to numerous small filters, there is one on the ore dryers filtering 700,000 cfm (19,824 m³/min) and a normal ambient temperature filter filtering 600,000 cfm (16,992 m³/min).

Fans and Fan Systems

It is certainly preferable to operate fan systems that control asbestos fibre dust so that the entire system is under negative pressure. All leaks would, therefore, leak room air into the system instead of leaking dust out. In that event, the system fans are located on the clean-air side of filters. Fans used in that location may be air-foil bladed or backwardly curved fans to save power. In small systems, material-handling fans with "air" wheels are also used.

In some instances, where it is desirable to simplify systems or to reduce costs, filters have been operated under positive pressure with fans handling dust-laden air. Fans in that location are

radial-wheel, material-handling fans. Of course, the system following the fan, and the fan itself, must be completely leak-tight.

Vacuum Cleaning Systems

Regulations recently promulgated prohibit the use of brooms and compressed air to clean dust off equipment in plants and mines that use or manufacture asbestos fibres. Effective and well-designed vacuum cleaning equipment is required.

There are numerous types of portable vacuum cleaning units on the market. They range from the great array of unit suitable for household use to large, heavy-duty units designed primarily for industrial work. Most of the light-duty units available on the market have no place in industrial plants.

- Tools and hose must be 1½ or 2 inches (3.8 or 5.1 cm) in diameter. Smaller equipment cleans too slowly. Larger equipment is too unwieldy.
- The static pressure in the 1½ or 2-inch (3.8 or 5.1 cm) pipe of a tool connector to a 25-foot (7.6 m) length of flexible hose should be 1 to 2 inches (2.5 to 5.1 cm) of mercury. This pressure should not fall off rapidly with use.
- The most important single feature of a well-designed vacuum unit is the filter. It should be a fabric filter of sufficient area to maintain good suction at the tools in use. Small single bags and paper filters are inadequate to do a good filtration job.
- A heavy-duty, multistage centrifugal compressor, powered by a 3 to 7½ horse-power motor, can generate the required air-flow and pressure to operate a satisfactory machine.
- The unit must be equipped with a reasonable size dust bucket so that cleaning can go on for adequate periods.

Stationary systems have been used in asbestos mines and plants for many years. Piping systems, carefully designed, can bring vacuum cleaning connections to every area of a mill or

plant so that men equipped with a 25-foot (7.6 M) length of hose and tools can clean everywhere. The central station equipment is similar to that desirable for portable equipment, except that the size and pressure must be greater. The capacity depends on the number of men who will use the system at any one time. The pressure must be sufficient to deal with the long piping system.

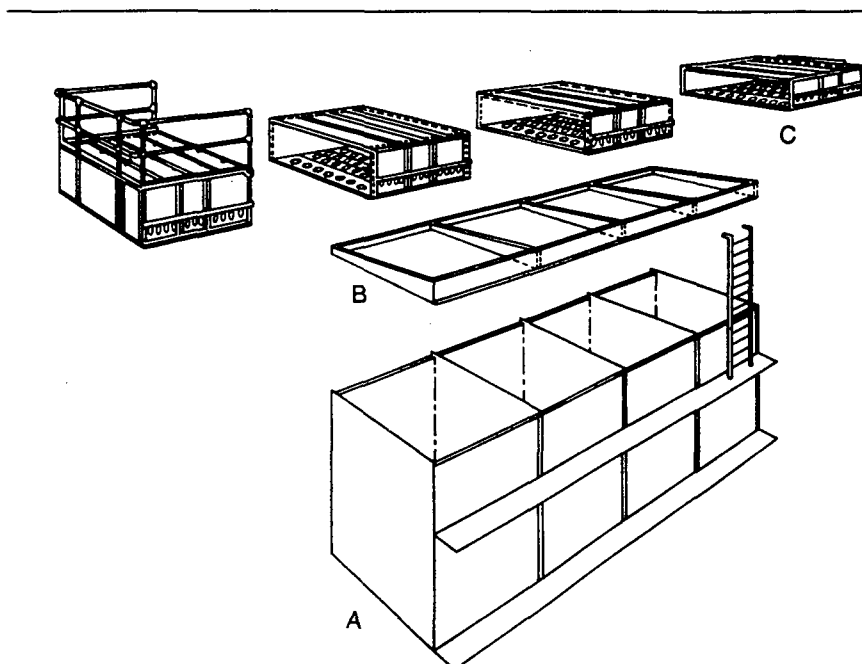
- _____: Asbestos. The Need for and Feasibility of Air Pollution Control. National Academy of Science, Washington, D.C. (1971).
- Badallet, M.S.: A Mineral of Unparalleled Properties. *Can Inst. Mining and Met.* 54:151 (1951).
- Bamblin, W.P.: Dust Control in the Asbestos Textile Industry. *Ann. Occup. Hyg.* 2:54 (1959).

In recent years a growing number of plants have decided to rebuild rather than replace their baghouse collectors. Increased costs of labor and materials for new construction, increased maintenance frequency of existing baghouses, greater dust loading and enlarged plant capacity are some of the reasons behind this decision. Generally, a rebuild involves removing an older shaker type bag collector and installing a pulse jet unit in its place. While dismantling is relatively simple, rebuilding requires much the same engineering specialization as design and construction of a new system. Not only must a rebuilt system be economical — it must also operate efficiently and meet local and federal dust control regulations.

To fully understand the merits of baghouse rebuilds it is necessary to explore the differences between shaker and pulse jet collectors. Basically, shakers collect dust on the inside surfaces of their collection bags, while pulse jet units collect dust on outside surfaces.

This gives rise to two different bag cleaning methods. In shaker collectors the bags are firmly attached to a ceil plate at the bottom of the baghouse and to racks at the top. To clean the bags a motor is activated to vibrate or shake the racks. The shaking action dislodges the collected dust and empties it into the baghouse hopper. But while the bags are being cleaned in this manner, the flow of effluent air through them must be stopped. Otherwise, dislodged dust will tend to be re-entrained on the bags.

Where only intermittent dust collection is required, the entire baghouse is shut down while bag cleaning takes place. Where continuous collection is necessary, a compartmentalized unit is employed. One compartment of the unit is down while others continue to operate.



Existing baghouse (A) is first "gutted". A roof leveling wedge, or transition piece (B) is designed to accommodate changeover from sloped roof characteristic of shaker baghouses. Clean air modules (C) are pre-engineered by Johnson-March and shipped to customers for installation.

Modules are designed to fit over existing baghouse compartments, which are retained for structural support. The modules contain cell plates, compressed air manifold and headers and top access doors. They are designed to mate with existing flanges.

Pulse jet units, on the other hand, are designed exclusively for continuous duty operation. Dust collected on the outside of the bag surfaces is continuously discharged into the hopper by electronically timed jets or pulses of compressed air which travel downward from venturis along the length of the bag. Average duration of the pulse is 1/10th of a second. The flexing action of the bag caused by these continuous air pulses accomplishes the cleaning but does not interfere with dust collection.

Since all bags are performing the collection function at all times, collection of a pulse jet unit is greater than that of a similar volume shaker unit. This capability is expressed in terms of air to cloth ratio.

Normally, collectors are rated on the ability to handle a given cfm at atmospheric pressure with a design pressure drop across the collector. The equation is as follows:

$$\text{air-to-cloth} = \frac{\text{air flow in cfm}}{\text{total cloth area in sq. ft.}}$$

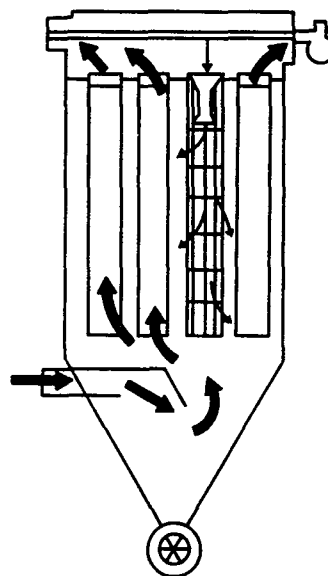
The higher the air to cloth ratio, the lower the relative cost of the collector. The air to cloth ratio for shaker collectors is generally in the area of 3.5:1 or less. Pulse jet collectors can operate effectively at air to cloth ratios of up to 12:1. The type of dust to be collected, dust loading, particle size and the temperature of the air stream are the factors that determine the necessary air-to-cloth ratio.

The major justification for most baghouse rebuilds comes not from the savings on "cloth" but from the ability to handle a greater volume of dust laden air or a greater volume of dust in a given volume of air. The original baghouse structure is retained, and approximately the same number of bags may be employed when a pulse jet collector replaces a shaker unit. There is no new space required and the existing dust disposal system can frequently be used. However, the dust collection capacity of the unit is increased relative to its previous capacity.

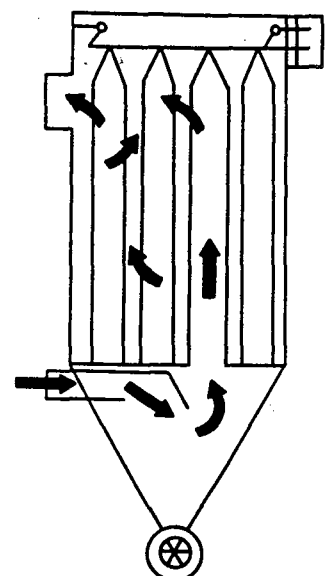
Bothersome maintenance is another reason for converting. Since bag cleaning in shaker collectors is accomplished mechanically, moving parts are subject to wear. Fasteners and bag clamps can be jarred loose by repeated shaking or vibration, bag material abrades, and electric motors wear out.

Pulse jet collectors have no moving parts. While not maintenance free, they reflect modern simplicity of design and operation with such features as solid-state timers, simplified point to point wiring, and compressed air rather than electrical motors as a power source for bag cleaning.

In addition, they offer the benefits of top access. Bags can be replaced from the roof of the structure simply by removing clamps and lifting the bags up through the cell plate.



In pulse jet collectors, the dust particles (black arrows) collect on the outside surfaces of the filter bags. Short pulses of compressed air (smaller arrows) dislodge the dust which then falls into the hopper.



In shaker type collectors, the dust collects on the inside surfaces of the bags. A shaker mechanism dislodges dust which falls into the hopper.

In shaker collectors, bags are fastened at both top and bottom. Maintenance personnel must enter the collector housing through side access doors, remove clamps from the cell plate at the bottom and then climb ladders to unfasten clamps that connect the bags to shaker headers at the top of the unit. Handling dusty bags can be uncomfortable and irritating.

Eliminating side-access not only increases ease of maintenance, but also allows for additional productive space within the structure. Where a certain amount of space once had to be allotted to access aisles, it can now be used to accommodate collection bags.

Converting a shaker collector to a pulse jet collector involves two basic procedures: dismantling the existing system and installing the new one.

Generally, a set of plans and specs for the original collector are sent to the firm contracted to engineer the rebuild.

A proposal is drawn from this information as well as data from a field engineer who inspects and photographs the existing installation, determines the capacity and dust loading of the operation, measures the ductwork housing, and hopper, and verifies the structural integrity of the existing collector.

Based on the information they've received, office engineers draw up modification plans. First, the customary sloped roof of shaker collectors must be changed to a flat roof for top access. A custom designed transition piece or level wedge is drawn and fabricated.

Next, clean air modules are designed for interface with the existing collector. Clean air modules contain cell plates, compressed air manifold and headers and top access doors. They are pre-engineered to mate with existing flanges and to fit over existing baghouse compartments.

Third, bag materials are selected based on type of dust to be collected and operating temperatures to be encountered. Bag selection requires a thorough knowledge of physical and chemical properties of available materials, their resistance to acids, alkalis and flex abrasion, for example.

Bags, cages and venturis are shipped to the site, the transition piece is installed to level the roof, clean air modules are fitted over the existing compartments, bags, cages and venturis are installed. A timer control panel is wired to air solenoids. Once the system is connected to a compressed air source it is ready for operation.

The costs of tearing down the old installation have been saved; the costs of building an entirely new baghouse have been eliminated; and the performance of the "rebuilt" collector is identical to that of a "new" unit, backed up by a manufacturer's warranty. In short, by rebuilding, dust collection capacity can be increased at only a fraction of the cost required for a completely new installation.

The Clear Choice in Dust Control.

Johnson-March designs, engineers and manufactures Fabric Filters and Chemical Wet Suppression Systems for dust control for almost any application regardless of size and complexity.

Johnson-March Corporation
3018 Market Street
Philadelphia, PA 19104
(215) 243-1700

Export Department
1201 Chestnut Street, 14th Floor
Philadelphia, PA 19107

Abart Engineering Co., Ltd.,
505 Eglinton Avenue West
Toronto, Ontario, Canada M5N 1B2

Bulletin No. 203 AN-3M-978

Introduction

With the advent of stricter emission standards designed to produce the national quality standard of $75\mu\text{g}/\text{m}^3$ of particulate, only the most efficient removal devices will be suitable. The baghouse traditionally yields high removal efficiencies (99.9 + percent).

A baghouse is a large metal box divided into two functional areas. The first of these, the dirty air plenum, may be a part of the baghouse proper or it may take the form of a distribution manifold. The function of the dirty air plenum is to distribute the fouled gas evenly to the filtering elements or bags. The baghouse hopper, which is the receptacle for collected material, is part of the dirty air plenum. The clean air plenum is that part of the baghouse where recombination of the air circuits from each of the individual bags takes place. The interface separating the clean air and dirty air plenums is the filtering media or bags.

There are three important mechanisms involved in removing particles from a flowing gas stream using filter media: impaction, interception, and diffusion. These three mechanisms which are responsible for collision of a particle on a target, are of paramount importance when the baghouse is first brought on line and the bags are clean. After a short time, however, the bags become caked with a layer of dust and this dust cake actually becomes the filtering medium. No matter how vigorously the bags are shaken, collapsed, or pulsed, a residual dust cake is retained after each on-line cleaning. The bags act primarily as a matrix to support the dust cake.

Baghouse Types

All baghouses operate in basically the same way: dirty gas is ducted to the unit where it is filtered by cloth tubes or bags. This filtering action is extremely efficient and results in virtually 100 percent of the entrained particulate remaining in the unit on the bags. The bags must be periodically purged of this collected material. The method used for this cleaning characterizes one type of baghouse from another.

All baghouses are either *intermittent* or *continuous automatic*. Intermittent baghouses are designed to be cleaned after the unit has ceased filtering, say at the end of the work day. Intermittent baghouses cannot be cleaned while on line, and thus are limited to low dust loadings or infrequent operation. They have the distinct advantage of being low priced. Continuous automatic baghouses, on the other hand, are more expensive but are able to operate 24 hours a day without rest and can handle high dust loadings.

Baghouses are characterized and identified according to the method used to remove collected material from the bags. This is accomplished in a variety of ways, including shaking the bags, reversing the direction of air flow through the bags, flowing a jet of air on the bags from a reciprocating manifold, or rapidly expanding the bags by a pulse of compressed air.

The bags in *shaker-type baghouses* are supported by a structural framework. The structural framework is free to oscillate when driven by a small electric motor. Periodically, on a timed basis, a damper isolates a compartment of the shaker baghouse so that no air flows. The bags in that compartment are then shaken for approximately a minute during which time the collected dust cake is dislodged from the bags. The dust falls into the hopper for subsequent removal.

Reverse flow baghouses are equipped with an auxiliary fan that forces air through the bags in the direction opposite to filtration. This backwash action collapses the bag and fractures the dustcake. When the bag is reinflate by being brought back on-line, the fractured dustcake is dislodged into the hopper. If the unit operates under suction (the main fan is located on the "clean" side of the baghouse) reducing pressure in the baghouse may eliminate the need for an auxiliary fan.

Reverse jet baghouses incorporate a jet case or manifold that surrounds each bag. The manifold travels the length of the bag in a constantly repeating cycle. As it passes over the surface of the bags, a jet of high pressure air issues from orifices in the manifold and blows the dust cake off the bags.

In recent years *reverse pulse baghouse* have enjoyed a rapidly increasing use. This design utilizes a short (usually less than 100 milliseconds) pulse of compressed air through a venturi, or diffuser, directed from the top to the bottom of the bag, Fig. 1. This primary pulse of air aspirates secondary air as it passes through the venturi. The resulting air mass violently expands the bag and casts off the collected dust cake. A modification of this technique is the *pressurized plenum type* of cleaning. In this case an isolated compartment above several rows of bags is supplied with pressurized air. The change in pressure differential across the bags when the damper is operated causes the bags to flex and cast off the dust cake.

What to Know Before You Buy

Caking is the formation of a solid mat of self-adhering dust on the dirty air side of the bag which cannot be removed by the normal cleaning mechanism of the dust collector. The most common cause of caking is the presence of water droplets in the gas stream which causes mud to form on the bags. This later dries into a hard cake. The water droplets can be caused by the malfunction of water spray cooling equipment, or more commonly, from condensation.

Water, in the form of condensate, is a common cause of malfunction. If the temperature of the hot humid gas falls below the dew point temperature in the baghouse, water will condense, combine with the collected dust and blind the bags with mud. The gross gas temperature does not have to reach the dew point for this phenomenon to occur: only the metal skin of the baghouse need be below this temperature. For this reason many baghouses are insulated to retard heat transfer and maintain skin temperature above the dew point.

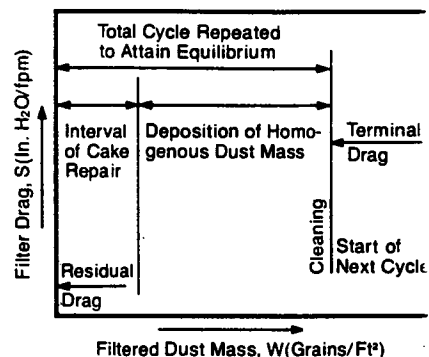
Two types of *burning* can destroy bags. Baghouses have a rather low temperature limitation ranging from 180°F to 500°F (82 to 288°C). Consequently, on those applications generating high temperature off-gas, there is a practical limitation of using those fabrics able to withstand at least 400°F (204°C). Even then, a very reliable means of gas cooling, such as evaporative cooling, is required (*Pollution Engineering*, Nov./Dec. 1970). Even when the gas temperature is closely controlled, there is the possibility of a hot spark reaching the bags and burning a hole.

Abrasion is a natural phenomenon resulting from handling dust-laden gases. Some wear on bags occurs from direct impaction, but wear is greatly increased when dust strikes a bag tangentially. Elimination of abrasion is impossible, but proper design of a baghouse will retard this cause of bag failure by channeling the air in the least destructive way, and/or by holding gas velocity to a minimum.

The destruction of a bag by chemical attack is generally due to misapplication or misoperation. Processes which generate gases at elevated temperature frequently produce water vapor and acid radicals which, at a given temperature (the acid dew point), will react and form an acid vapor. The acid dew point is dependent upon the concentrations of the constituent in the gas, and is therefore very difficult to predict.

Bags also tend to wear out from aging. After hundreds of thousands of cleaning cycles, the fabric weakens and will ultimately fail. The occurrence is as unavoidable as human deterioration, but, like humans, the better the bag is cared for, and the better the original equipment design, the longer it will last.

Fig. 1. Filter Drag Cycle.



The fundamental criterion used in applying any baghouse to any application is the "air-to-cloth ratio," defined as the ratio of actual volumetric air flow rate to net cloth area.

$$AC = \frac{Q}{A}$$

where: AC = Air to cloth ratio, fmp
Q = Volumetric air flow, acfm
A = Net cloth area, sq. ft.

AC is equal to the superficial face velocity of the air as it passes through the cloth. Shaker and reverse air baghouses normally operate at an air-to-cloth ratio of from 1 to 3, while reverse pulse baghouses operate at about 3 to 6 times this range. Units which are cleaned with a compartment off-line must be outfitted with an extra compartment in order to keep a minimum net cloth area on line at all times. In extreme cases, this can double the size of the baghouse.

A second important operating characteristic is the "filter drag" given by:

$$S = \frac{\Delta P}{V}$$

where: S = Filter drag, in. H₂O/fpm
ΔP = Pressure drop across filter, in. H₂O
V = Superficial face velocity, fpm

As this equation indicates, baghouses do not obey the fan law, which states that the pressure drop varies as the square of the volumetric air flow. Virtually all other devices obey this law.

Filtering Bags

The most important components of any baghouses are the filtering elements, or bags. Perhaps less is known about predicting their in-service performance than about any other component. In general, bags are either woven or felted. Woven bags are used in shaker and reverse air baghouses; felted bags are used in reverse pulse, plenum pulse, and jet case baghouses.

Woven bags are usually furnished with a weight of 5 to 10 oz. per sq. yd. (.17 to .33 kg per m²) and a permeability (acfm passing through one sq. ft. of cloth with pressure differential of 0.5 in. H₂O) of approximately 10 to 30 acfm. Felted bags are heavier and much fuzzier, weighing 10 to 20 oz. per sq. yd. (.33 to .67 kg per m²). They also have a permeability of approximately 10 to 30 acfm.

A common problem with many man-made fibers is their tendency to elongate under load and shrink at higher temperature. This lack of dimensional stability may cause a reduction in cleaning efficiency or premature mechanical failure of the bags. To avoid or minimize these problems, many fabrics are *heat-set*. Spun fabrics may also be singed or sheared for reducing the surface hairs in order to present a smooth surface to the dust cake, thus making it easier for the dust cake to dislodge during the cleaning cycle. Many other surface finishes and mechanical operations may be performed on the cloth to accomplish specific aims. Resin finishes provide a smoother surface; graphite finishes may be of value in eliminating build-ups of static charge; napping a fabric may help improve collection efficiency. Resins or graphite are used to improve abrasion resistance.

Limitations

Although baghouses operate at the highest collection efficiency level (99.9 + percent) all is not perfect. For given application baghouses will probably be one of the more expensive solutions and will probably require the most space for installation (see Table). The cost of maintaining such facilities as settling ponds or providing chemical additives in wet systems may, however, offset this price disadvantage. Baghouses will generally require much less power to achieve high efficiency operation than water scrubbers and, of course, have no water requirements.

The highest maintenance component of a baghouse is the bags. The bags represent 20 to 40 percent of the equipment cost and probably have an average life of 18 to 36 months. This means that the unit will be rebagged from three to seven times assuming 10 year amortization of the unit.

There are several causes for failure — blinding, caking, burning, abrasion, chemical attack, and aging. The circumstances that can cause the above to occur are varied — some due to normal operation, and some due to misapplication or improper operation. Blinding occurs when dust is captured within the bag material and the cleaning mechanism is unable to dislodge it. Either the cleaning mechanism is not powerful enough, or the nature of the dust is such that it can readily enter the fabric. Obviously blinding is the result of either misoperation (the cleaning mechanism is not powerful enough) or misapplication (the nature of the dust is at fault).

Rule-of-Thumb Costs of Typical Collectors of Standard Mild Steel Construction

Type of collector	Dollars per cubic feet per minute		
	Equipment cost	Erection cost	Yearly maintenance and repair cost
Mechanical collector	0.07-0.25	0.03-0.12	0.005-0.02
Electrostatic precipitator	0.25-1.00	0.12-0.50	0.01-0.025
Fabric filter	0.35-1.25	0.25-0.50	0.02-0.08
Wet scrubber	0.10-0.40	0.04-0.16	0.02-0.05

How to Buy a Baghouse

If you have an air pollution or dust control problem in your plant and are considering purchasing a baghouse, here are some do's and don'ts:

Do: Write specifications that include volume, temperature, dust and water control of the gas stream. Specifications should clearly state the application.

Don't: Specify crucial parameters such as air-to-cloth ratio. No one knows the manufacturer's equipment like the manufacturer. Trust him to make the correct decisions based on experience and require a performance guarantee.

Do: State the applicable code requirements and performance expected.

Don't: Request a bag-life guarantee; most manufacturers won't give one.

Do: Spell out peripheral equipment you want quoted with baghouse; i.e., fan, motor, screw conveyor, etc. If you want a turnkey job, require that the equipment price be broken out separately from the erection price.

Don't: Require detailed proposal if "budget" figures will do.

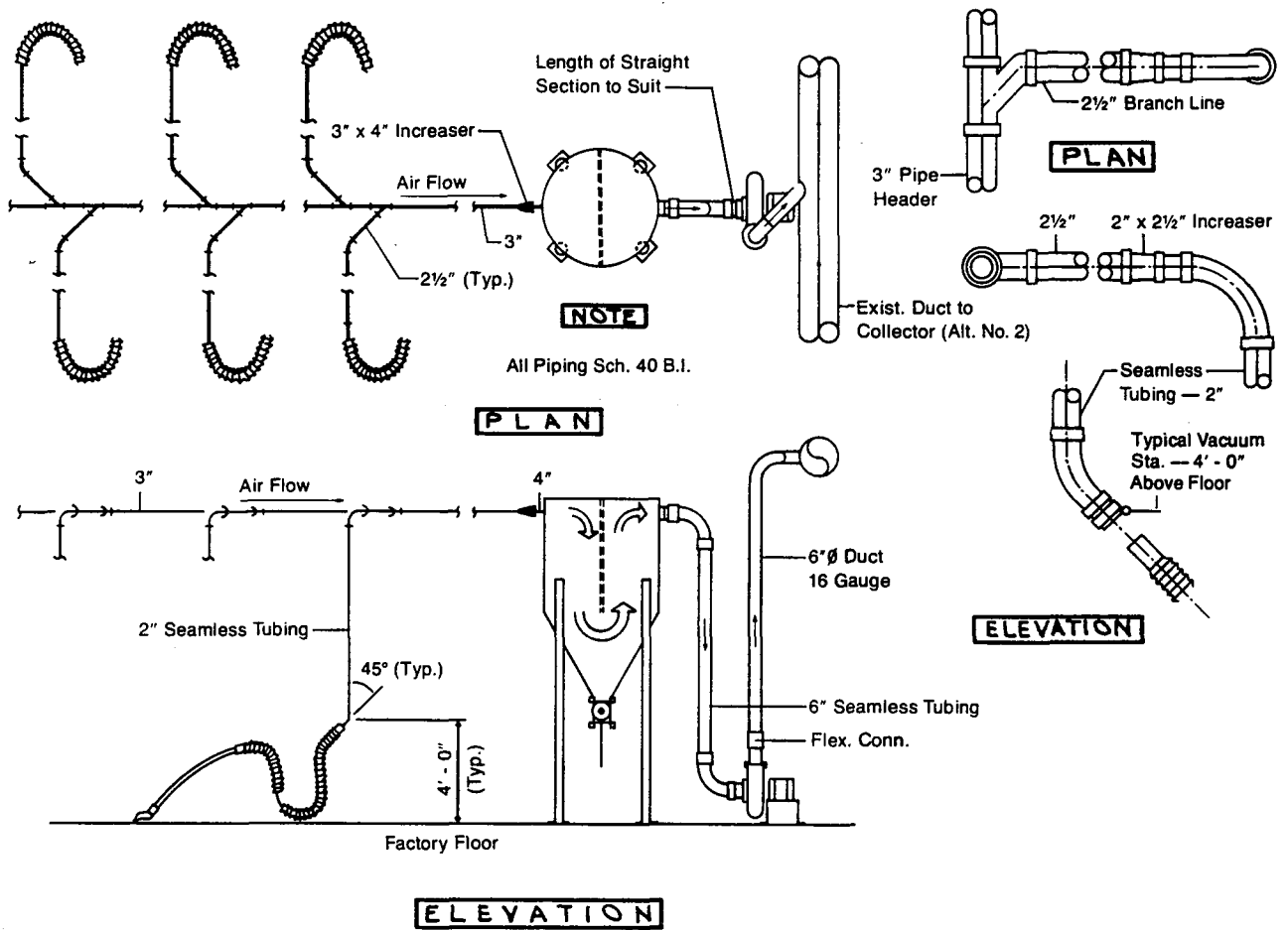
Do: Expect the manufacturer to explain his features and evaluate them as they pertain to your application and plant operations.

Don't: Arbitrarily request changes to standard design. "Specials" cost much more and require fantastic lead time.

Do: Check with the manufacturer's customers — they know his ability to perform.

Don't: Expect to visit an installation identical to the one you're considering. No two operations are alike. Also, improvements are being made daily that may make what you buy better than what is in the field.

Do: Require factory assembly and prebagging if at all possible. This will be less expensive and cause fewer headaches than doing it at your plant.



TYPICAL
VACUUM SYSTEM

Summary

Described below is one method of installing a vacuum system utilizing less costly components and existing dust collection and waste disposal equipment that can effect a saving in initial investment of up to 30% to 40% over commercial systems, plus reduced power, maintenance and handling costs.

Description

General. The system consists of standard vacuum hoses and tools connected to a piping system (see dwg. 30383-4). Location of outlets should be governed by area of activity and the reach of standard 25 ft. (7.6 m) hoses. The air is exhausted by an industrial fan and discharged into a nearby dust main, which carries the dusty air to an existing cloth dust collector. This can effect a considerable saving in piping, as well as eliminating the need for a separate dust collector to meet air pollution standards.

Selection of Pickups. A basic system is sized to cover an area with up to 20 stations where a maximum of two vacuum stations are expected to be in use at one time. (400 cfm) (11.3 m³/min.)

Additional stations should be handled by adding a parallel system for each two stations required, to maintain carrying velocities.

The usual maximum for one installation would be six stations simultaneous with a 900 cfm (25.5 m³/min.) exhauster and approximately 60 stations total.

Fan. The fan should be selected per the attached specification. The volume is selected as follows:

- Basic system (2 stations in use): 400 cfm. (11.3 m³/min.)
- Two parallel systems (4 stations in use): 800 cfm (22.7 m³/min.)
- Three parallel systems (6 stations in use): 1200 cfm. (34.0 m³/min.)

The total pressure is selected as follows:

- Maximum length of longest branch approx. 150'-200': (45.7-61.0 m) use 40" (101.6cm) T.P. Water Gauge.
- Maximum length of longest branch approx. 250'-300': (76.2-91.4 m) use 60" (152.4 cm) T.P. Water Gauge.

Typical fan selections are:

- Buffalo Forge, Type "RE", extra heavy wheel.
- Sprout—Waldron Industrial Fan

Dust Trap. In highly abrasive situations, such as transite and cement board plants, a dust trap should be installed preceeding the fan.

This trap is sized to handle up to 1200 cfm (34.0 m³/min.) (the largest single system recommended).

Supplier	Description
Multi-Fab, Inc. 726 Wilhelm Street Harrison, New Jersey 07029-2094 U.S.A. 201-484-6373	Micro-Tool dust arrestors are of modular design that provides for space saving installation, while meeting a wide variety of industrial dust control requirements and plant installation arrangements. Single module units are available from 100 cfm to 2,000 cfm. Multiple module units range from 2,000 cfm up to 40,000 cfm.
Dallow Lambart Ltd. 6 Stratton Street London, England	Unimaster dust control units are engineered to provide economical and effective solutions to a wide range of industrial dust problems. The five basic Unimaster constructions can be combined with a standard range of fan sizes, filtration areas and dust container capacities to offer a total of more than 500 different Unimaster units.
Kermatrol 606 Wilshire Blvd. Santa Monica, California 90401 213-451-5738	Kermatrol dust collectors are modularly designed to meet a wide variety of industrial dust control requirements or plant installation arrangements. A single modular unit has a 2,000 cfm capacity. Arrangements of multiple module units can provide virtually any size system desired.
Johnson-March Corp. 3018 Market Street Philadelphia, Pennsylvania 19104 215-243-1700	Sky-Kleen pulse jet type dust collectors are available in three series depending on plant requirements.
Research-Cottrell Flex-Kleen 222 South Riverside Plaza Chicago, Illinois 60606 312-648-5300	Flex-Kleen pulse jet type dust collectors are available in three series depending on plant requirements.

Dust Control Equipment Suppliers

Sly Manufacturing Co.

U.S.A.

Sly Manufacturing Co.
21945 Drake Road
Strongsville, Ohio 44136
P.O. Box 5939
Cleveland, Ohio 44101
U.S.A.

Canada

McCarthy & Robinson (1966) Ltd.
321 Progress Avenue
Scarborough, Ontario
Canada M1P 2Z7
Office: (416) 298-1630

Puerto Rico

Ing. Luis Del Rio, President
E S E C O, Inc.
P.O. Box 3919
Carolina, Puerto Rico 00630
Office: (809) 762-7775

United Kingdom

Actair International Ltd.
Penarth Road
Cardiff, Wales CF1 7UG
United Kingdom
Telex: 49373
Office: (0222) 387873

Australia

Mideco (Sales) Pty. Ltd.
15 Metropolitan Avenue
Nunawading, Victoria 3131
Australia
Telex: AA-33061
Office: 878-5588

Pactecon Pulse Clean Filters: Collects
99.9% of particles over ½ micron.
Available in two model series for up to
25,000 cfm (PC-100; PC-200).
(Note: They list asbestos as a dust they
collect.)

Standard Filterbau

Standard Filterbau
Rosnerstrasse 6/8
Postfach 7608
D-4400 Munster
Germany
Telefon (0251) 697-1
Telex 08-92714 hazem d

Air Pulse Pocket Filter DT28
Air Pulse Bag Filter DS36

Both available in 7 sizes depending on
filter area needs.

Both use air pulse cleaning mechanism.

Wheeabrator Corporation

Wheeabrator Corporation
Wheeabrator Division
Mishawaka, Indiana
U.S.A.

Wheeabrator Corporation of Canac
P.O. Box 370
Oakville, Ontario
Canada

This company supplies all equipment
necessary for baghouse type dust
collecting, except fans.
Bags, shakers, shaking motor/frames,
plenums, valves, etc.

Fibre Lifting Devices

For Handling Pressure Packed Bags or High Density Blocks

Approximate Size:
Gripper 17" X 8" X 8" (43.2 X 20.3 X 20.3 cm)

Fibers Handled:
All Paper Wrapped Units.

Approximate Capacity:
1-3 Bags per Minute.

Supplier:
The Gripper is made presently by
JM Asbestos

1980 Estimated Prices:

The Mechanical Gripper can be used to lift both High Density Blocks or pressure packed bags. Estimate cost is \$400 (Canadian).

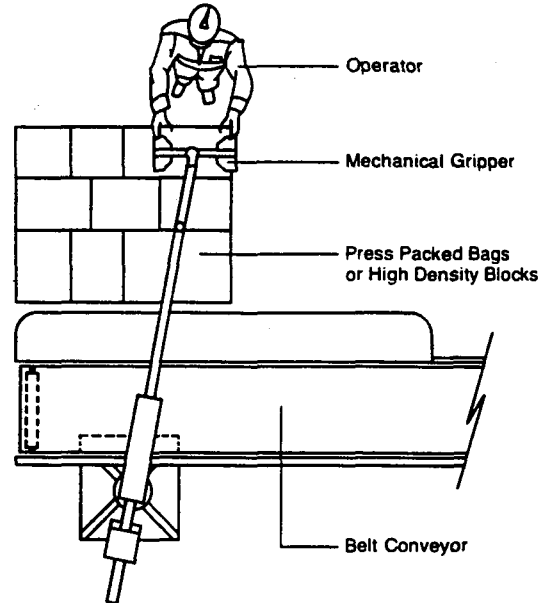
The industrial manipulator in this illustration is called a Conco Balancer – estimated cost will range from \$1000 U.S. (airlift) to \$4500 U.S. (balance master) f.o.b. Mendota, Ill.

A trial unit is being fabricated by:

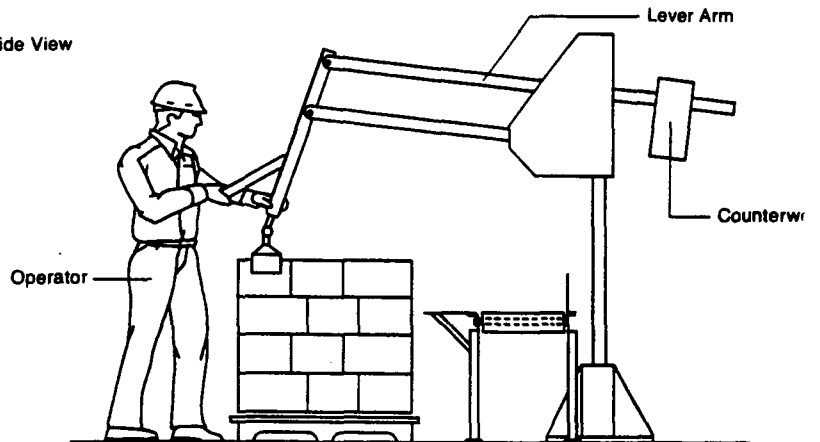
Conco Balancer Division
Mendota, Ill. 61342
(815) 539-7411

Industrial Manipulator with Mechanical Gripper for Handling Pressure Packed Bags or High Density Blocks

Plan View

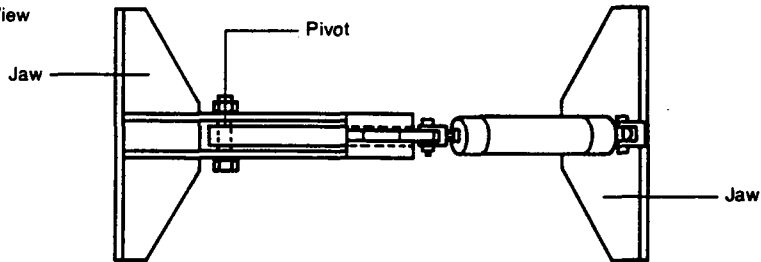


Side View

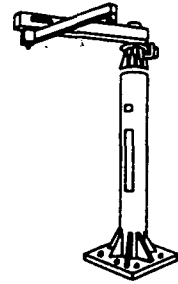
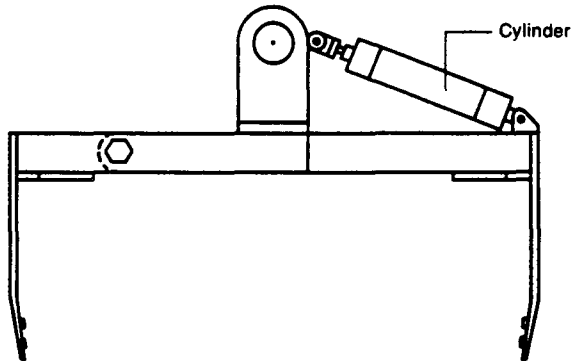


Mechanical Gripper

Plan View



Side View



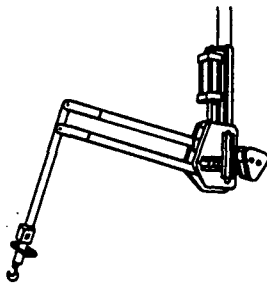
Articulated Jib Crane

Provides reach-in ability, maneuverability and flexibility. Articulated for lateral movement to operate in confined areas where ordinary jib cranes cannot function.



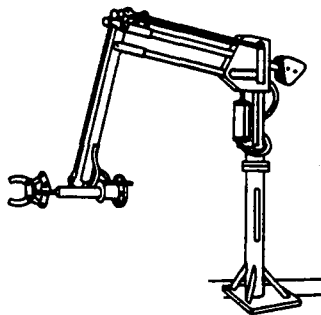
Airlift

Low-cost load handling with speed and precision. Eliminates manhandling yet retains load "feel" to accurate placement or positioning.



Balance Master

Smooth, precise, floating action, plus reach-in enables one worker to handle heavy, awkward or repetitive loads with ease and efficiency.



Parallel Linkage

Parallel linkage provides unique reach-in ability where space is limited.

The Versatile Package Transfer System

The JSK Uni-Lift is a totally new concept in package handling, and includes many unique design features.

The lifting or lowering operation is based upon moving rigid platforms which pick up a package at the infeed point, transport it to the outfeed roller conveyor whilst remaining horizontal at all times.

The Uni-Lift can have single or multiple infeeds as well as single or multiple outfeeds, making it ideal for transferring packages between levels and on a continuous conveying system.

The Uni-Lift is designed using standard components and is tailored to suit a customer's specific application making it ideal for installation on both new and existing sites.

JSK Product Range

- Fully Automatic Sack Splitter
- Low Speed Auto Sack Splitter
- Drum Tip Unit
- Uni-Lift Elevator and Conveyors
- Compactors and Balers
- Automatic Bin Filling Chutes
- Scissor Lifts and Depalletizers
- Control System and Panels

Incorporated in the JSK Uni-Lift are the following features:

Simple Infeed System

Roller Conveyor feeding direct onto platform, no sequenced STOP/STARTING of packages, therefore no complicated control circuit.

Positive Pick-up

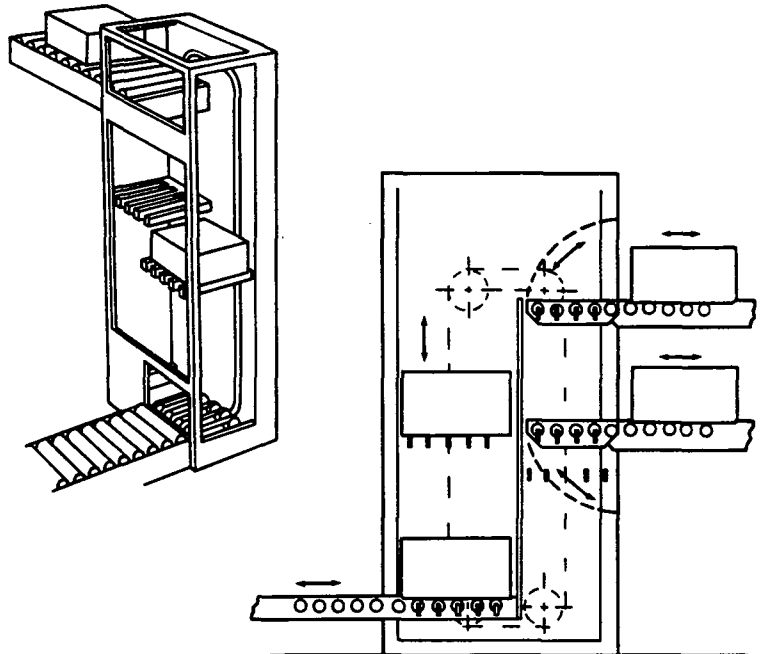
Rigid Platform lifts the packages vertically from the infeed roller conveyor.

Rigid Platforms

Packages are carried on rigid platforms which remain horizontal.

Positive Outfeed

Packages are placed onto powered roller outfeed conveyor by moving platform, packages are driven from the outfeed on rollers.



High Throughputs

Loads up 50 Kg, elevated or lowered at rates up to 30 per minute. (Higher speeds available dependent on application).

Wide Load Range

Standard Unit is rated to handle packages up to 150 Kg (Higher loads rating available).

Versatile Feeding Options

Single or multiple infeeds and outfeeds. Outfeed direction can be in line, at 90° or 180° to infeed.

Automatic or manual feed options available.

Test Facilities

Full test plant facilities are available at our Chesterfield works for customer demonstrations and trials.

For further details please contact:

JSK (Materials Handling) Ltd.

Unit 2, Carrwood Road, Chesterfield Trading Estate, Chesterfield S41 9QB.
Telephone: 0246-453480. Telex: 966219.

Our policy is one of continuous improvement and we reserve the right to make changes to the specification as they are incorporated in production.

Bag Openers

**Recommended Control
Procedure No. 5**

Contents

- 1. Products and Operations Covered by These Recommendations**
- 2. Basic Requirements**
- 3. Removal of Outer Protective Packaging**
- 4. Transport to Bag-Opening Station**
- 5. Mechanical Bag-Opening Stations**
- 6. Manual Bag-Opening Stations**
- 7. Conveyors for Loose Asbestos Fibre**
- 8. Empty Bags**
- 9. High-Density Block Packaging**
- 10. General**

1. Products and Operations Covered by These Recommendations

- 1.1 Chrysotile asbestos fibre
- 1.2 Amosite asbestos fibre
- 1.3 Crocidolite asbestos fibre
- 1.4 Any other asbestos fibre or mixture thereof.

These recommendations cover the machinery, equipment and work practices to be employed for removing asbestos fibre from the packages in which it is delivered into the manufacturing process. The recommendations will ensure the controlled handling of raw asbestos and particularly should prevent:

- (a) The freeing of respirable fine dust (generally less than 1 per cent of raw asbestos).
- (b) Generating respirable fine dust:
 - Through spillage
 - From emptied asbestos bags

2. Basic Requirements

2.1 Today it is known that the inhalation of respirable fine asbestos dust may — under certain circumstances — cause serious bodily harm. Many asbestos fibre producers therefore prominently display warning labels on the packages of asbestos to signify that careful methods should be employed when using the asbestos fibre.

2.2 Asbestos fibre producers have developed a number of methods of packaging to ensure safe and spillage-free arrival of asbestos fibre at the final destination, i.e. the asbestos-using plant. These methods of packaging are designed to permit various techniques of handling, transportation and storage which minimize the possibility of damage to bags and consequent spillage (see RCP4) and the creation of respirable fine asbestos dust.

2.3 Consumers of asbestos fibre (i.e. manufacturers of asbestos-containing products) become responsible for the control of harmful asbestos dust emission as soon as the asbestos fibre comes into their possession. One of the most critical times when dust emission can occur is during the removal of asbestos fibre from the packages and introducing it into the manufacturing process. However, this phase can be controlled through the use of proper equipment and work practices. Furthermore, these means can readily be implemented because they are fully within the control of the asbestos consumer.

2.4 The recommendations in the following sections are designed to enable the consumer of asbestos to handle the fibres safely.

3. Removal of Outer Protective Packaging

3.1 Chrysotile asbestos is generally packaged in woven and coated plastic bags or multiwall paper bags. These are stacked in an interlocked manner, either strapped on a pallet, or in a manner held firmly in place by the use of plastic stretch- or shrink-wrapping. These outer protective materials should be left intact until the asbestos is to be used. After the unit of asbestos bags has been transported to the location where it is to be sorted or used, the plastic cover or strapping should be carefully removed in a manner to avoid damaging the asbestos bags and creating dust. There are special tools available for slitting the plastic cover, and/or cutting the strapping, without cutting into the asbestos bags. Any bags found to be torn or damaged must be repaired immediately. Spillage should be promptly vacuum cleaned.

3.2 In the case of amphibole asbestos, which is generally packaged in woven and coated plastic bags, approximately six bags are stacked and compressed together. They are held in the compressed state with heavy wire ties. These bales are then placed on pallets two bales per layer, either two or three layers high. They are held firmly in place by the use of plastic covers and strapping. All of these protective materials should be left intact until the unit is removed from storage and is being prepared for final use.

Carefully cut the outer strapping and remove the plastic cover so as to avoid damaging the asbestos bags and creating dust. Each bale should then be removed from the pallet and placed adjacent to the asbestos-using station.

This can be done efficiently by using a fork-lift truck equipped with squeeze clamps. Once in place, the bale wires can be cut by using 600mm long blunt-nosed bolt cutters. It is important always to cut the wires on the side of the bale opposite to the wire clips, or if the bale wire clips are facing the operator then the bale wire must be cut above the retaining clip. (See Fig. 1.) The reason for these precautions is to protect the operator from the possibility of being struck by the bale wire.

4. Transport of Individual Bags to The Bag-Opening Station

The asbestos bags should be left in the original pallet loads and transported by fork-lift or crane to the closest point adjacent to the bag-opening station. After removal of the outer packaging, as outlined in item 3, the individual bags may be transported to the bag-opening station by:

- Chute or U-shaped channels.
- Conveyor belt.
- Mechanical lifting device.
- Manual handling.

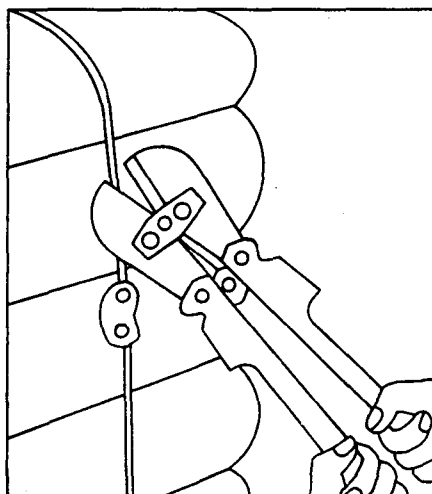


Figure 1

4.1 Chute or U-Shaped Channel

These methods require sufficient height to allow the operator and asbestos bags to be located above the bag-opening station. They also require the operator to be present to feed each bag into the system at the time it is needed.

4.2 Conveyor Belt

Greater flexibility and automation can be achieved by using belt conveyors. They can be of a length to allow loading a complete batch of asbestos bags on the conveyor at one time. In addition an electronic programming device can be incorporated which allows the operator to be doing other things while the conveyor automatically feeds the asbestos bags into the bag-opener. If different types of asbestos are required in the same batch it is possible to use electronic programming to mix bags on the conveyor or to use multiple conveyors, each conveyor being loaded with a different type of asbestos. The programming device can be set to activate each conveyor and feed the required number of bags. With this type of installation the worker is only required to maintain adequate stocks of the correct asbestos bags on each conveyor.

4.3 Mechanical Lifting Device

The transfer of bags from the pallet to the bag-opening station (or conveyor belt, etc.) can be done with mechanical lifting devices. This procedure eliminates the need for the worker actually to handle the asbestos bags. However, it is important that these devices do not create respirable dust, for example, by the use of compressed air.

4.4 Manual Handling

If for various reasons it is not possible to use the systems named above, the bags may be handled manually. This can be accomplished by the use of, for example, hand trolleys. However, it is important that hooks or other tools which can cause damage to the asbestos bags are not used.

In general, the transportation areas should be cleaned periodically using an approved method such as vacuuming.

5. Mechanical Bag-Opening Stations

Mechanical bag-opening machines are now available which operate successfully with bags of asbestos fibre. They can be combined with various other pieces of equipment to create partially automated systems. This in turn eliminates the need for workers to be involved with opened bags or loose asbestos fibre.

There are many different plant layouts where asbestos is used. The specific design of a mechanical bag-opening installation will therefore vary to suit any particular plant operation.

Consequently, no specific system can be recommended here. However, it is important that any system includes the following components:

- Bag-opening machine.
- Totally enclosed system to convey the loose asbestos when it is discharged from the bag-opener to the next stage of the process.
- Totally enclosed system to handle the empty bags.
- Dust control ventilation on all equipment.

6. Manual Bag-Opening Stations

If it is not possible to use bag-opening machines as described above, it is important that proper care be taken to ensure that the manual bag opening is done in a safe and dust-free manner.

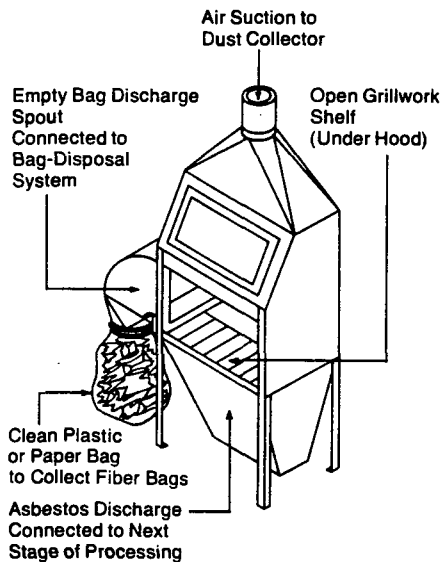
6.1 Each station where asbestos bags are to be opened manually must be designed to include these features:

- An enclosure inside which the asbestos bags are opened and emptied.
- An enclosure equipped with air suction to ensure control of all dust emissions during bag opening.
- The disposal of empty bags into a dust-controlled receptacle.

6.2 An example of a manual bag-opening station is shown at Fig. 2; other designs are available upon request.

The asbestos bag must be put in the bag-opening chamber before it is slit to remove the contents. An air flow volume of approximately 60 cubic metres per minute must be entering through the opening at the front of the chamber to ensure that dust does not escape. This is maintained by suction at the dust pipe. Once the asbestos has been discharged, the empty bag must be disposed of immediately in a safe, dust-free manner. This is accomplished by having a large discharge spout affixed to one side of the chamber with the final bag-disposal system attached to it.

Figure 2



6.3 Whichever bag-opening system is used, mechanical or manual, it is recommended that the dust control air filter be positioned in such a way that the collected dust falling from the filter during the cleaning cycle is reintroduced immediately into the process.

7. Conveyors for Loose Asbestos Fibre

When loose asbestos is discharged from the bag-opening machine it must be conveyed to the next stage of processing in a totally enclosed system. The least complex method is direct by gravity. For example, the bag-opener is positioned immediately above the mixer and discharges directly into it. If this is not possible other methods include screw conveyors, belt conveyors, bucket elevators and pneumatic conveyors of the vacuum type. It is imperative with each type that the system is totally enclosed and equipped with air suction to ensure that no dust can be emitted. Pressurized pneumatic systems are not recommended because any leaks will cause dust to be expelled into the atmosphere.

8. Empty Bags

The empty bags discharged from the bag-opener generally contain a slight residue of asbestos fibre. Hence, they must be treated with the same precautions as the asbestos itself. This means conveying them by direct means to the bag-disposal system. The least complex method is by gravity through a totally enclosed system. If this is not feasible, screw conveyors or belt conveyors can be employed. They too must be totally enclosed and equipped with air suction to ensure that no dust can be emitted. It is recommended that bag disposal be done by grinding or melting devices or by using a clean plastic bag to collect the empties. Refer to RCP4 — Section 9 — Disposal of Packing Materials.

9. High-density Block Packaging

One Canadian asbestos producer has developed 'high-density block packaging'. This consists of compressing the fibre into a solid block (about half the volume of a normal pressure-packed bag). This producer has also developed a block-breaker which is capable of crushing the blocks as well as pressure-packed fibre. This means that both pressure-packed and high-density block fibre can be treated in the same block-breaker to render the fibre suitable for onward processing.

10. General

Further information on the names and addresses of the equipment manufacturers or any aspect of the safe opening of asbestos bags will gladly be supplied by the Asbestos International Association or by any of the Association Members whose addresses are contained elsewhere in this publication.

Manual Bag Opening Station

Basic Unit

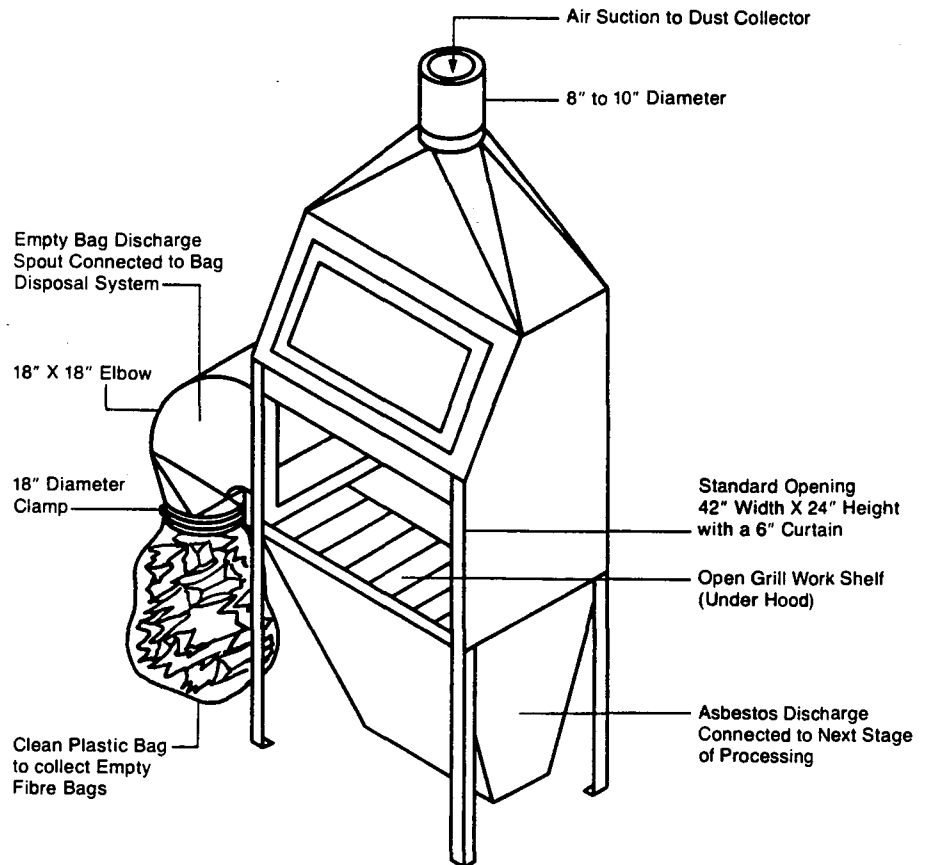
Approximate Size: Can be custom designed to fit customer need. Basic model 3'6" x 3' x 6" (106.7 x 91.4 x 182.9 cm)

Fibers Handled: All types and grades.

Supplier: Can be made up by most metal shops. Usually made in customer's own plant.

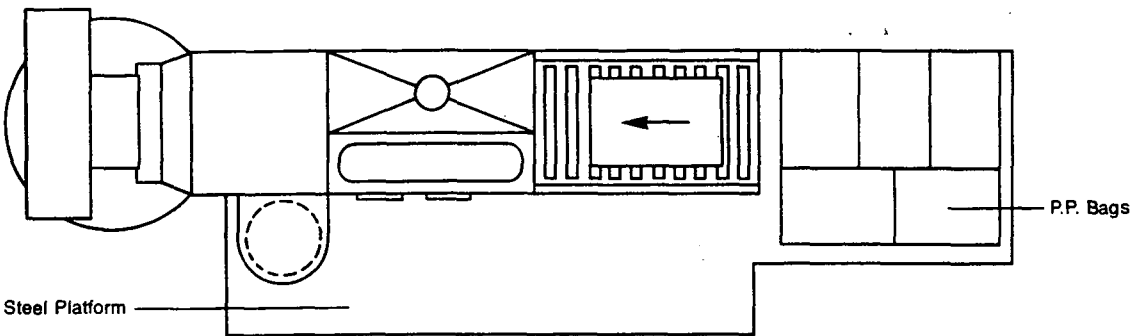
Approximate Cost: \$1,000.00 (Canadian) 1981.

Comments: Should be connected to a good dust collection system. Will require 800 to 1,000 cfm (22.7 to 28.3 m³/min.). Table height should be approximately 2'8" (81.3 cm) off floor.

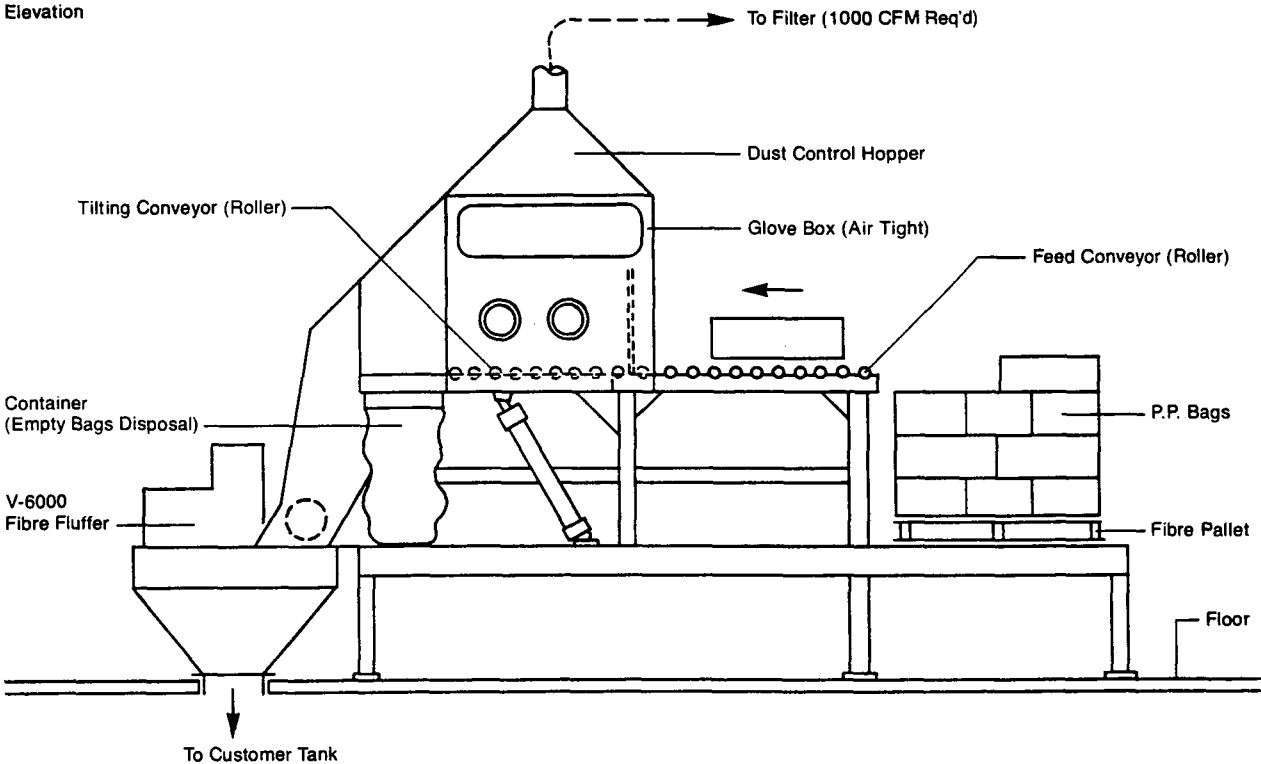


An Example of an In-Line Manual Bag Opening Station

Plan View



Elevation



**The Bag Dump Station with Efficient
Dust Control!**

Today's strict dust control regulations make collection of airborne particles in work areas a necessity. Young Industries' Self-Contained Filter/Bag Dump Stations are designed to provide maximum dust control for all powdered materials, and without external ducting, auxiliary fans or filters.

Young Filter/Bag Dump Stations are designed for bag, drum, and tray dumping operations, with design flexibility to accommodate all standard or special type material containers.

Stations are available with standard:

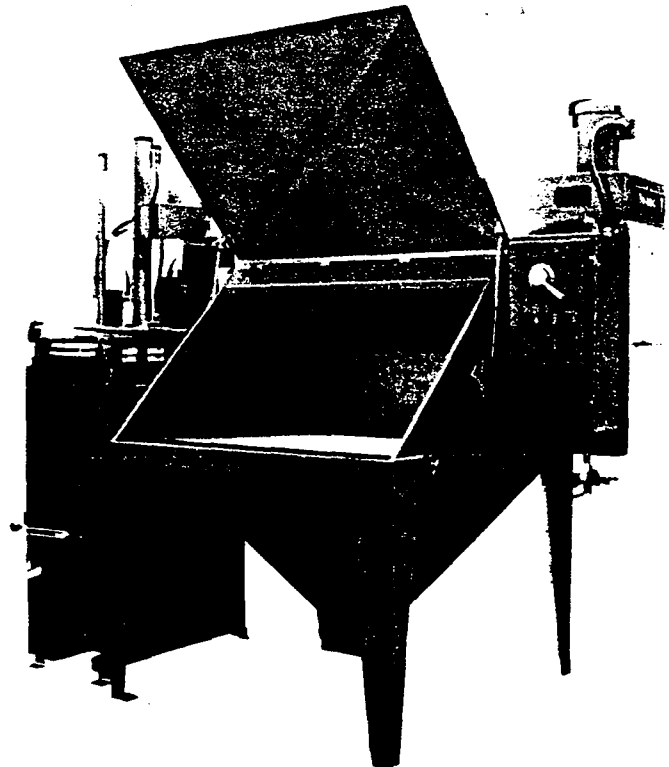
- Pyramid Hoppers — for gravity discharge, rotary airlocks, air feeder pick-up manifolds or to match other type conveyor inlets.
- Trough Hoppers — with discharge screw conveyor or lump breaker.
- Dual Hoppers — when cross contamination with collected dust cannot be tolerated.
- Flanged Units — for mounting directly to mixers or bins.

Continuous Cleaning Operation

Each Bag Dump Station incorporates a Young "Uni-Cage" Horizontal Pulse Jet Filter-Collector and Fan for dust control and product recovery. As bags or drums are emptied, material passes through the bag support grating and into the discharge hopper.

An air stream carries fine dust particles into the multiple filter section, depositing it on the exterior of the filter bags. A Solid State Timer automatically controls the filter cleaning cycle by introducing pulses of high pressure air into the bags. Accumulated dust drops into the hopper for discharge.

The filtered air is exhausted through the blower silencing plenum and returned to the immediate work area, saving energy and eliminating a make-up system for conditioned or heated air.



Easy Access, Low Maintenance

"Uni-Cage" external bag replacement simplifies maintenance. A hinged access door provides easy visual inspection of the filter bags. Jet pipe and filter tube assemblies can be individually removed.

Standard units are equipped with 14 oz. polyester felt filter bags, with other materials available to meet special process specification. Filter/Bag Dump Stations are shipped completely shop assembled for easy field installation. Standard materials of construction include carbon steel and stainless steel with a variety of finishes or coatings.

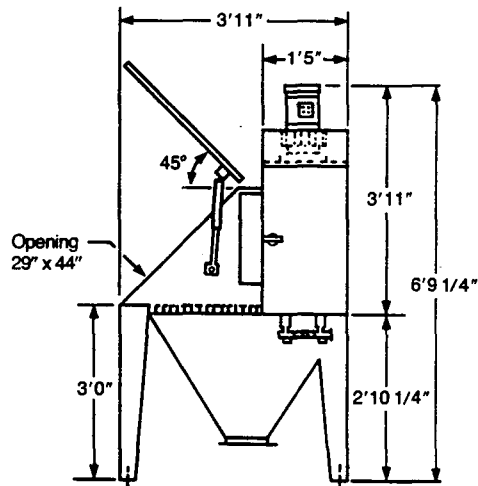
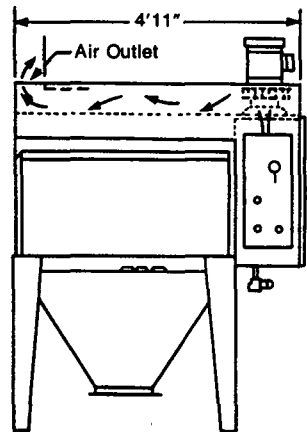
Controls

Stations include factory mounted Control Panel, NEMA XII (dust-tight) with main disconnect, motor starter(s), control transformer, filter timer and pushbutton controls.

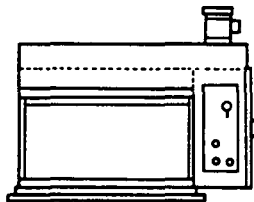
Optional Accessories

Charging opening door with gas spring cylinders protects the Bag Dump Static opening from foreign objects when not in use. Explosion-proof motors, pushbutton station, and starter panel are also available.

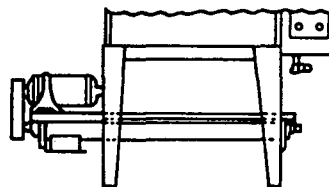
Pyramid Hopper



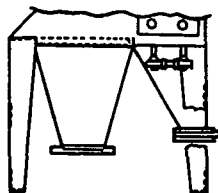
Flange Mounted



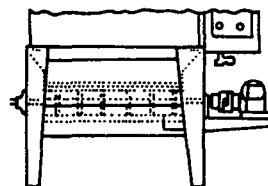
Screw Conveyor



Dual Hopper



Lump Breaker



For information only. For installation, request certified drawings.

The Young Industries, Inc.
Muncy, Pennsylvania 17756
Phone: 717-546-3165

Bulletin 208-377

Patent Pending
Specifications Subject to Change Without Notice.

Manual Sack Tip

The JSK Manual Sack Tip is the complete answer to low cost sack emptying in a dust free atmosphere. The compact and robust unit embodies a simple and effective operating principle with the facility to open all types of sacks.

- Simple concept ensures all sack types and products are handled.
- Efficient discharge even on sacks with liners or lumpy products.
- Unit designed for easy clean down and minimum cross contamination.
- Compact self contained unit easily installed in new or existing plants.
- Various outlet chute options available.

Waste Compactor

The JSK Waste Compactor is a simple, robust and lowcost machine, also available as a separate unit, and suitable for compacting paper, card, sacks, plastics and foils. The compacted waste is extruded into polythene sacks or tubing, producing a clean, convenient package for subsequent handling.

- Compactor driven by single continuous running motor, no hydraulics, pneumatics or complicated controls.
- Continuous collection and compaction principle allows manual or automatic feed options.
- Dust emission fully controlled during compaction of emptied sacks, plastics trimmings and fibrous products.
- Waste compacted into polythene sacks or tubing for dust free handling after removal from compactor.

Machine Operation

- Sack is placed on infeed tray and slit manually by the operator.
- Air is drawn into the unit through the infeed, entraining any airborne dust.
- Product discharges from the sack through the fixed mesh into the outlet chute with the minimum of operator effort.
- The empty sack is posted over the rear of the tipping hopper into the integral compactor where it is compressed into a polythene sack or tubing.



A Drum Tip and Manual Sack Tip combination installed at Don International, a major world brake and clutch lining manufacturer, to handle Johns-Manville Pressure Pack Asbestos and drums of brake lining resin in a dust controlled extraction hood to comply with safety regulations.

The installation consists of two drum tip units mounted side by side tipping drums of brake lining resins into mixers beneath a mezzanine floor.

Each drum tip is covered by a dust extraction hood system which incorporates an asbestos sack handling unit which faces each drum tip. This enables sacks of asbestos to be manually slit and the contents tipped into the same mixer as the respective drum tip.

The two Manual Sack Tip sections are served by a common horizontal roller conveyor and an inclined belt conveyor feeding from floor level between the two drum tip units. Empty asbestos sacks are posted through the side of each unit into a waste collection sack.

Machine Specifications

- 150 sacks per hour Max.
- Power required 2.2 KW (optional dust Extn. Unit 1.5 KW)
- Weight approx. 170 Kg
- Mild Steel constn. epoxy finished (Stainless Steel available to order)

Machine Dimensions

1230 cm deep x 1230 cm high x 1850 cm long

Ask for — Drg No.: J15 Manual Sack Tip
Drg No.: J20 Waste Compactor

JSK Product Range

- Fully Automatic Sack Splitter
- Manual Sack Splitter
- Drum Tip Unit
- Uni-Lift Elevator and Conveyors

- Compactors and Balers
- Automatic Bin Filling Chutes
- Scissor Lifts and Depalletizers
- Control System and Panels

Test Facilities

Full test plant facilities are available at our Chesterfield works for customer demonstrations and trials.

For further details please contact:

JSK (Materials Handling) Ltd.

Unit 2, Carrwood Road
Chesterfield Trading Estate
Chesterfield S41 9QB
Tel: 0246-453480, Telex: 966219.

The high speed machine for handling all types of powdered, granular, fibrous and pressure packed materials in a dust controlled environment.

All Products Handled

Unlike all other Sack Splitters, the JSK machine is not sensitive to material characteristics:

- Free Flowing
- Agglomerated
- Pressure-Packed Asbestos — are all handled with no adjustments and at similar throughput rates.
- Crystalline
- Fibrous

All Sack Types Opened

- Multi Walled Paper
- Paper with Plastic Liners
- Plastic
- Woven Polypropylene
- Hessian — are all cut cleanly by the flat edged rotary blades, minimizing product contamination. The hardened steel blades ensure simple and infrequent sharpening. The unique splitting operation requires no adjustments for varying sack sizes.

High Product Discharge Efficiency

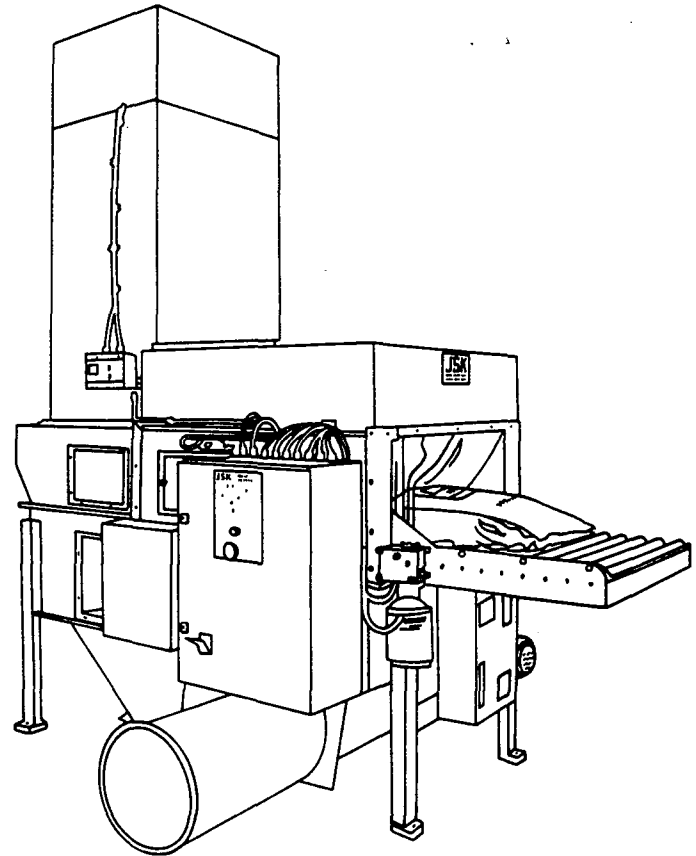
By splitting along three sides sacks are fully opened and corner pockets emptied ensuring high discharge efficiency even on fibrous, pressure-packed, lumpy and agglomerated products. Discharge is further enhanced by the unique rotating brush sweeping the entire inner surface of the sack.

Designed for Cleanliness and Dust Tight Operation

Attention to cleanliness in the initial design has resulted in:

- No Internal Flanges
- Vertical Machine Sides
- Minimum Hang Up Points
- Easy Clean Down
- Simple Conversion to Food Quality

All flanges are sealed, the machine being maintained under slight negative pressure by the optional Dust Extraction Unit, with direct material feedback, giving totally dust tight operation.



Integral Waste Compaction

Sacks are automatically fed into the integral waste sack compactor where they are compressed into plastic tubes or bags reducing the volume of waste and eliminating dust emission during subsequent handling.

Simple Operation and Maintenance

The machine operates on a continuous slitting principle, the only Stop/Start cycle being the infeed conveyor. The following incorporated features guarantee simple operation control and maintenance:

- Integral Interlocked Control Panel with Machine Mimic
- All Motors and Drive External
- Motors to IP55 as Standard (other options available)
- Safety Interlocked Doors
- Viewing and Access Windows

Compact Unit for Easy Installation

Small physical machine dimensions ensure a minimum of floor space is occupied. Low infeed requires no long, space consuming, infeed conveyor. The machine is delivered ready-wired and tested requiring only mains electricity supply.

Test Facilities

Full test plant are available at our Chesterfield works for customer demonstrations and trials.

Machine Operation

Bags are automatically fed into the machine from the infeed conveyor in a continuous cycling operation.

Automatically adjusting rotary blades cut each bag on three sides.

The material is ejected from the opened bag under gravity.

The waste bags are ejected and compacted into polythene bags in a fully dust tight operation.

Machine Specification

Sack Sizes

The machine accepts sacks up to 2m long x 750mm wide x 370mm deep.

Throughput Rates

From 120-750 sacks per hour depending on sack dimensions.

Emptying Efficiency

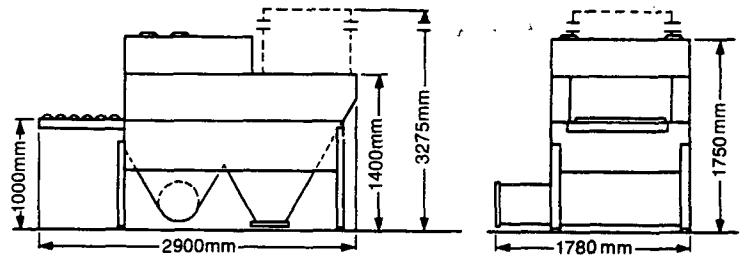
Maximum product retention from 0.1 to 0.5%.

Weight

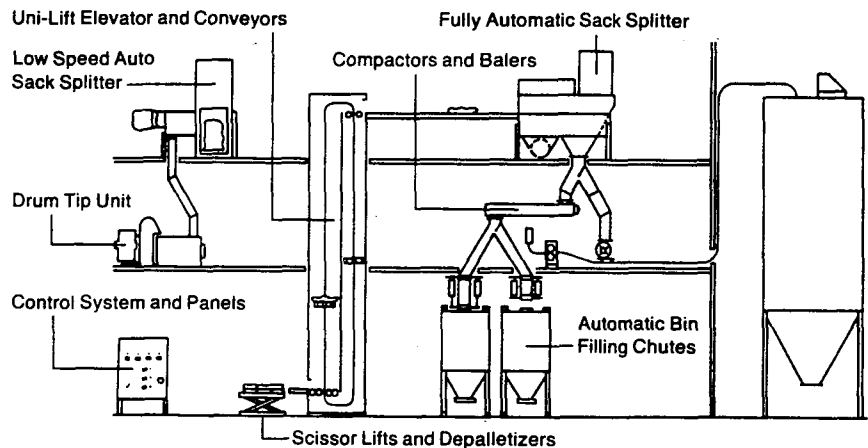
Approximate weight 1250 kg.

Materials of Construction

Mild steel construction with sprayed epoxy paint finish as standard. Various coatings, platings and stainless steel finishes available to suit individual requirements.



JSK Product Range



JSK Systems

JSK offer a service to manage and supply complete systems. Because the many years of experience in the powder and materials handling fields, JSK are able to provide:

- Assistance in system layout and planning at initial design stage.
- Quotations and drawings for full systems.
- Contract management including mechanical and electrical installation, commissioning and after sales back-up.

JSK (Materials Handling) Ltd.

Chesterfield Trading Estate,
Carrwood Road,
Chesterfield, Derbyshire S41 9QB.
Telephone: Chesterfield (0246) 453480
Telex: 966219.

Our policy is one of continuous improvement and we reserve the right to make changes to the specification as they are incorporated in production.

JSK Ltd.

Sack Splitter

Additional Addresses

Macawber Engineering Inc.

Clydesdale Street,
Blount County Industrial Park,
Maryville, Tennessee 37801.
Telephone: (615) 984-5286.
Telex: 557-439.

Macawber Engineering GmbH.

4300 Essen, Langenberger Strasse 449,
West Germany.
Telephone: (0201) 210 58 64 05.
Telex: 8579915.

Macawber Engineering Limited.

Shaw Lane Industrial Estate,
Doncaster, South Yorkshire DN2 4SE.
Telephone: (0302) 21313.
Telex: 547273.

Macawber Engineering Pty. Limited.

P.O. Box 216, 15 Pavitt Crescent,
North Wyong, NSW 2259.
Telephone: (043) 531788.
Telex: AA72343.

Macawber Engineering Inc.,

Clydesdale Street,
Blount County Industrial Park,
Maryville, TN 37801.
Telephone: (615) 984-5286.
Telex: 557-4439.

Atlanta: (404) 252-6828,
Erie: (814) 838-6431

General Description of Operation

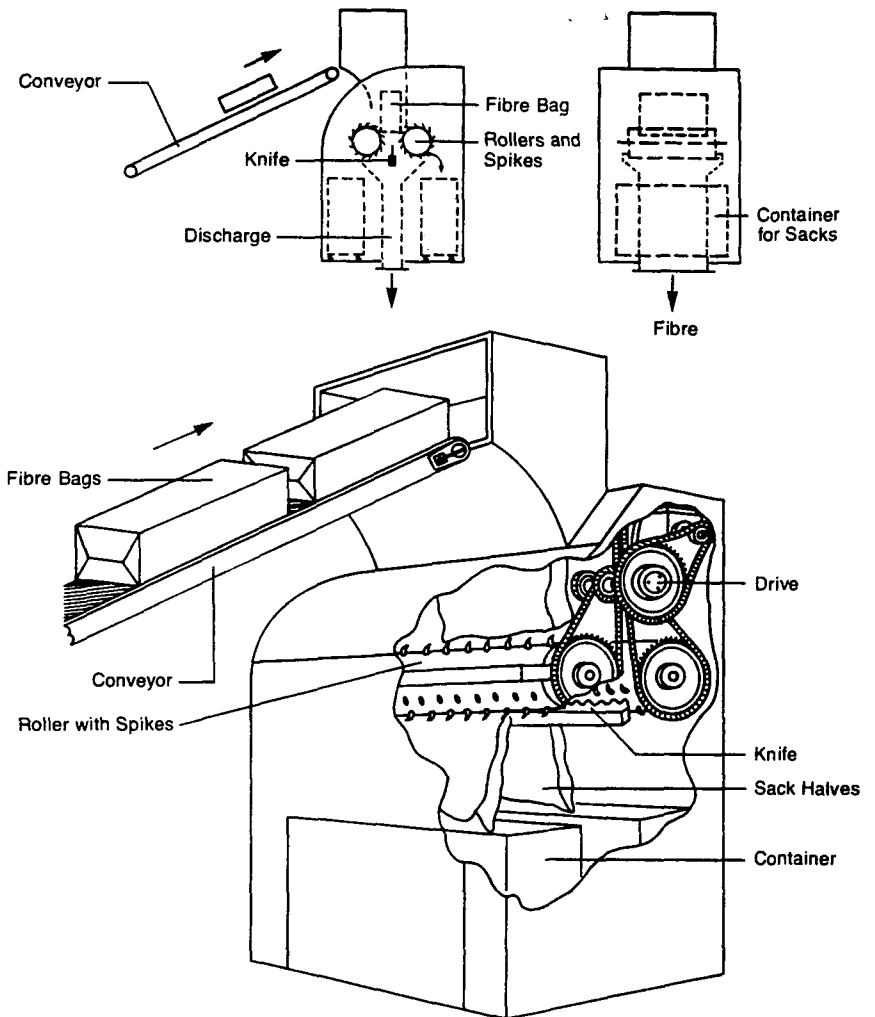
The Bel-Tyne Automatic Bag Opener will handle any type and size bag; multi-walled, paper sack, polywoven, jute, etc., including combined variance such as plastic lined bags. It was originally designed to handle pressure packed asbestos and found instant acceptance in the industry. It is now used in a wide range of industries from food processing to the heavy chemical companies.

The ability of the Bel-Tyne Automatic Bag Opener to handle all types of bags, and do so in an enclosed atmosphere, makes it ideally suited to batch blending operations. When conveyor fed it is not necessary to pre-position or space them on the conveyor. The opener will automatically position them within the feed chute and control the rate at which the bags are fed.

The bags which have been cut lengthwise to insure maximum material discharge, are dedusted of any loose material remaining on them. They are then compacted by twin compacting units for discharge into a suitable container, usually plastic bags. This eliminates the need for further handling of the contaminated sacks and prevents further environmental pollution.

The machine is simple and uncomplicated in design. Of heavy construction, the rate of feed is adjustable so as to handle any type of fiber and degree of pressure packing. Discharge of the material is virtually 100%. The Automatic Bel-Tyne Bag Opener can be fitted with breaker rolls on the discharge. As only a minimum of suction is required, an integral dust collection system is not included. We would supply this and any other ancillary equipment necessary. The Bel-Tyne Automatic Bag Opener is complete with control panel for a complete interlocking system. It can be provided with explosion proof motors.

Bel-Tyne Bag Opener



Approximate Size:

96" high X 61" wide X 55" long (243.8 X 154.9 X 139.7 cm) — machine 48" X 48" X 72" (121.9 X 121.9 X 182.9 cm) — separate dust control*

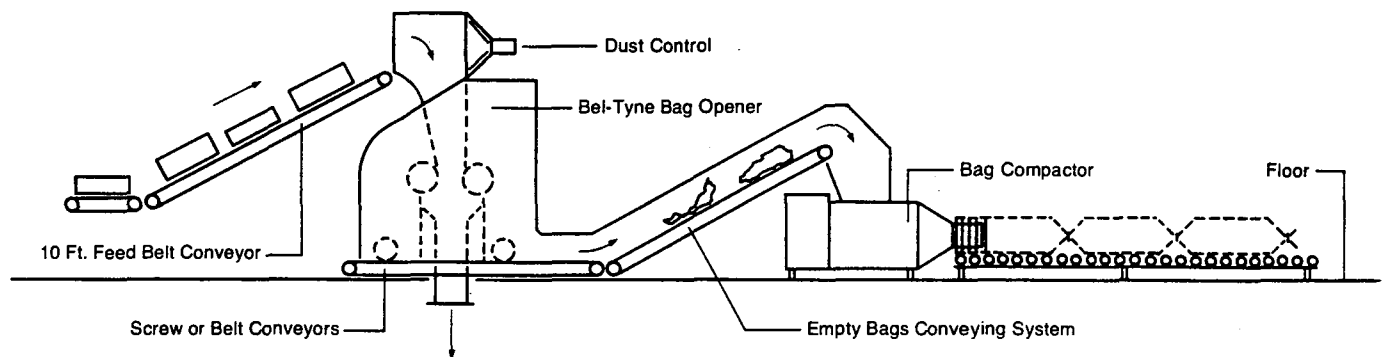
Fibers Handled:

All types and grades of pressure packed material.

Approximate Capacity:

Groups 3 & 4 up to 120 bags per hour
Groups 5, 6 & 7 up to 160 bags per hour

Bel-Tyne Bag Opening System



Dust Control — requires 700-1000 cfm (19.8-28.3 m³/min.)

Note: The cutting blade has to be resharpened every 2000 bags (10 min. job to replace)

Weight: Approximately 1670 kg = 3682 lbs.

It is a fully automatic machine specifically designed to open all types and grades of pressure packed asbestos fiber. It automatically adjusts to differing bag sizes.

Fully enclosed system for use in dust controlled environment.

Eliminates empty bag handling.

It is a relatively simple, compact and dependable machine. It performs well with poly or woven-poly bags but does allow some pieces of paper bag to escape with the fiber. With paper bags a scalping screen would be necessary to remove the pieces of paper.

Price

(Dec. 1979)

\$33,750.00 (U.S.) — f.o.b. East Coast ports (N.Y., Baltimore, etc.) complete with compactor and electrical panel.

Optional Extras:

Feed conveyor \$4,700.00 U.S. (supplied from U.S.A.)

Suppliers:

Bel-Tyne International, Inc.

1600 Pennsylvania Ave.

York, PA

USA 17404

Bel-Tyne Co. Ltd.

Victoria Works

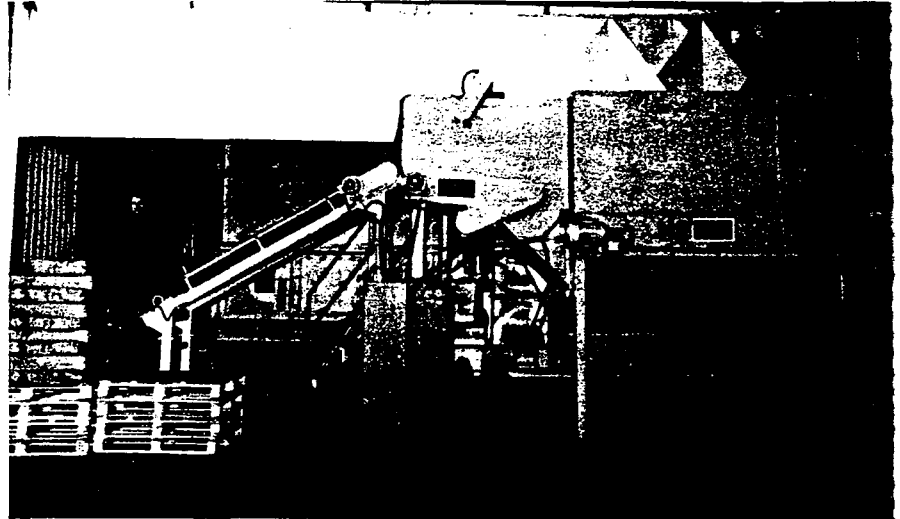
Brewery Street

Stockport, SK1 2BQ

England

Operation

Bags are slit open then tumbled in a trommel screen to release fibre. Empty bags are collected and compacted into polythene bags ready for discard.



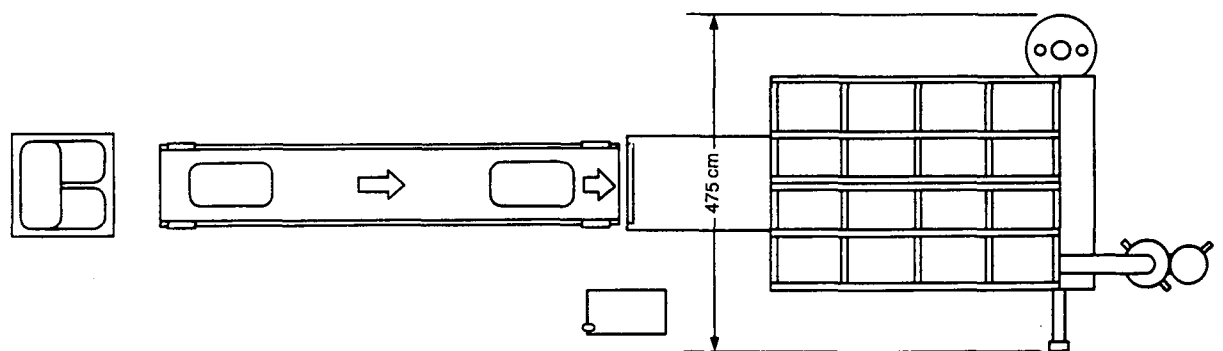
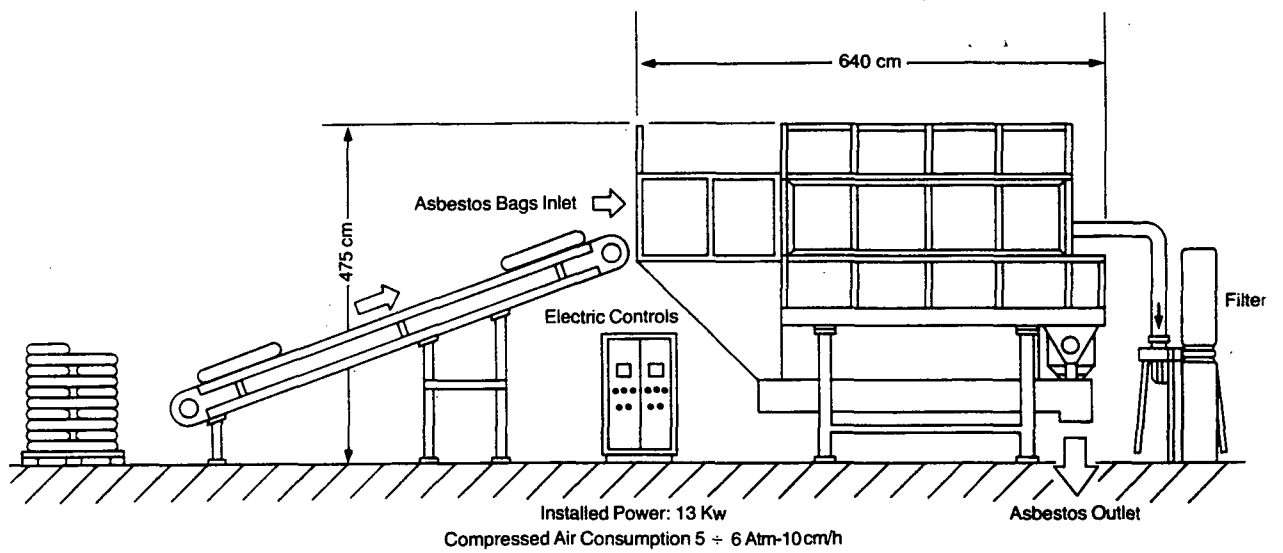
Technical Characteristics

The Bag Breaker can empty any type of asbestos bags, jute bags excepted.

- Capacity: 200 and more bags per hour
- Residual asbestos in the wrap after Bag Breaker treatment: Less than 1 gr. per bag
- In the atmosphere near Bag Breaker: Less than 0,1 fibres per cu. cm
- Asbestos comes out soft and it is ready to be processed
- Installed power: 13 Kw
- Consumption of compressed air at 5 ÷ 6 Atm: 10 cu. cm per hour
- Surface requirements: 26 sq. m — max. height: 4,75 m
- Wraps of bags after Bag Breaker treatment are given back, pressed, in a plastic bag
- By request: it is possible to use kneaders for paper bags

Manufacturer:

SPA Ispra
20037 Paderno Dugnano
Milan, Italy
Via Gallilei, 19
Telex N 330113



Bag Opener and Destroyer

General Description

BOD 80 — Bag Opener and Destroyer is able to automatically open and empty any kind of pressed and unpressed asbestos bags.

It entirely solves the ecological problem of destroying empty bags made of non-degradable materials.

It granulates the empty bags and recycles the fragment into the slurry.

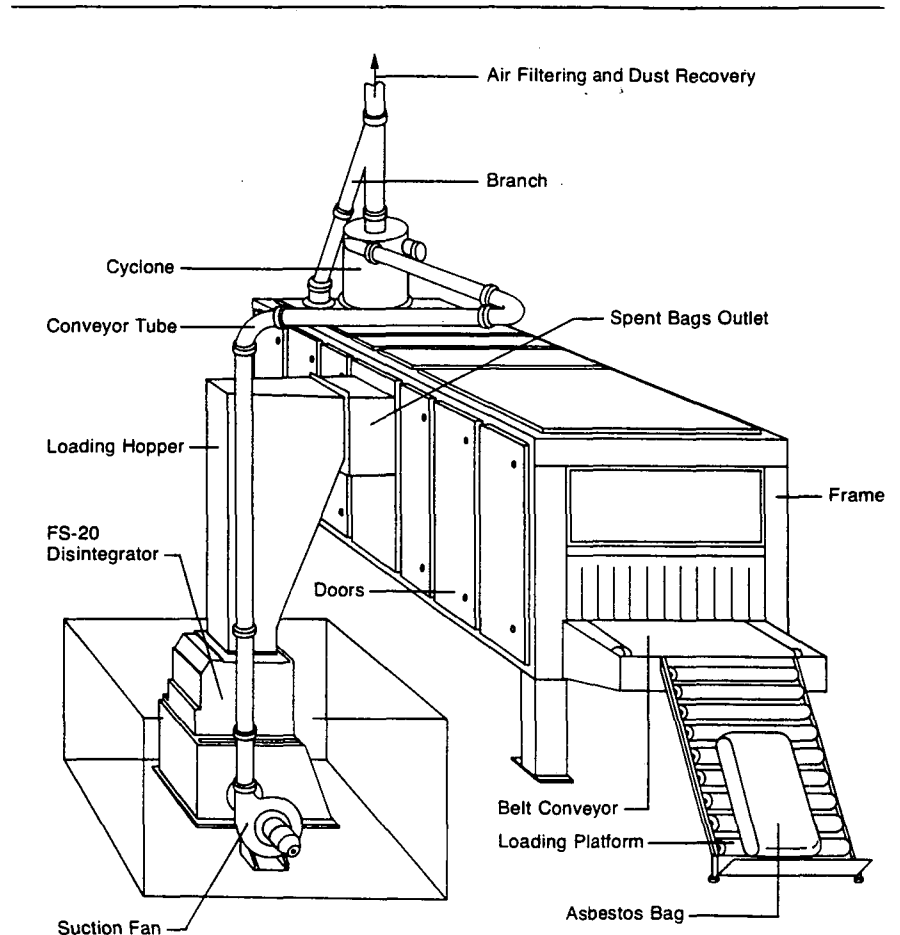
It opens and destroys any kind and size of bags containing asbestos fibres or any other material.

The study and planning of BOD 80 have required about 3 years, and in this period, several prototypes were made, which, submitted to very severe tests in actual working conditions, have allowed us to realize the definite machine.

The asbestos bags are introduced into the machine by means of a conveyor belt.

The bags, after being cut and emptied, are automatically introduced into a proper disintegrator which reduces them into fine fragments. These, at the customer's choice, can be gathered in special containers or recycled and mixed with the asbestos fibres to be incorporated in the end product.

- The machine is completely closed and dustproof.
- Maintenance is practically nil.
- All the parts which require lubrication are centralized outside the machine.
- The covering is equipped with transparent panels which allow supervision in every working stage.
- The overall dimensions are very reduced and occupy a surface of about 14 sq. m.
- Working is very simple and safe; it does not require compressed air or hydraulic automation.



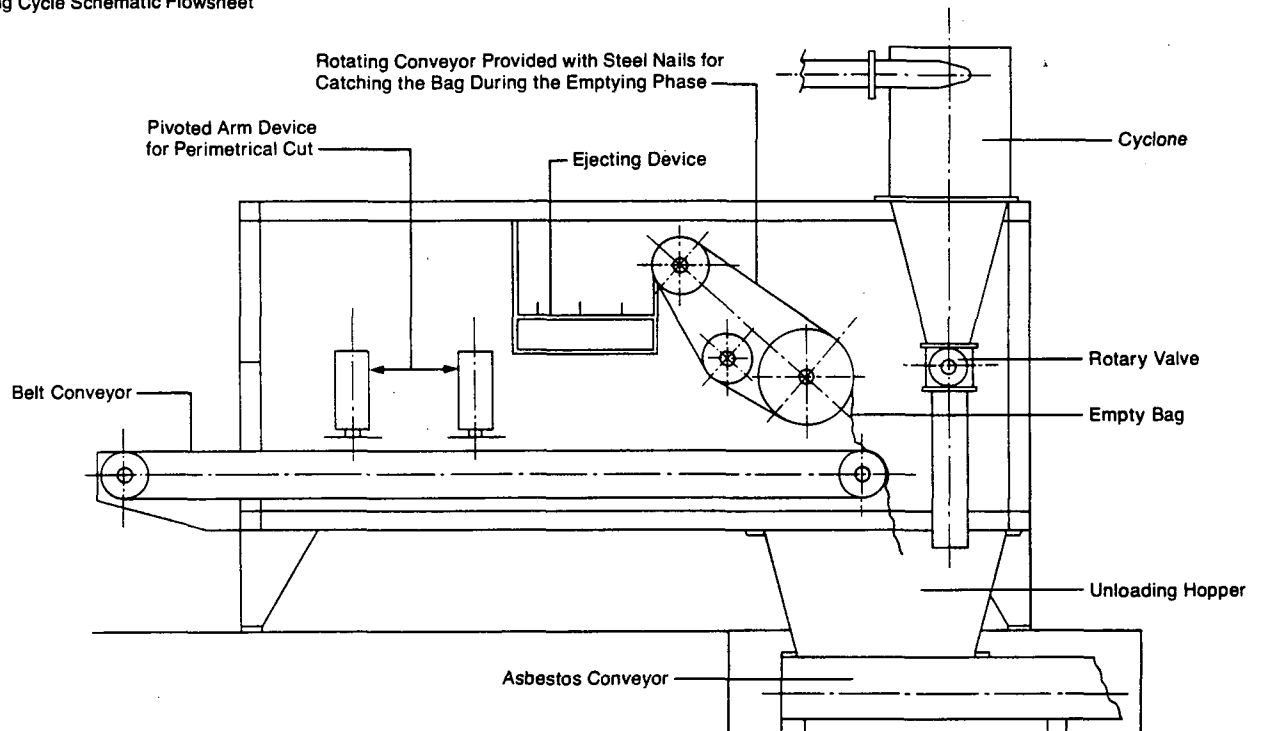
BOD 80 is completely equipped for the working program and does not require any optional accessories.

The modularity and reduced dimensions allow the easy installation in existing plants.

BOD 80 is also equipped with an electric board which allows the working control in automatic-manual cycle.

The plant for the granulation and recovery of spent bags can be separately supplied.

Working Cycle Schematic Flowsheet



Specifications for the Working Cycle

The working cycle of BOD 80 consists of three stages:

1. Bag cutting and emptying operation.
2. Wrapping recovery and ejection.
3. Crushing and recycling of smithereens.

Stage 1 — Bag Cutting and Emptying Operation

A conveyor carries the bag inside the machine to the cutting device.

Two revolving discs, controlled by as many motors, are respectively placed on the right and left side of the conveyor and are employed to cut three edges of the bag while this one is carried towards the discharge hopper.

The cutting blades 300 mm. in outside diameter are made of a steel disc on whose circumference sintered sectors are fixed (tungsten carbide). The

employment of the discs is advantageous for two reasons:

- Supplies of interchanging pieces are not necessary since the discs are normally used for the longitudinal and transverse cutting of A/C wet sheets.
- Sharpening is made after 1500 working hours since the tungsten carbide is a wear resistant material.

Stage 2 — Wrapping Recovery and Ejection

The wrapping, after being cut, is caught by a proper conveyor and pours out its contents into the hopper and then goes on towards the ejecting device connected to the disintegrator throat.

The conveyor which hooks up and recovers the wrapping, is provided with a proper device with retractable nails so

as to guarantee assurance and safety in the different working cycles. The loss of wrapping or parts of it is practically impossible.

Stage 3 — Crushing and Recycling of Smithereens

The wrapping, passing through the ejector, is automatically introduced into the disintegrator and smashed to smithereens in a very short time.

These ones, at the customer's choice, can be separated in proper containers or directly recycled and mixed with the asbestos fibres to be incorporated in the end product. Small asbestos clots, which may be kept in the creases of the wrapping, are carried through the disintegrator and are immediately recycled and recovered without any loss.

**Bag Opener and
Destroyer**

Specifications

Output	200 bags/hour
Bag Sizes	Max. height 400 mm (16") Max. length 2000 mm (78") Max. width 1000 mm (39") Min. width 300 mm (12")
Wrapping	Paper, polypropylene, polyethylene, etc. Jute excluded.
Pollution	Less than 0.1 asbestos fibre/cm ³ air

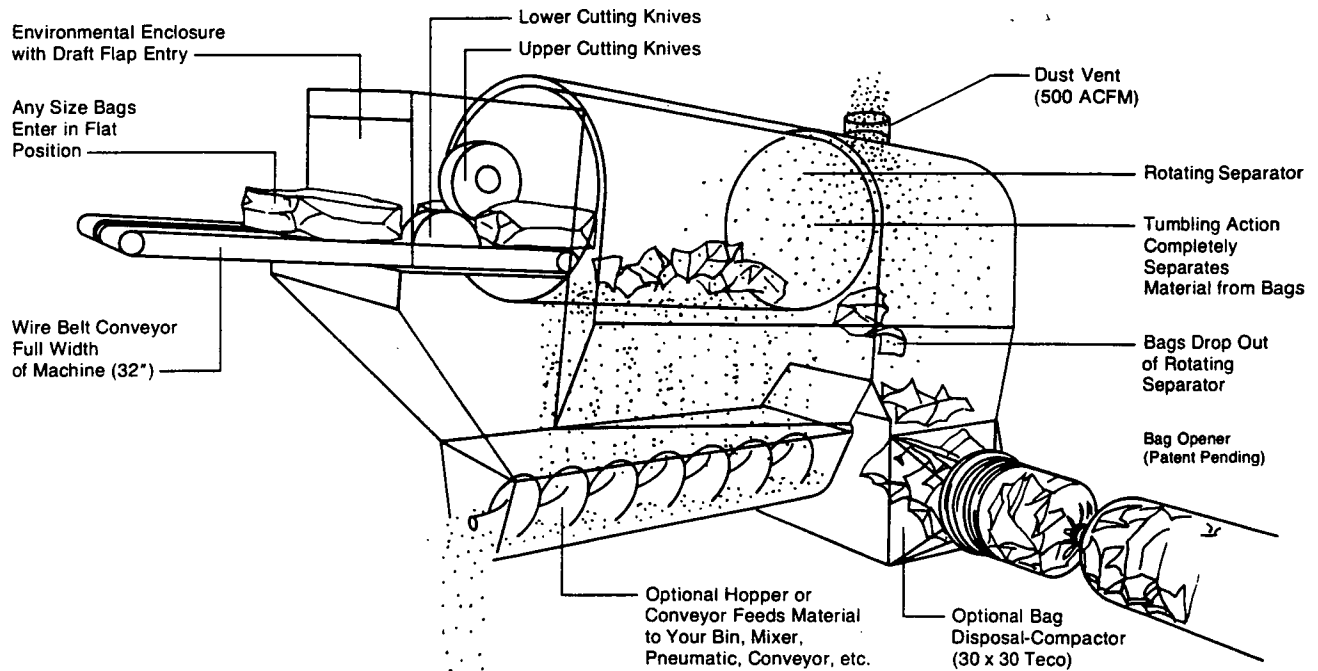
Electric Power

The installed power is 23.5 Kw., distributed as follows:

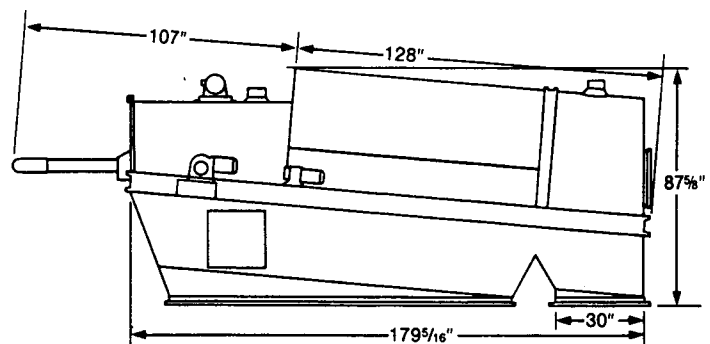
Bag opener	7.0 Kw
Disintegrator with Suction Fan	16.5 Kw
	<u>23.5 Kw</u>
Dust Exhausting Unit	The dust exhausting equipment can be supplied with filter and accessories, coupled with a suction fan rated at 2,000 m ³ /hr.

Designed and manufactured by:

Salvaneschi
27, Via Roma
P.O. Box 19
27043 Broni (PV) Italia
Telex 320541 SALVITI
Tel. (0385) 51.024 - 51-133
Telegr. F.LLI SALVANESCHI



Model #RTS-100 is a larger unit with infeed conveyor for any and varying or mixed size industrial bags. It is custom set at the factory to handle your particular type and particle size material. Feed is continuous up to 25 bags per minute depending on the material flow characteristics. Unit is completely enclosed and requires only minimal venting for complete dust control. Razor sharp knives slit the bag as it is conveyed in a *flat condition* into a rotary separator. A screen (with mesh sized to meet your requirements) permits material to drop into an optional collecting unit which can be supplied in a variety of design options. The bags are ejected continuously and, with our optional 30 x 30 Empty Bag Compactor, are automatically compacted to a fraction of their original bulk — already packaged for easy and clean disposal. Unit can be fed from a remote location (via flat belt conveyors) and no "positioning" of the bag is required.



Other available options:

- Built-in bag-type dust collectors
- Complete structural supports
- Complete stainless steel units
- Empty bag enclosures
- Built-in product crusher for lumpy material.

Taunton Engineering Co., Inc.
700 West Water Street
Taunton, MA 02780
Telephone (617) 823-1776

Emphasizing Engineering

FORM No. 78-1

Approximate Size

4575 x 1300 x 1760 (cm)

Fibers Handled

All types and grades of pressure packed material.

Approximate Capacity

Normal, using 50 kgs bags.

6 bags/min. = 18 M tonnes/hour.

Maximum, instantaneous output
8-10 bag/min.

Dust Control

Requires 3000 m³/Hr.

Fully enclosed system for use in dust
controlled environment.

Bag Disposal Options

- Shredding of bag into pieces 1-5 cm².
- Fine shredding to recycle with Asbestos.
- Bailing of bags in compactor.

Operation

This machine mechanically handles the bags, opens, then separates the product (Asbestos), then disposes of the empty bags.

The bags can be either manually fed into or automatically brought to the machine by conveyor.

The bags are slit on three sides by rotating carbide tipped discs. The empty bag is gripped, emptied, then dumped in a bin for further disposal.

Armand Colinet

Society Anonyme
B-7078 Le Roeulx
Belgium

Fibre Fluffing Devices

This machine is capable of fully restoring fiber to a precompressed state, as measured by such tests as Surface Area and Efficiency. We feel it is the best available.

Should be connected to a good dust collecting system. Requires 500-1000 c.f.m. (14.2-28.3m³/min)

The picker roller breaks up the unwrapped bag of fiber into small pieces which are fluffed by the double stage fan blades below.

The capacity of the machine can be controlled by increasing or decreasing the speed of the picker roller — necessary to change sheeves on gear reducer.

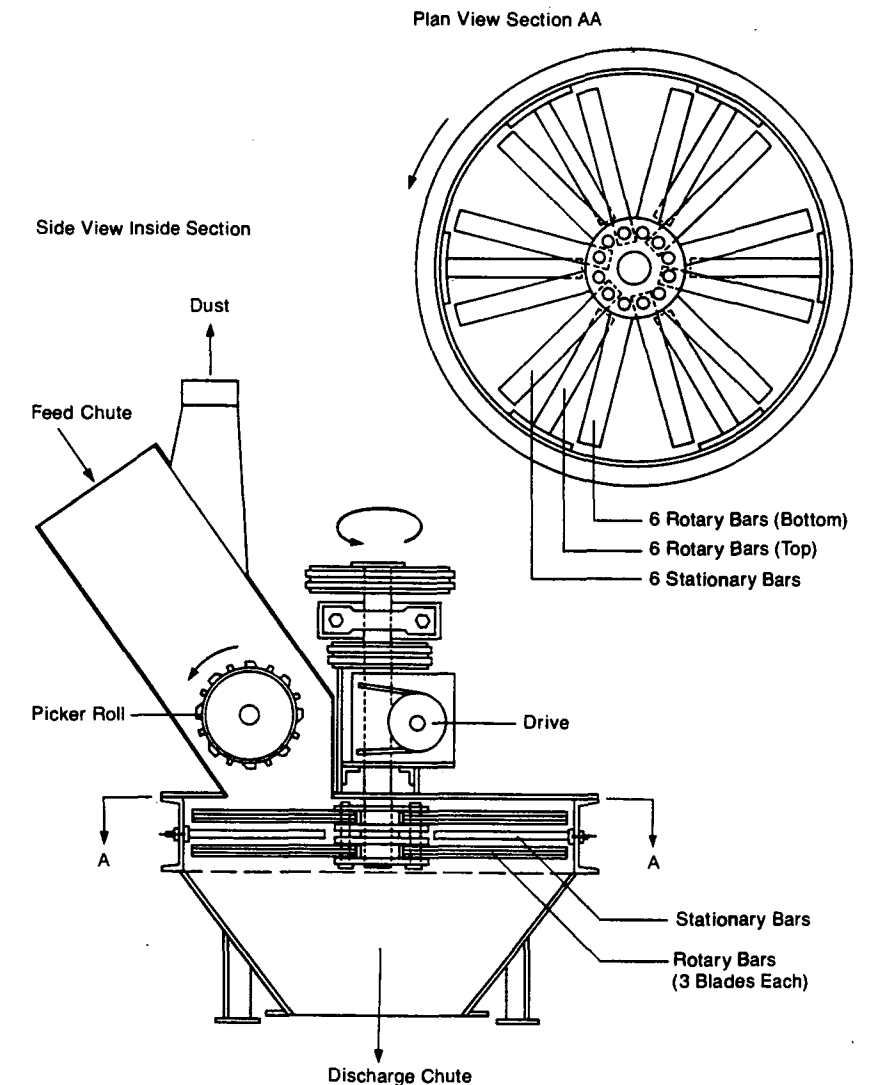
Approximate Size:
48" X 60" X 48" (121.9cm X 152.4cm X 121.9cm)

Fibers Handled:
All Chrysotile Grades.

Approximate Feed Rate:
Group 3 up to 1 T.P.H.
Group 4 up to 1½ T.P.H.
Group 5 up to 3 T.P.H.
Group 6 up to 6 T.P.H.
Group 7 up to 8 T.P.H.

Price:
May 1981 \$5,200.00 (Canadian) f.o.b.
Black Lake complete with mechanical components and safety guards, but without electrical motor.

Motor: \$300.00 (Canadian)
5 HP, 1800 RPM, T.E.F.C.
Electric motor 220/440 V
3 phase, 60 HZ
All duties and taxes extra if applicable.
Terms: Net 30 days.



Supplier:
Fournier Steel Works
P.O. Box 460
Black Lake
Quebec, Canada
Phone: 418-423-4243
Mr. Paul Aubé

Since their introduction in 1975 over 100 V-5000 and V-6000's have been manufactured and sold into the Asbestos and Chemical Industries. Many V-5000's have since been modified to V-6000's so that they could handle the more densified pressure packed bags introduced into the market place with the metrification of the Canadian Asbestos Industry.

Model No:
V-5000 Modification Kit

Price:
(Oct. 1980) \$678 Canadian)
f.o.b. Black Lake
All taxes and duties extra if applicable.

Kit includes:
Motor Drive Sheeve
V-Belts
Blades: (36) in set
Pins
New Hub
Fixed (stationary) Blades (6)
All necessary fasteners

This will modify a V-5000 fluffer so that it becomes a model V-6000.

Supplier:
Fournier Steel Works
P.O. Box 460
Black Lake
Québec, Canada
Phone: 418-423-4243
Mr. Paul Aubé

This is a very sturdy model of the old moody fluffer. This machine does a reasonable job of refluffing the fiber to a precompressed state and is particularly designed for refluffing long fiber such as Group 3.

Note: Because of its relative high cost, this machine should only be used if the V-6000 or H-7000 will not fit into the customer's operation.

Approximate Size:

81" long X 43" high X 43" wide (205.7 X 109.2 X 109.2cm)

Fibers Handled:

All Chrysotile Grades.

Approximate Feed Rate:

Up to 8 T.P.H. depending on grade
Group 3 up to 1 T.P.H.
Group 4 up to 2 T.P.H.
Group 5 up to 4 T.P.H.
Group 6 up to 6 T.P.H.
Group 7 up to 8 T.P.H.

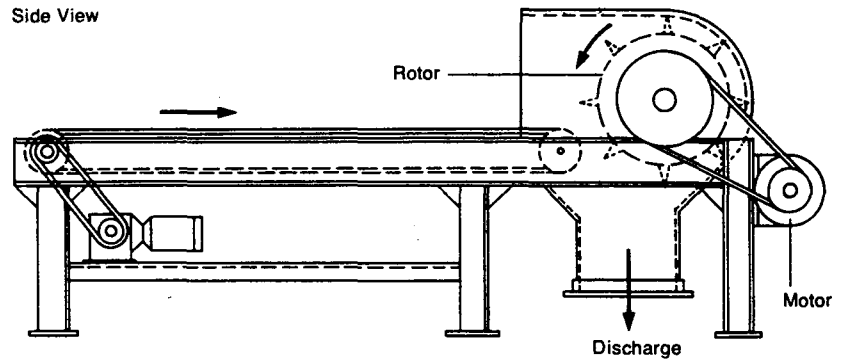
Price:

(Dec. 1979) approximately \$6,800.00
(Canadian) f.o.b. Black Lake
motor required 5 HP approx. \$250
(Canadian)

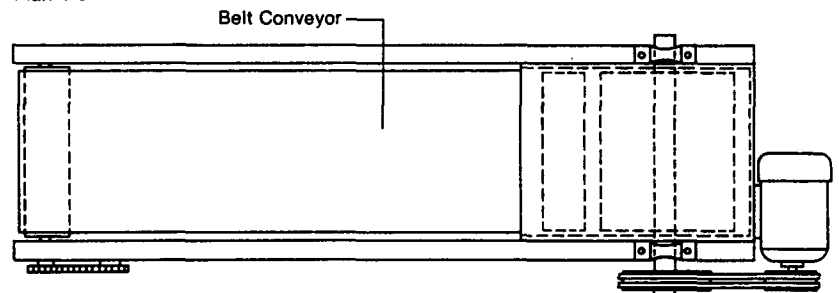
Supplier:

Fournier Steel Works
P.O. Box 460
Black Lake
Québec, Canada
Phone: 418-423-4243
Mr. Paul Aubé

Side View



Plan View



Shredder should have a breaker ahead of it so that small pieces are fed to rotating blades.

Usually mounted in an enclosed area such as a chute.

Must be connected to a good dust collection system.

Will require approximately 800 c.f.m. (22.7 m³/min)

This machine will restore the fiber to a state almost equal to noncompressed. It is almost as effective as the V-6000.

Best application is where space is a major consideration.

Available in 1/4" and 1/8" (.64cm and .32cm) spacing

Approximate Size:

Basic Model 12" X 12" X 12" (30.5cm X 30.5cm X 30.5cm)

Usually custom made to customer requirements.

Fibers Handled:

Chrysotile Grades 4 to 7.

Approximate Capacity:

Up to 10 T.P.H. depending on grade.

Group 4 up to 2 T.P.H.

Group 5 up to 3 T.P.H.

Group 6 up to 4 T.P.H.

Group 7 up to 10 T.P.H.

Price:

(Dec. 1979) approx. \$1,500.00

(Canadian) for standard 12" X 12" x 12" model.

Supplier:

Fournier Steel Works

P.O. Box 460

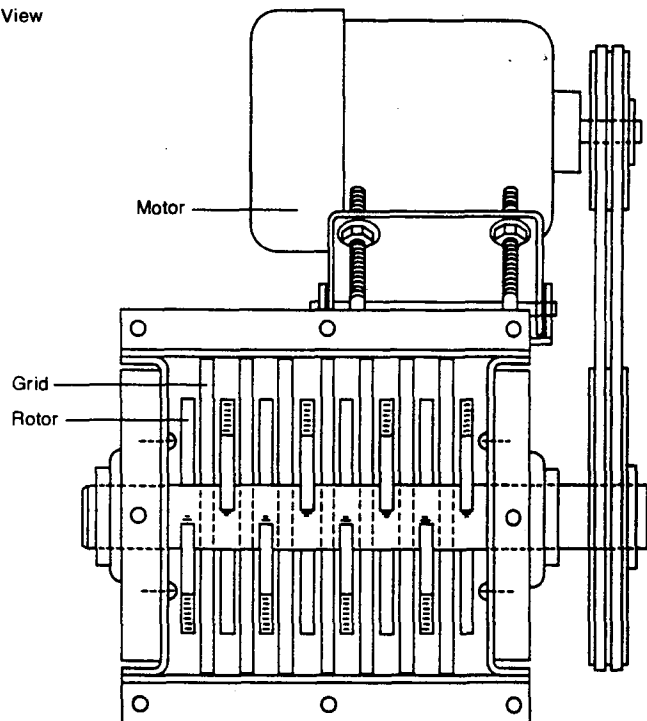
Black Lake

Québec, Canada

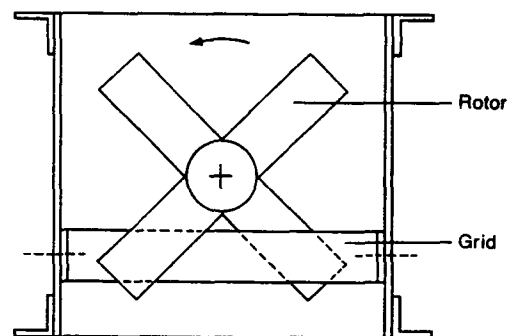
Phone: 418-423-4243

Mr. Paul Aubé

Top View



End View
Inside Section



Introducing Expo's Asbestos Fiber Fluffer specially designed for compressed fibers with feed screw conveyor.

Featuring:

- Screw conveyor can be made to specified length and height
- Processes up to 100 lbs. per min.
- Positive flow action eliminates blow back
- Mounted on heavy duty casters

Specifications:

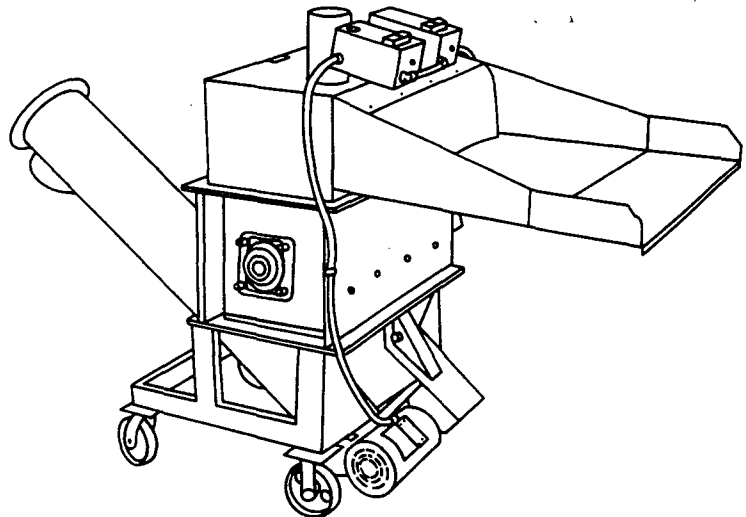
Power:	3 Phase 240, 440, 60 Cycle
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Overall Height:	51"
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Width:	38"
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Construction:	All Steel
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Special Power Requirements:	Available on Request
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The Asbestos Fiber Fluffer includes a three-phase motor and screw conveyor as standard items. Expo can build a fluffer within two weeks after the order is placed.

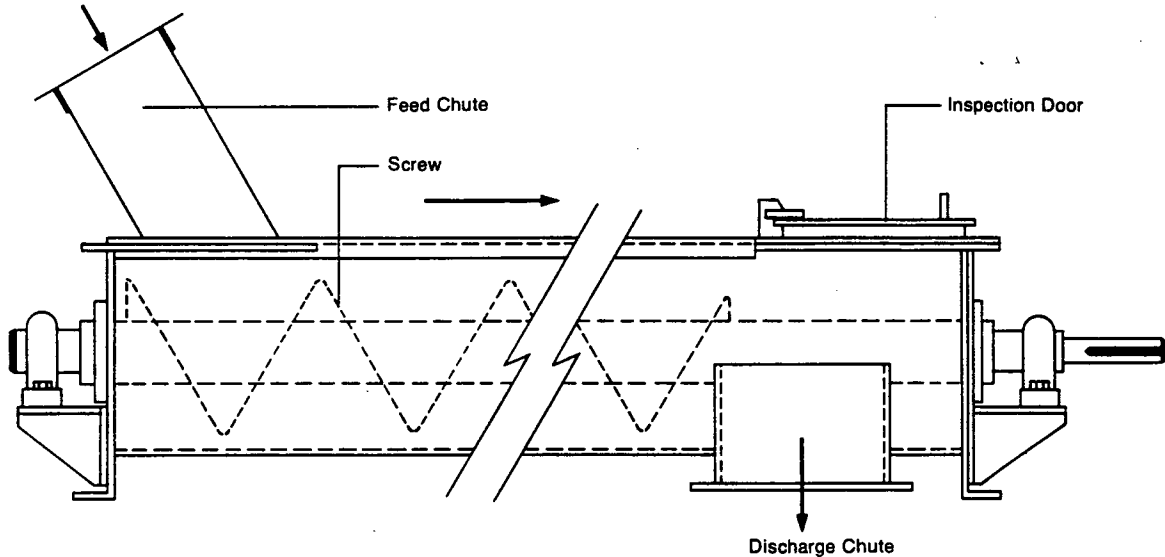
For further information, quotes and shipping schedules, contact:

Expo Machinery, Inc.
4832 Ridge Road
Cleveland, Ohio 44144
Phone: 216 398-0110

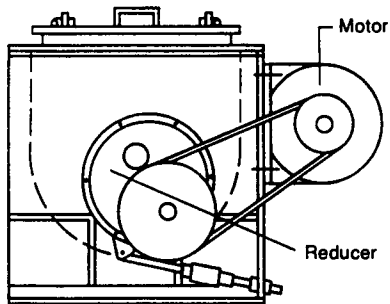
Asbestos Conveying Devices

Screw Conveyors

Side View



End View



Approximate Size:

Will depend on Customer Requirements. Usual diameter 12" to 14" (30.5cm to 35.6cm)
Max. length 25' (7.6m) per section

Fibers Handled:

All Chrysotile Grades.

Approximate Capacity:

Depends on Density of Fiber Handled, size of screw, etc.

Fiber Grade	Diameter	Capacity	Approx. Density (lbs/cu ft)
Group 3	14" min. (35.6cm)	up to 3 TPH	6 (96.1 kg/m ³)
Group 4	14" min. (35.6cm)	up to 5 TPH	8 (128.2 kg/m ³)
Group 5	14" min. (35.6cm)	up to 5 TPH	10 (160.2 kg/m ³)
Group 6	12" min. (30.5cm)	up to 5 TPH	13 (208.3 kg/m ³)
Group 7	12" min. (30.5cm)	up to 5 TPH	15 (240.3 kg/m ³)

The above are based on a screw with pitch = diameter, rotating at 40 RPM and 50% loading.

Notes:

Shaft 6" (15.2cm) diameter tube minimum, use 1" (2.5cm) clearance between trough and flights. max. incline = 30°. No internal bearings

Approximate Price: (1980)

12" or 14" (30.5cm or 35.6cm) —
\$2500-\$3000 (Can.) f.o.b. supplier
Installation cost - \$500 (Can.)

Suppliers:

Fournier Steel Works Ltd.
P.O. Box 460
Black Lake
Quebec, Canada

Continental Conveyors & Machine Works Ltd.

470 St. Alphonse Street East
Thetford Mines
Quebec, Canada

Sprout Waldron & Co. Inc.

Muncy, Pa 17756
(or) Rosemont, Ill 60018
U.S.A.

FMC Corporation

Material Handling Equipment Division

Screw Conveyors

U.S.A.

Division Headquarters & International Operations

Homer City, Pennsylvania 15748
Phone: (412) 479-8011
Telex: 86-6505
Answerback FMC MTHGEQ HCTY

Conveyor Equipment Operation

P.O. Box 1370
Tupelo, Mississippi 38801
Phone: (601) 869-5711

Regional Sales Offices

Atlanta Region

3301 Buckeye Road N.E.
Suite 211
Atlanta, Georgia 30341
(404) 455-8123

Boston Region

One Militia Drive
Lexington, Massachusetts 02173
(617) 862-2590

Chicago Region

125 Windsor Drive, Suite 128
Oak Brook, Illinois 60521
(312) 325-3250

Minneapolis Area

6040 Earle Brown Drive
Minneapolis, Minnesota 55430
(612) 566-9756

Cleveland Region

3645 Warrensville Center Road
Shaker Heights, Ohio 44122
(216) 751-1225

Houston Region

126 Northpoint Drive, Suite 110
Houston, Texas 77060
(713) 931-4939

Dallas Area

4515 Prentice Street, Room 108
Dallas, Texas 75206
(214) 691-9379

Los Angeles Region

20800 South Belshaw Avenue
Carson, California 90746
(213) 638-0557

Fresno Area

5326 East Pine Avenue, Box 7863
Fresno, California 93727
(209) 252-3311

Portland Area

2303 E. Burnside, Suite 202
Portland, Oregon 97232
(503) 232-8135

Reading Region

529 Reading Avenue, Suite C
West Reading, Pennsylvania 19611
(215) 378-0175

Philadelphia Area

10965 Decatur Road
Philadelphia, Pennsylvania 19154
(215) 677-5600

International Operations

Canada

FMC of Canada Limited
Material Handling Equipment Division
Box 173 Station H
Toronto Ontario Canada M4C 5H9
Phone: (416) 750-4400
Cable: LINKBELT, TORONTO

Spain

Tarnos Instalaciones Industriales, S.A.
(FMC Affiliate)
Pl. de Angel Carbajo, 6
Madrid 20 Spain
Phone: 2708807
Cable: TARNOSA MADRID

Bucket Elevators

Size:
Will Depend on Customer
Requirements.

Fibers Handled:
All Chrysotile Grades.

Suppliers:
**Continental Conveyors & Machine
Works Ltd.**
470 St. Alphonse Street East
Thetford Mines, Quebec

Link Belt Ltd.
945 Beaumont Ave.
Montreal, P.Q.

Link Belt Ltd.
605 James St. North
Hamilton, Ont.

Notes:
Should be connected to good dust
collector requires approx. 1000 c.f.m.

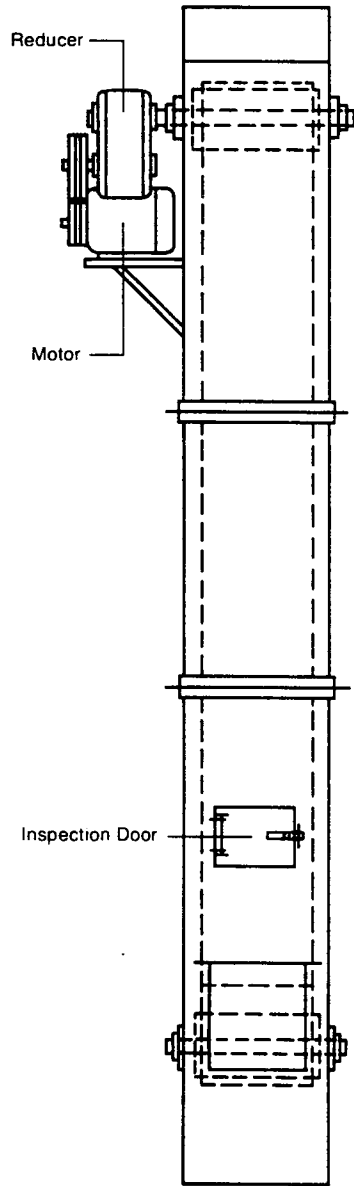
Max. height of elevator — 80 ft. (24.4 m)

Use continuous steel elevator buckets
and belt (No chains).

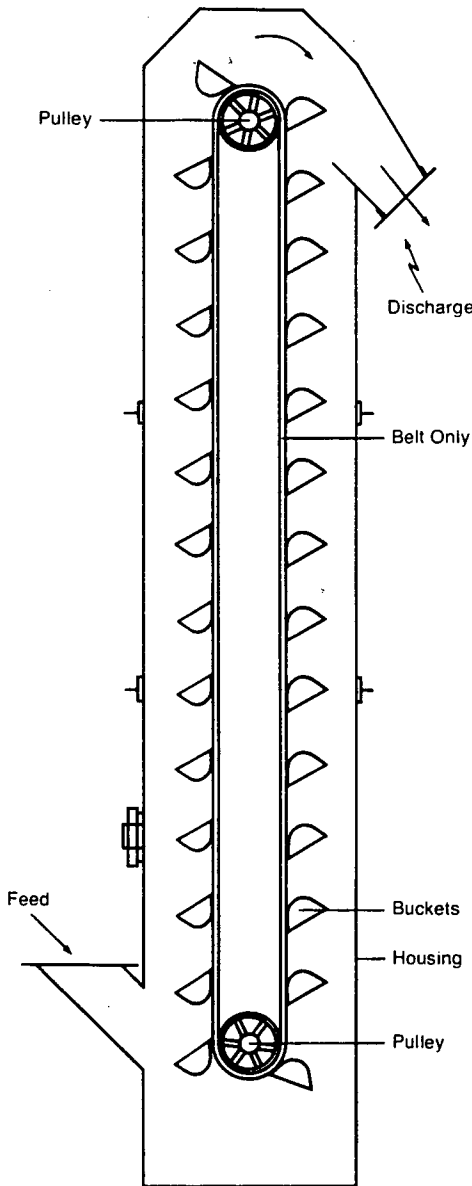
Approximate Cost: 1980
\$5,000 f.o.b. for 30" (76.2 cm) high
elevator. (Canadian)

Approximate Capacity:
Depends on Density of Fiber, Type of
Buckets, Width of Belt, etc. (see below)

Elevation



Section



Fiber Grade	Approx. Density (lbs/cu.ft.)	Capacity (tons/hr.)
Group 3	6 (96.1 kg/m ³)	up to 1 (0.9 tonne/hr.)
Group 4	8 (128.2 kg/m ³)	up to 2 (1.8 tonne/hr.)
Group 5	10 (160.2 kg/m ³)	up to 2 (1.8 tonne/hr.)
Group 6	13 (208.3 kg/m ³)	up to 3 (2.7 tonne/hr.)
Group 7	15 (240.3 kg/m ³)	up to 3 (2.7 tonne/hr.)

Above based on a standard 12" (30.5 cm) wide belt, with a standard medium front
bucket for vertical elevators running at 30 fpm (20 RPM).

**Additional
Suppliers**

**Screw Conveyors
and Bucket Elevators**

Sprout-Waldron & Company, Inc.
Muncy, Pennsylvania 17756
U.S.A.
717-546-8221

Sprout, Waldron of Canada Ltd.
P.O. Box 515, Waterloo Square,
Waterloo, Ontario,
Canada
519-579-4210

Sprout, Waldron — France,
66 Rue Des Cevennes 75,
Paris XV
France

Sprout Waldron & Company, Inc.
Broseley House, 81 Union Street
Oldham, Lancashire
England
061-633-4172

Bag and Waste Disposal

Disposal

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Bag and Waste
Disposal

**Recommended Control
Procedure No. 3**

Contents

1. Asbestos Waste

2. Types of Asbestos Waste

3. Collection of Waste

- 3.1 Fine dust
- 3.2 Loose fibre, swarf and floor sweepings
- 3.3 Wet waste in the form of sludge or slurry
- 3.4 Waste from fixing or removal of thermal insulation or of sprayed insulation containing asbestos
- 3.5 Offcuts, broken pieces and rejects of friable materials
- 3.6 Offcuts, broken pieces and rejects from high-density products
- 3.7 Empty sacks or bags
- 3.8 Labelling
- 3.9 Isolation of asbestos waste

4. Disposal of Waste

- 4.1 In Transit
- 4.2 At Disposal Site
- 4.3 Personal Protection and Hygiene

5. Waste Disposal Instructions

1. Asbestos Waste

1.1 This document gives the recommended procedures for handling and disposing of asbestos waste. However, one should not overlook the most effective and economic method of control, that is, the *avoidance* of waste. Some types of asbestos waste can be re-cycled or can provide raw material for a different product. The creation of waste may be minimised by improved production techniques.

1.2 There is general agreement that the occupational hazards associated with asbestos arise through the excessive inhalation of respirable asbestos fibres. There is no evidence at the present time of any harmful effects due to the ingestion (swallowing) of asbestos from drinking water. Therefore, the methods of waste disposal recommended concentrate on the need to avoid the escape into the atmosphere of unacceptable levels of respirable asbestos dust from the waste material:

- 1.2.1 During collection.
- 1.2.2 During transit to the disposal site.
- 1.2.3 When finally deposited.

2. Types of Asbestos Waste

2.1 It is important to consider the different types of asbestos waste which may be encountered. They will generally fall into one or other of the following categories:

- 2.1.1 Fine dust — from dust control equipment, filter units, vacuum cleaners.
- 2.1.2 Loose fibre, swarf, floor sweepings, etc.
- 2.1.3 Wet waste in the form of sludge, slurry, lumps, and/or pellets containing asbestos.
- 2.1.4 Waste material from the fixing or removal of thermal insulation or sprayed insulation containing asbestos.
- 2.1.5 Offcuts, broken pieces and rejects from friable materials.

2.1.6 Offcuts, broken pieces and rejects from high-density products, where the asbestos is firmly bonded with other materials, e.g. asbestos cement, moulded plastics, etc.

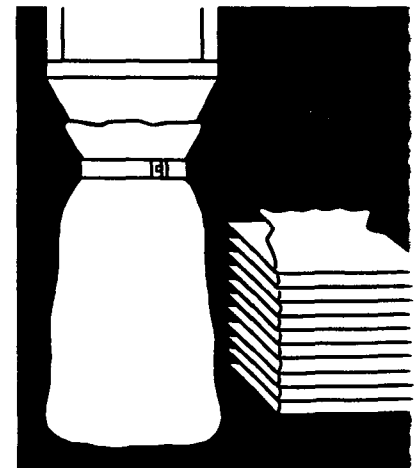
2.1.7 Empty sacks or bags which have contained loose asbestos fibres or mixtures containing asbestos fibres.

3. Collection of Waste

3.1 Fine dust

Fine dust may be produced from material conveyors, mixing equipment or by such processes as sawing, sanding or machining.

3.1.1 The dust is collected by installing extraction systems. The air is filtered and the dust collected in hoppers which are normally fitted with bagging-off outlets. These outlets should be designed to make bag changing easy and dust leakage minimal.



3.1.2 Polyethylene bags of adequate strength for good handling are recommended so that the dust level can be seen and the bag changed before it is over-filled (200 gauge polyethylene double sealed at bottom, has been found satisfactory).

3.1.3 Other types of impermeable bags such as multi-wall paper sacks may be acceptable, if there is no risk of deterioration (e.g. by wetting) before disposal. When filled, the bags should be sealed so as to prevent the escape of dust during subsequent handling.

3.1.4 Polyethylene bags should be twisted tightly, folded over and the neck secured in the folded position by wire tie, adhesive tape or other equally effective method. Paper bags should be folded over twice and stapled along the folded edge.

3.1.5 Approved respirators and suitable protective clothing must be worn when changing bags on a dust collector. In some cases, dust is removed by wet collectors. The resultant slurry is dealt with in 4.1.3.

3.2 Loose fibre, swarf and floor sweepings

3.2.1 Loose fibre is often handled by fixed extraction systems and filter units in the same way as fine dust. It can also accumulate in fibre-testing laboratories. Wherever possible, such material should be consumed in the production process.

3.2.2 Swarf accumulates around and under machines and on floors. Cleaning around machines and the collection of swarf should be carried out by the use of vacuum cleaners suitable for asbestos or by other dustless methods. Where vacuum cleaners are used, they should be fitted with disposable paper or plastic bags rather than fabric dust-bags which would require emptying.

3.2.3 Loose material collected by other means should be placed in impermeable bags and sealed, as in 3.1.2 to 3.1.4.

3.2.4 Information and recommendations concerning suitable dust-collecting machines can be provided upon request.

3.3 Wet waste in the form of sludge or slurry containing asbestos

3.3.1 Waste asbestos in the form of sludge or slurries likely to arise from industrial processes (e.g. board making) should only be transported in purpose-built vehicles. These should be such as to prevent spillage of liquid which may subsequently dry out and from which unacceptable quantities of asbestos dust might be released (see 4.1.3 and 4.2.5).

3.4 Waste materials from fixing or removal of (1) thermal insulation or (2) sprayed insulation containing asbestos

3.4.1 Waste material from fixing or stripping operations can be conveniently collected on polyethylene sheeting which is subsequently folded to form a sealed container.

3.4.2 Where such material has been allowed to fall on floors, it should be thoroughly damped before sweeping up and the damped material should be placed in impermeable bags or other disposable receptacles and sealed, as in 3.1.2 to 3.1.4.



3.4.3 In some cases, removal may be effected by the use of large quantities of water so that a slurry is created. In this case the wet material may be more conveniently collected and removed in special containers (see 4.1.3).

3.5 Offcuts, broken pieces and rejects of friable materials

3.5.1 By 'friable' we mean material, usually of low density, which is fragile and breaks easily into small pieces.

3.5.2 The variety of shapes and size offcuts, rejects, etc., in different factories calls for individual collection and disposal methods. Where possible, provision should be made in the design of machines for the automatic removal of offcuts, etc., and their collection in disposable receptacles which can be removed and sealed as described in 3.1.2 to 3.1.4. Wherever practicable, effort should be made to reprocess such material into the end product:

3.5.3 When automatic removal and collection is impracticable, suitable receptacles must be provided. Attention should be given to the following requirements:

- Receptacles must be capable of being closed so as to prevent the escape of dust.
- If, during use, dust arises from the mouth of the receptacle, a dust extraction hood should be provided to prevent the uncontrolled escape of dust into the work-place.
- The supply of receptacles should be sufficient to prevent overfilling and to be conveniently available to the work-place.
- Regular removal of full receptacles and replacement by empty ones should be arranged.

3.5.4 Offcuts and rejects may sometimes need to be broken down to a more convenient size for collection. Wherever possible this should be done mechanically with adequately ventilated equipment.

3.5.5 When this is not possible, methods should be devised to reduce the creation of dust as far as possible (for example, by wetting) and the work should be performed in an area from which asbestos dust cannot escape to other working-areas. Employees engaged in this work must be issued with approved respirators and protective clothing.

3.6 Offcuts, broken pieces and rejects from high-density products such as asbestos cement, moulded plastic materials, etc.

3.6.1 Waste material of this kind does not normally give rise to the emission of dangerous dust and in such cases need not be placed in special receptacles. Where such material is kept separate from other asbestos waste, it may be stored in a suitable area to await transport and disposal as detailed in 4.

3.7 Sacks or bags which have contained asbestos

3.7.1 Sacks or bags which have contained loose asbestos fibres, or mixtures including loose asbestos fibres, should be deposited in a suitable receptacle (see 3.5.3) immediately after being emptied.

3.7.2 For disposal (as in 4) the sacks or bags should be bundled, under a dust extraction hood, and then sealed in an impermeable bag as in 3.1.2 to 3.1.4.

3.7.3 A further method of plastic bag disposal is to melt it. By melting the empty plastic bags and wrappers, the asbestos residue becomes embedded in the melted plastic. As a result of the asbestos being 'locked in', it should be possible to dispose of this material in any normal disposal site. Specific low-volume melting equipment, which can be employed at individual bag-opening stations, is in development.

3.7.4 In no case should these bags be re-used for packing or for any purpose other than that described at 3.7.5.

3.7.5 Bags can be re-used for re-cycling or incorporation in some end products (see AIA RCP4) provided that the re-using plant is aware of the need for controls when handling asbestos.

3.8 Labelling

It is recommended that all waste materials in categories 3.1 to 3.7 be identified by a label or by imprint on the disposal receptacle as "Asbestos Waste — for Disposal as Instructed". Where the waste is of a dusty nature, the additional words "Do not inhale Dust" is recommended.

3.9 Isolation of asbestos waste

Care should be taken not to mix asbestos waste with other waste material for which there are no special disposal requirements (e.g. common factory refuse). Ensure that bags containing asbestos are not exposed to damage from trucks, etc., likely to cause spillage. Where possible, a separate store area is recommended for asbestos waste awaiting disposal.

4. Disposal of Waste

4.1 In transit

4.1.1 Asbestos waste, whether loose or in sealed receptacles, should be disposed of in such a way that no dust is emitted into the air during transport, or in the act of dumping or subsequently. Waste which is adequately contained in impermeable bags or other sealed receptacles does not require special transport.

4.1.2 Special containers can be obtained which, when filled, are removed by specially fitted road vehicles direct to a disposal site. Care must be taken to prevent the emission of dust from these containers.

4.1.3 Wet waste should be transported to the disposal area in sludge-tankers or similar vehicles. Before use for other purposes, all vehicles and containers should be cleared of loose fibre or dust, by vacuum cleaning, watering or other dustless methods.

4.1.4 In the event of accidental spillage (for example, as the result of a road accident) during transport to the disposal site; the action to be taken will depend upon the type of waste involved and the extent of the spillage.

4.1.4.1 Where the amount of the spilled material is small, the waste should be re-collected into its original container and re-loaded by the driver without delay.

4.1.4.2 In the event of substantial spillage, it may be necessary to seek assistance and certain precautions will need to be taken. Should the material be dusty, it should be contained as quickly as possible by covering or wetting or both. The spilled material should be removed as quickly as possible, safety precautions being observed according to the nature of the waste.



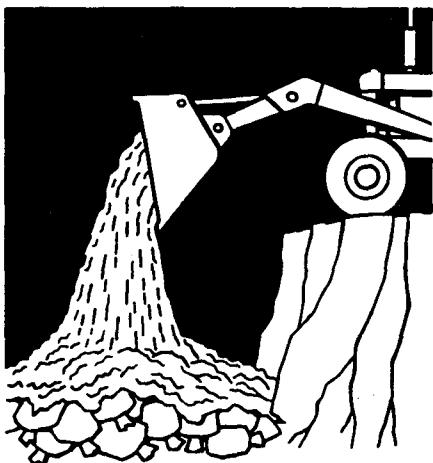
4.1.5 Written instructions on the action to be taken in the event of accidental spillage should be issued to drivers of vehicles used for carrying asbestos waste.

4.2 At disposal site

4.2.1 It should be clearly established in advance that the site to be used is suitable and acceptable for reception of the type of waste to be delivered.

4.2.2 The waste should be deposited at a disposal site where there is vehicular access to the working face.

4.2.3 All asbestos waste, when deposited on land-fill sites, should be so deposited that, on completion of the site filling, the asbestos waste is covered to such an extent that, under normal circumstances, the asbestos will not be exposed by subsequent excavation. A depth of at least 25 cm is recommended during daily covering until the final covering is made, when a much greater depth will be required.



4.2.4 Certain water-filled sites may be suitable for the disposal of particular types of asbestos.

4.2.5 The disposal of wet waste on a dry waste disposal site may be acceptable provided that the quantities are not excessive.

4.2.6 Whilst it is accepted that waste from high-density materials such as asbestos cement, moulded plastic materials, etc., is not likely to produce a dust hazard when dumped, a hazard may arise subsequently if the waste is subjected to pounding by vehicles passing over it. In general, therefore, the methods of disposal described above should also be adopted for this type of waste.

4.3 Personal protection and hygiene

4.3.1 Any persons who in the course of their work of collecting, transporting or disposal may be exposed to a higher level than the accepted TLV of respirable asbestos dust, must be provided with suitable protection.

4.3.2 Vehicles and re-usable receptacles and covers must be cleaned after use so that they are free of residual asbestos dust.

5. Waste Disposal Instructions

5.1 Where a firm itself disposes of its asbestos waste, written instructions based upon these recommendations should be issued to the staff concerned.

5.2 If a waste disposal contractor is employed, the relevant terms of these recommendations should be incorporated in the contract.

5.3 The contract should state clearly that the waste disposal contractor is responsible for observing the recommended precautions at the disposal site.

5.4 Firms should make periodic checks to ensure that the contractor is obeying instructions.

Disposal of Packing Materials

1. It is important to recognise that empty asbestos bags and wrapping contain a small residue of loose asbestos. Therefore they must be carefully handled in a manner to avoid creating dust, and disposed of by one of the methods listed below:

They are:

1.1 Grinding for inclusion in the end product.

1.2 Melting for safe disposal in normal waste-dumps.

1.3 Recycling into secondary plastic products.

1.4 Bagging.

2. Grinding

Chopping equipment has been developed which can cut the plastic materials into particles small enough to permit their inclusion in some end products. It is important to note that the empty bags and wrapping material amount to about 0.5 per cent of the asbestos. If the end product, such as asbestos cement sheets, contains 10 per cent asbestos, the plastic then becomes only .05 per cent of the final product. Two criteria are important for this concept to be successful. The plastic must be compatible with the process and other ingredients in the end product, and the plastic particles must be cut fine enough to ensure that they disperse properly.

3. Melting

If the end product cannot accept the plastic, an alternative is to melt it. By melting the empty plastic bags and wrappers, the asbestos residue becomes embedded in the melted plastic. As a result of the asbestos being 'locked in', it should be possible to dispose of this material in any normal waste dump. Specific low-volume melting equipment, which can be employed at individual bag-opening stations is in development.

4. Recycling

Work has now been completed which demonstrates that the melted plastic material can also be incorporated into secondary plastic applications. For example, it can be added as an ingredient in the manufacture of certain plastic pipe or moulded parts where recycled plastic is permissible. It is recognised that the cost of the moulding equipment is quite high and would require a large usage of asbestos bags to justify the installation of equipment at the asbestos-using plant. Therefore, the final choice of whether to re-use the plastic in this manner will depend on the economics of the specific situation.

5. Bagging

Unless one of the above three methods can be adopted, used packing materials should be collected under suitable dust control conditions into an impermeable container (such as new, unused plastic bags) immediately after being emptied. Such containers should be properly sealed and despatched for disposal at authorised waste dumps. In no case should bags which have contained asbestos fibre be re-used in any other manner than described above.

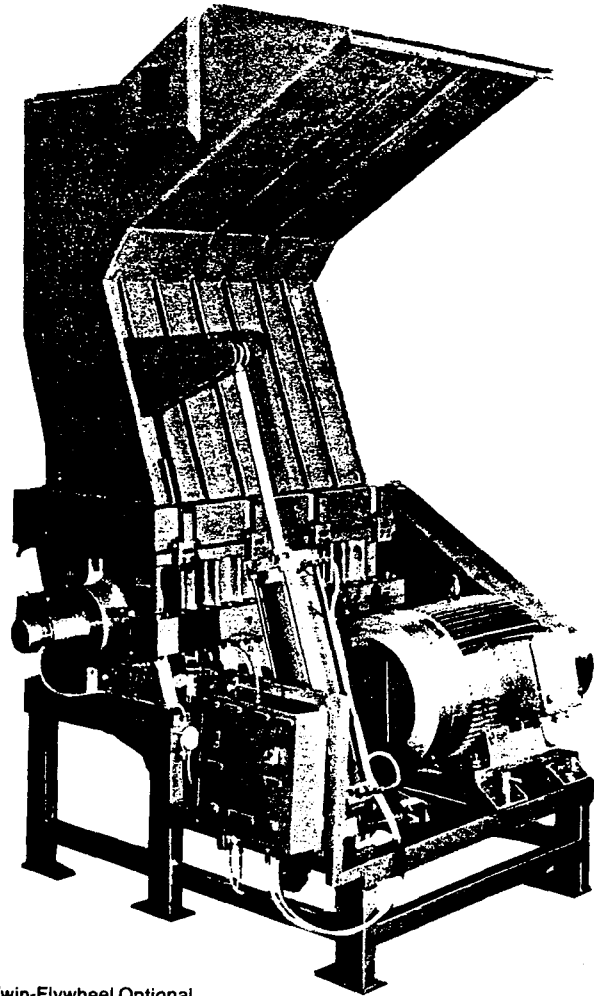
Rapid 2442H heavy duty granulators are very efficient, designed to reclaim tough bulky parts, large diameter pipe, fibres and film at high output rates.

They are quality-built to provide long, dependable service life.

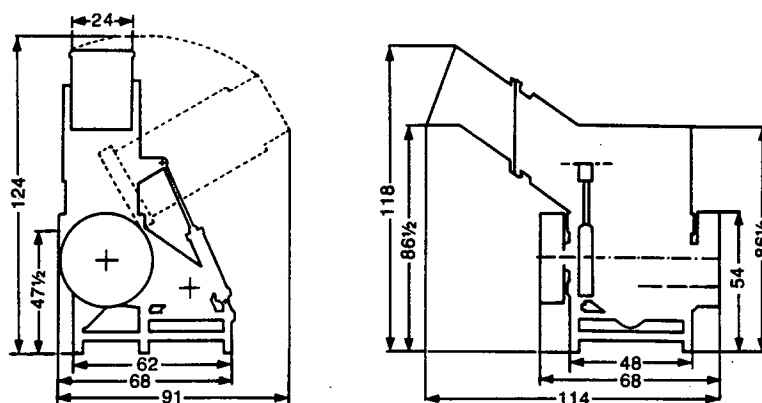
Rapid granulators are engineered with production and service people in mind.

Rapid features which can maximize your profitability:

- Herringbone "V" design open rotor — to ensure even granulation load distribution and maximum cooling.
- Scissor-action cutting knives — 10 rotating, 2 fixed — cuts energy consumption and assures quiet, cool operation.
- Adjustable rotor knives — increase operating efficiency, decrease noise levels and help minimize fines.
- Heavy construction — thick plate double wall hopper and cast iron cutting chamber supported by a tubular steel base for long dependable service life.
- Friction coupling — to prevent drive and/or rotor damage due to locked rotor condition.
- Zero speed switch — to prevent drive damage.
- Easy access to cutting chamber — for knife adjustment and blow-through cleaning.
- Pneu-Vey transition — designed for maximum air flow to ensure efficient material evacuation.
- Built-in safety provisions — limit switches prevent accidental operation when granulator is being serviced.
- High-quality TEFC motors — standard on all models.



Twin-Flywheel Optional



Dimensions in inches

Rapid Granulator, Inc.
2730 Eastrock Dr., P.O. Box 5887
Rockford, Illinois 61125
Tel: 815-962-3259
Telex: 257-333

*Plastic processing equipment
manufacturer*

Printed in U.S.A. 3-79

Specifications

	Standard	Optional
Cutting Chamber	24" x 41.5" opening Cast iron construction	Stainless steel or non-corrosive material on contacting surfaces
Rotor	5 blade slant, scissors cutting action.	
Rotor Knives	10 high carbon/high chrome — adjustable.	High alloy.
Bed Knives	2 high carbon/high chrome — fixed — reversible cutting edges	High alloy. 3 Fixed — reversible cutting edges.
Screen	1/8", 1/4", 5/16", 3/8", 1/2", 5/8", 3/4", 1" Reversible. Screen chamber hinged. Air cylinder actuated.	To meet customer specifications
Hopper	24" x 24" feed opening. Hinged for easy access to cutting chamber. Air cylinder actuated.	Sheet-pipe-combination to meet customer specifications.
Base	Low profile, Pneu-Vey, heavy duty welded construction with adjustable motor mount.	High level indicator.
Motor	100 HP 230/460V, 3 PH, 60 HZ TEFC	208V or 575V, 75 HP 125 HP TEFC
Drive	V-belt featuring flywheel type pulley, friction coupling and zero speed switch.	High amp meter. Twin-flywheel.
Throughput	2500-6000 lbs/hr	
Weight	9,000 lbs	

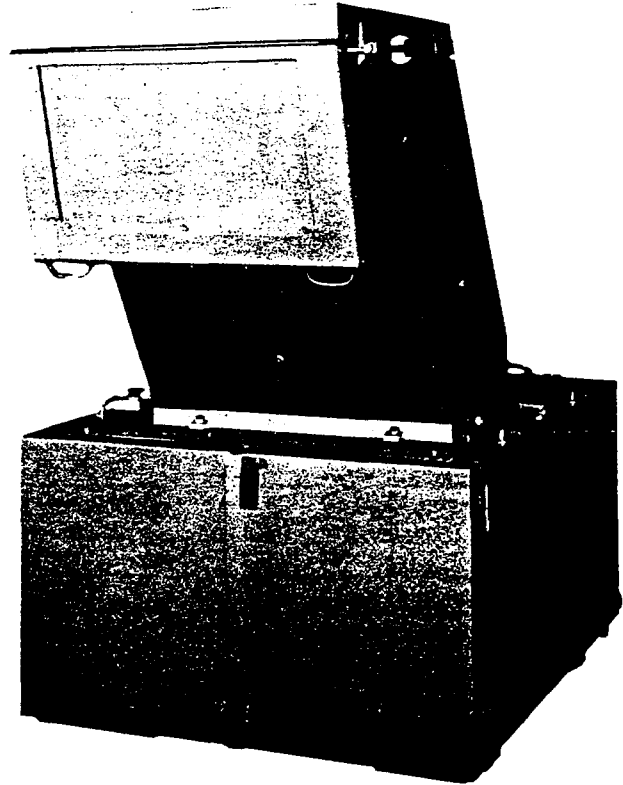
Rapid 1224K granulators are quiet, convenient and very efficient, designed to reclaim tough, bulky parts, sprues and runners, pipe, extruded profile, and film at 85dBA.

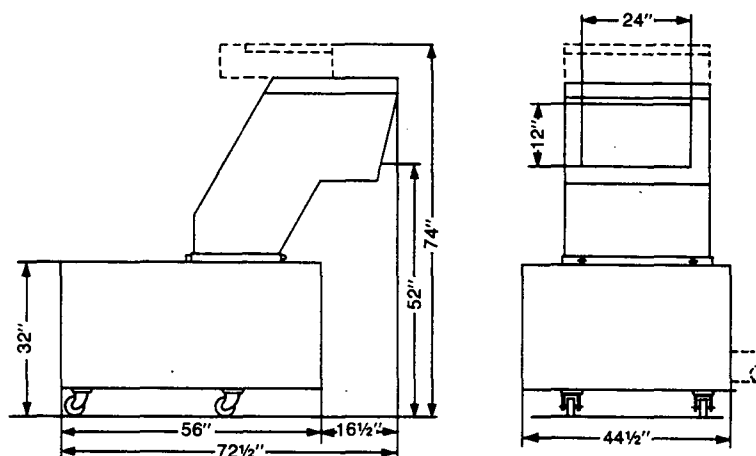
They are quality-built to provide long, dependable service life.

Rapid granulators are engineered with production and service people in mind.

Rapid features which can maximize your profitability:

- Tangential feed — This inherent cutting-chamber design ensures positive feeding for smooth operation and high granulation capacity. "Flyback" is virtually eliminated with significant noise reduction.
- Herringbone "V" design open rotor — to ensure even granulation load distribution and maximum cooling.
- Scissor-action cutting knives — 6 rotating, 2 fixed — cut energy consumption and assure quiet, cool operation.
- Adjustable rotor knives — increase operating efficiency, decrease noise levels and help minimize fines.
- Easy access to cutting chamber — for knife adjustment and blow-through cleaning.
- Built-in safety provisions — limit switches prevent accidental operation when granulator is being serviced.
- Integral sound insulation — assures a comfortable working environment at audio levels below 85 dBA and allows easy access for maintenance.
- High-quality TEFC motors — standard on all models.





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 Rockford, Illinois 61125
 Tel: 815-962-3259
 Telex: 257-333

*Plastic processing equipment
 manufacturer*

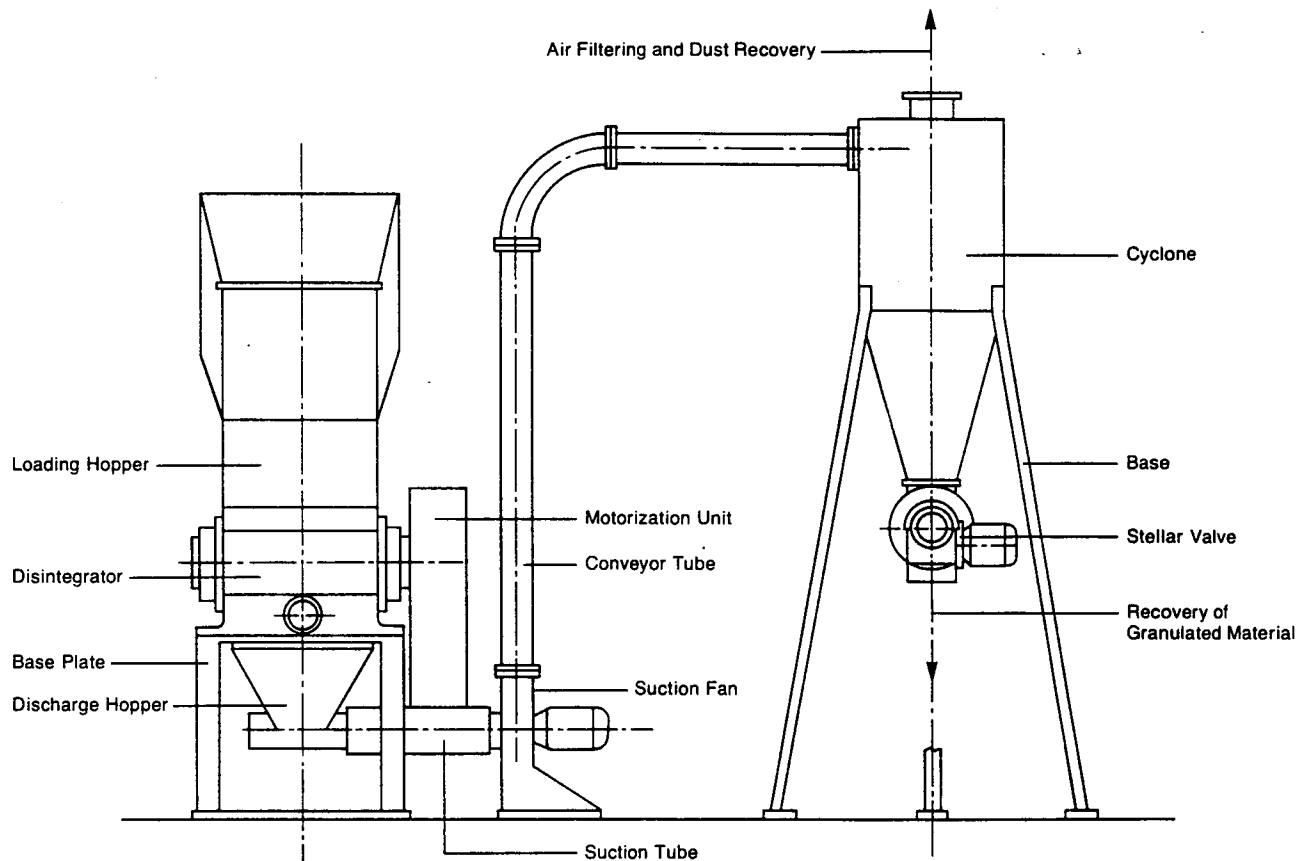
Printed in U.S.A. 3-79

Specifications

	Standard	Optional
Cutting Chamber	12" x 24" opening Tangential feed	Stainless steel or non-corrosive material on contacting surfaces
Rotor	Herringbone "V" open-design, 3 blade — slant — scissors cutting action.	5 blade rotor.
Rotor Knives	6 high carbon/high chrome — adjustable.	High alloy. Tungsten carbide surface coated.
Bed Knives	2 high carbon/high chrome — fixed.	High alloy. Tungsten carbide surface coated.
Screen	1/8", 1/4", 5/16", 3/8", 1/2", 5/8", 3/4", 1" Reversible. Screen chamber, hinged for easy access to screen and cutting chamber.	To meet customer specifications
Hopper Design	12" x 24" feed opening. Hinged for easy access to cutting chamber.	Sheet-pipe-combination to meet customer specifications. Air cylinder actuated.
Base	Low profile, bin type, heavy duty welded construction with adjustable motor mount, caster mounted.	Pneu-Vey. High level indicator.
Motor	15-25-40-50 HP 230/460V, 3 PH, 60 HZ TEFC	208V 575V
Drive	V-belt featuring flywheel type pulley w/expandable bushing.	Friction clutch. Zero speed switch. Twin-flywheel.
Throughput	600-2000 lbs/hr	
Weight	3000 lbs	

Spent Bag Disintegrators

Typical Plant Layout



FS-20 disintegrators have been specially planned for reducing the bag wrappings into very small fragments, entirely solving the ecological problem of destroying non-degradable materials.

After the disintegration process, the spent bags can be gathered in suitable containers, or mixed with asbestos fibers and then incorporated in the end product.

The two types of disintegrators, which are now available, are mainly suitable for grinding polypropylene, polythelene and paper.

Type FS-20/400 — Output: 220 bags/hour.
Type FS-20/550 — Output: 300 bags/hour.

The high quality of the employed materials and the accurate mechanical working guarantee the reliability even in the most difficult conditions.

Blades and counter-blades, constructed with special hard steel, are equipped with micrometrical adjustment.

Each disintegrator is supplied with a forced water-cooling chamber in order

to prevent dangerous over-heating in the grinding shell and will process very tough plastic and other materials.

The screening grate can be rapidly adjusted or replaced allowing variation of size of the granulated material according to the different work requirements.

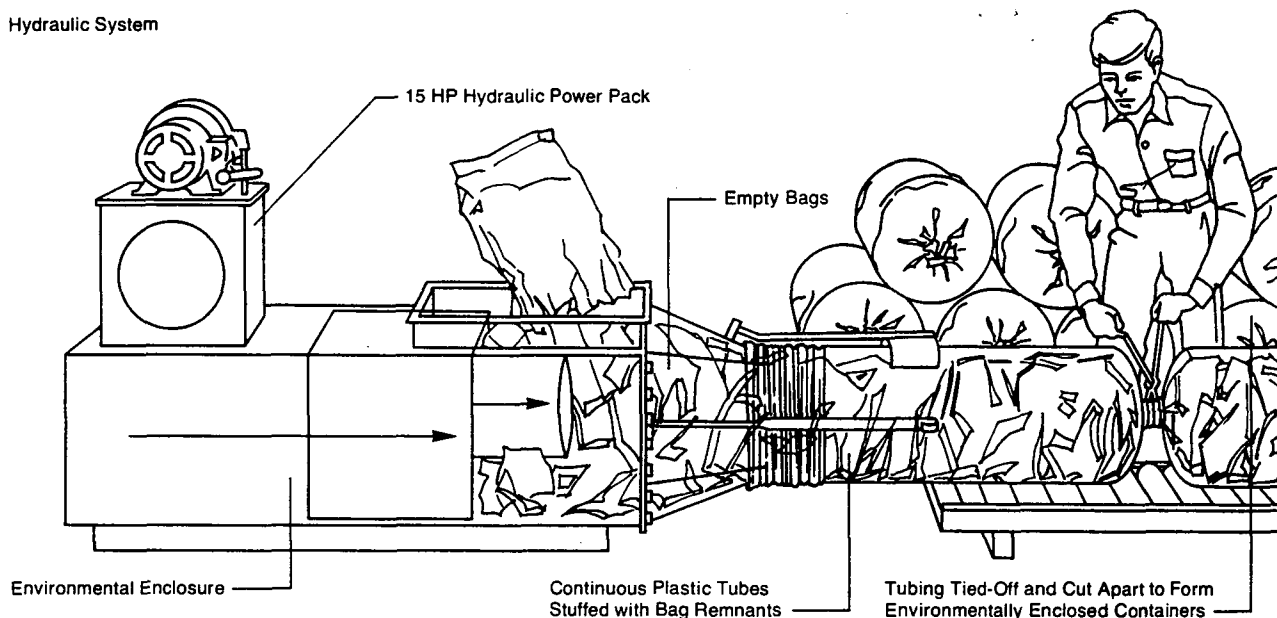
Every mechanism is easy to inspect both for adjustment and routine maintenance and all the parts to be oiled can be easily reached.

FS-20 Disintegrators
Technical Data

	FS-20/400	FS-20/550
Feeding Mouth	400 x 430 mm.	400 x 550 mm.
Blade Length	400 mm.	550 mm.
Revolving Blades	3	3
Counter-Blades	2	2
Installed Power	15 Kw.	18.5 Kw.
Rotor Diameter	350 mm.	350 mm.
Cooling	H ₂ O	H ₂ O
Fan		
Installed Power	1.5 Kw.	1.5 Kw.
Lift	150 mm./H ₂ O	150 mm./H ₂ O
Delivery	1200 m ³ /hr	1200 m ³ /hr

Salvaneschi Asbestos Cement
Machines
27, Via Roma
P.O. Box 19
27043 Broni (PV) Italia
(0385) 51.02451.133

Hydraulic System



Model 30 X 30 is a compaction device, arranged to cycle continuously, to dispose of empty bags without operator contact and in a minimum amount of space.

Empty bags drop into a receiving chamber, usually connected to the bag disposal chute of a bag opener, and are compacted, then extruded through the outlet nozzle into an expandable plastic sleeve—or to separate bags or containers. The operator has only to tie off sleeves or bags into convenient length units for disposal—all without dust from the empty bags escaping into the environment.

Carbon steel construction.

Approximate Size:

10 ft. long X 2½ ft. wide X 2 ft. high (6 ft. high with pump & control panel)

Grades Handled:

All

Capacity:

400 bags/hour

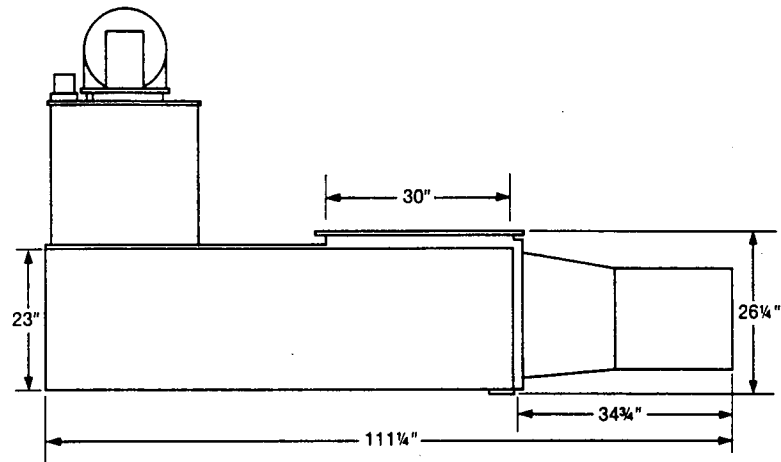
Price:

(June 1980) \$11,300. U.S. f.o.b. Taunton, Mass. Complete with controls, wired and ready to run.

Supplier:

Taunton Engineering Co.
700 West Water
Taunton, Mass.
02780

Compactor/Disposer
Model 30 X 30



Specifications

15 HP TEFC Motor	230/460 V
Line Pressure	2,500 P.S.I.
Reservoir	40 Gallons (151.4 lts.)
Pump	10 GPM Max. (37.9 lts.)
Electric Control Circuit	120 V NEMA 12
Cycle Time	23 Seconds
Plug Ram Size	11" (27.9cm)
Compactor Ram Size	20" x 30" (50.8cm x 76.2cm)

Compactors

Many suppliers of bag opening equipment already provide their machines with empty bag compactors as standard or optional items. These include Bel-Tyne International, Taunton Engineering Company, JSK Materials Handling Ltd., SPA Ispra, Salvaneschi and Armand Colinet S.A.

**Bag Opener &
Destroyer Type
Colinet**

Manufacturer
Armand Colinet SA
7078 Le Roelx
Belgium
Telex 57065 Colinet

Operation

Full bags are slit open and separated from the fibre. Optional equipment is available to either compact and bale the discarded bags or to chop them into fine pieces for use in the manufacturing process.

**Extruder Type:
Model**

(1) Reductomat

Arenco Machine Co. Inc.
500 Hollister Road
Teterboro, New Jersey
07608

Hopper fed polyethylene compactor. Using heat and hydraulic power plastic film is reduced to an 8" (20.3 cm) beam suitable for reprocessing.

(2) Kubota Extruder

Kubota Mfg.
Japan

Hopper fed extruder melts outer surface of extruded bags to form cylindrical slug suitable for discard.

**Tubes from
Recycled Bags**

Eternit-France has developed a process for recycling polyethylene asbestos bags which are used as raw material to make tubes of various diameters for electrical cabling and wiring. Since June 1979, the company has been recycling all the polyethylene bags it receives with asbestos deliveries originating in Canada and the Soviet Union which represents an annual volume of 300 to 500 tons (272.3 to 453.9 tonnes) of bags. Instead of being piled at dumps or simply discarded, the empty bags constitute a valuable and inexpensive raw material in the manufacturing of a product for which there is a high demand. (QAMA Bulletin)

Presented at the:
Brake Systems Institute Clinic
Nashville, Tennessee
March 1-3, 1981

Introduction

We are required by government regulations to collect more and more dust so that the work area is absolutely dust-free. Many industries have found that the dust collected can be agglomerated and then recycled to the process saving raw materials. Other industries find that it is an ever increasing problem to even dispose of the dust since most of it is now classified by E.P.A. as hazardous. The disposal of the dust is under government regulation and agglomeration is one of the alternatives for disposal.

Federal regulations set forth disposal requirements as follows: (1) Packaging so there is no visible emissions at any time; (2) Thoroughly wetting the dust to produce a slurry and then sealing in a leak-tight container; (3) Form into a non-friable pellet or other shape.

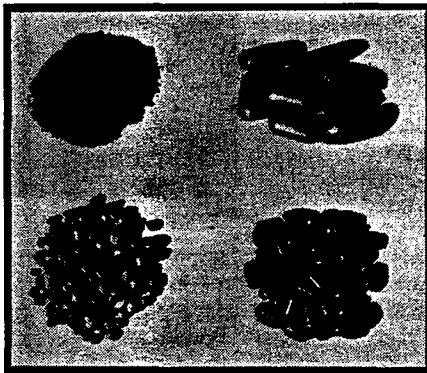


Figure 1

The third alternative was added to the regulation primarily because of the efforts of the Bendix Corporation and Ferro-Tech. Figure 1 is a photograph of dust which has been processed into pellets and briquettes both of which are non-friable.

History

Ferro-Tech cooperated with Bendix Corporation in 1972 and developed the process in which portland cement and asbestos dust were mixed with water on a disc pelletizer and spherical pellets were formed. Bob Burton, from the Bendix Southfield headquarters, organized a development program at our Grosse Ile facility utilizing our 16" Demo-Disc pelletizer and then a continuous pilot plant system was operated at Grosse Ile with a Ferro-Tech feeder and a 3'0" disc pelletizer. This pilot plant was then moved to Bendix's Green Island Plant where it was operated under the direction of David Stone, the Director of Engineering. After successful operation of the pilot plant a contract was awarded to Ferro-Tech for the design and construction of the first of several operating plants.

The pellets were nominally $\frac{1}{4}$ " to $\frac{1}{2}$ " in diameter and contained 15% to 40% moisture along with 4 to 8% portland cement. After 24 hours these pellets had a crushing strength of 5 to 10 pounds and they continued to grow stronger because of the continuing action of the portland cement. Even if the pellets were broken, they remained dust-free since they would only break into 2 or 3 pieces and never return to dust. In one plant where leaching of phenols occurred, the pelletizing eliminated this problem.

The bulk density of the pellets was 40 to 50 pounds per cubic foot compared to 15 to 20 pounds per cubic foot for the fine dust. Dust which contained phenolics was easily combustible because of the finely divided particles; pelletizing with portland cement binder eliminated this problem. This quality pellet is now produced in more than ten plants around the world.

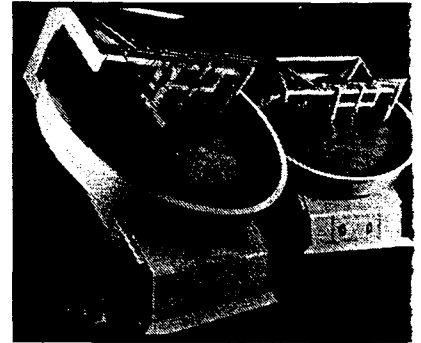


Figure 2

Disc Pelletizer Operation

A disc pelletizer shown in Figure 2 is described as a rotating cake pan tilted at 45°. This is a valid description with the balls being formed as the wetted particles roll down the face of the disc much as a snow ball rolls down a hill.

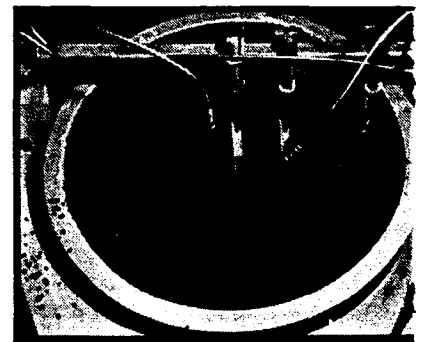
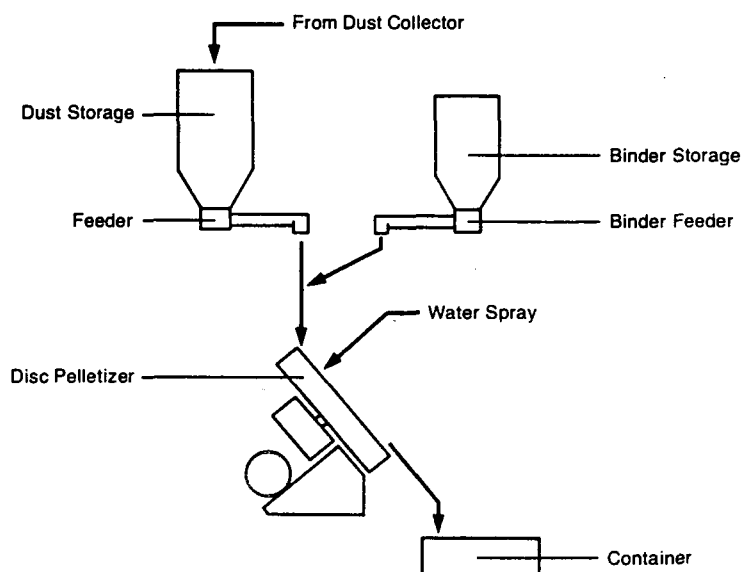


Figure 3

The operation of the disc pelletizer is simple and is characterized by the formation of a distinctive pattern of free flowing fines, agglomerates and finish balls. Figure 3 is a picture of an operating disc showing the main pelletizing features. The first stream contains the finished and near-finished pellets, the third stream contains the nuclei or seed pellets, while the second stream contains the transition or growing balls. In order to form pellets, the critical moisture range must be reached since pellet formation is a function of the surface tension of the water or other binding medium.

Figure 4

Process Flow Diagram
(Disc Pelletizer)



The depth of the pelletizer pan is critical in the sense that the spreading out of the streams insure that the fines and the finished pellets are separated and only the finished pellets are discharged from the pan. When the pan depth becomes too great the action of the pellets reaches a critical point and the separation no longer takes place. When this deep pan is operated both large pellets and fines are discharged and all control of the pelleting operation is lost.

Original Plant Design

The flow diagram for the original plants for pelletizing the asbestos dust is shown in Figure 4. These plants were built with the asbestos dust and portland cement being discharged together onto a disc pelletizer. The rolling and mixing action on the disc

blended the asbestos dust, portland cement and water together forming the pellets. While this system performed well, the mixing was not complete so it required as much as 5 to 10 percent of portland cement to produce an acceptable pellet. If better mixing had been utilized 30% of the portland cement could have been saved. Since the dry untreated dust was metered onto the disc, it was very difficult to eliminate all visible dust and still be able to monitor the action on the disc. Figure 5 shows one of the plants built by Ferro-Tech which pelletizes approximately 20 tons of dust each day.

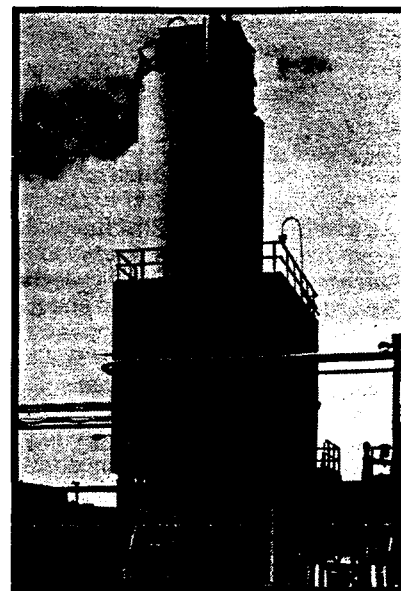


Figure 5

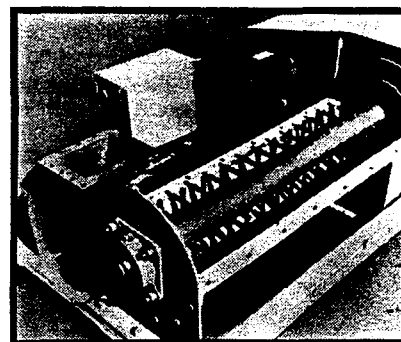


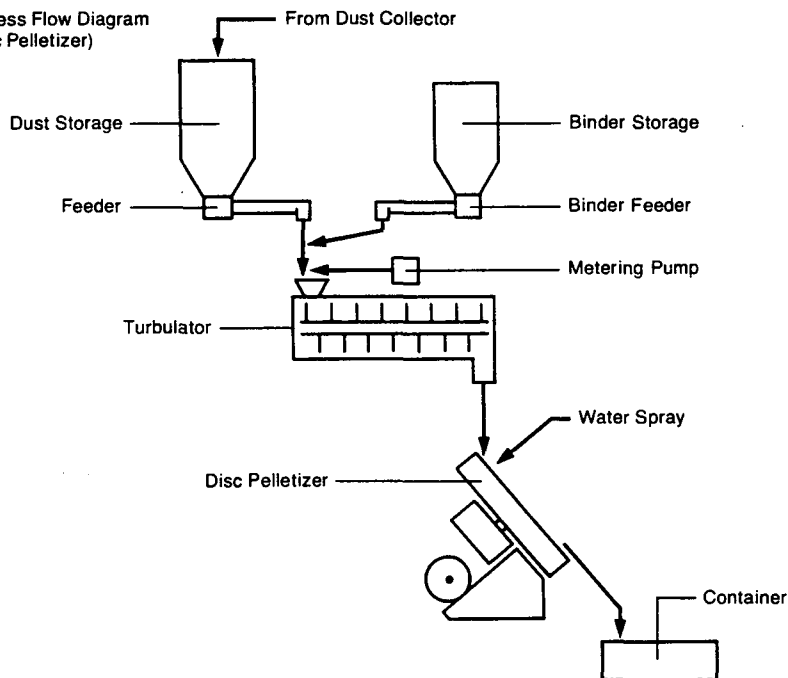
Figure 6

Latest Plant Design

At Ferro-Tech we are never satisfied with a process and are always trying to improve each process. We have observed in other industries that if thorough mixing is done much more effect is seen from a small amount of binder. We have used our Turbulator shown in Figure 6 to blend both small percentages of binder and also to wet the dust before it is discharged onto a disc pelletizer. As seen in Figure 7 a Turbulator has been added to the flow diagram so that the asbestos fines, the portland cement and the water are

Figure 7

Process Flow Diagram
(Disc Pelletizer)



thoroughly blended together before they are discharged onto the disc pelletizer. It was found that the portland cement could be reduced by $\frac{1}{3}$ and still have an acceptable pellet. A further advantage is that because of the intensity and thoroughness of the mixing of the water and dust in the Turbulator, the disc pelletizer operates much steadier and requires very little adjustment.

Asbestos Dust Briquetting

Many of the asbestos dusts which are collected can be briquetted into hard non-friable briquettes. Most of the asbestos dust contains resins which the briquetter used as a binder to produce a briquette with no other binder being required. Most of the briquetters on the market today will not briquette this type of material but Ferro-Tech developed a special briquetter as shown in Figure 8 which produces strong and durable

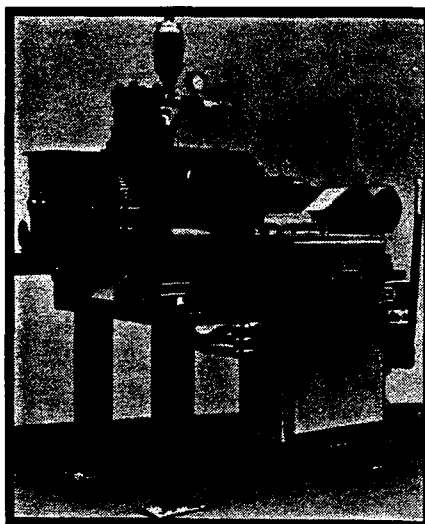


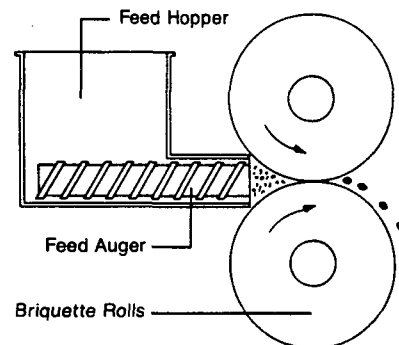
Figure 8

briquettes. The surface of these briquettes is very dense and almost completely sealed eliminating the probability of leaching.

Since nothing is done to the dust and nothing is added before briquetting the operation of the briquetter is very simple. Most of these briquetter systems are designed to operate completely automatically.

Figure 9

Arrangement of Rolls and Feed Auger



Briquetter Operation

The arrangement of the Ferro-Tech briquetter with its horizontal feed auger is as shown in Figure 9. The fine material is deaerated and densified in the feed hopper and the feed auger and then it is forced into the gap between the two opposing counter-rotating rolls. As the feed auger speed is increased more material is forced into the nip of the rolls and more pressure is applied to the briquette producing a harder and more dense briquette. As more material is forced into the pocket it becomes more difficult to turn the rolls and therefore more load is applied to the roll motor. Ferro-Tech's system for automatic operation controls the speed of the auger to maintain a constant load on the roll motor and this produces a uniform briquette.

In Ferro-Tech's automated system a high level detector in the surge bin turns on the briquetter. The briquetter then operates in the automatic mode until the level of the material reaches the low level detector in the bottom of the surge bin at which time the briquetter is turned off. When the material level again reaches the high level the cycle is repeated.

Conclusion

We now have two viable options to be considered before deciding upon a final system for agglomeration of asbestos waste. Disc pelletizing with the improvement of the Turbulator addition operates dust-free and has been proven to be an acceptable solution.

If the dust will briquette then a briquetting system will probably be lower in capital cost and will definitely have a lower operating cost since no binder is required and less or no operator attention is needed.

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U.S.A
412-898-1551
Telex 866452

Cassier Engineering Sales, Ltd.

P.O. Box 473, Station "H"
Montreal, Quebec H3G 2N3
Canada
514-935-0777
(Canadian Representative)

Disc or Drum Pelletizers

This company has worked with asbestos dust from baghouse. It was agglomerated in automatic pelletizing system, for safe, clean disposal. They also have experience with friction material waste.

"Pelletizing is defined as an agglomerating process whereby an amorphous mass of finely divided particules, such as dust, powder, fume, is formed into a pellet, a ball or granule in the presence of moisture added during the process. If required for increased product hardness or process considerations, a solid or liquid binder is added before or during pelletizing."

Sprout-Waldron

Muncy, Pennsylvania 17756
U.S.A.

Sprout-Waldron Ace Pellet Mills

These mills produce pellets by forcing the moist feed material (friction driven rolls) through holes in a die, then cutting them to length with fixed knives as the die revolves. Various sizes of dies are available. Three different Np models are available.

Airborne Fibre Counting Methods

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Bibliography

Acknowledgements

Prepared by the Dust Measurement Advisory Panel of the Asbestos International Association

1. Preface

Airborne asbestos fibre concentration of all types* in the working environment are generally determined by the Membrane Filter Method but experience has shown that this method does not always produce comparable results when used by different laboratories or by different workers. Differences can arise due to variations in sampling, preparation of the slide, optical counting, the calculation of the results and other influential factors. International comparisons of dust measurements for epidemiological studies are only feasible if agreement can be reached concerning all details of the method.

The "Reference Method for the Determination of Exposure to Airborne Asbestos Fibre Concentrations at Workplaces by Light Microscopy" set out in the following pages is an attempt by the Asbestos Industry to reach international agreement. It is hoped that the new technical information presented in this document will motivate a review of the various national methods so that results from different countries become more comparable.

2. Scope

This method describes the equipment and procedures required for sampling and sample evaluation, necessary to assess personal exposure and the control of occupational environments airborne fibres which are known to be predominantly asbestos. It should be emphasised that in mixed dust situations the presence of other fibres and fibre-like particles may interfere with the accuracy of counting.

* As defined in the United States Department of the Interior's Bureau of Mines information circular 1977 IC 8751 "Selected Silicate Minerals and Their Asbestiform Varieties — Mineralogical Definitions and Identification characterisations".

It must also be recognized that the use of this method has limitations when applied to samples containing acicular particles (e.g. talc, gypsum) and consequently should not be implemented without a full qualitative understanding of the sample. There are a variety of analytical methods which can be used to develop a full understanding of complex samples, e.g. polarizing light microscopy, electron microscopy, etc.

All particles complying with the defined geometric conditions (see 5.3.5) are, in the absence of other convincing information, to be considered as asbestos fibres and counted as such, thus ensuring that underestimates of asbestos exposure are minimized. It is also intended that the procedures described in this document should be used for epidemiology. However, for epidemiological purposes additional methods such as gravimetric, electron microscopic procedures, etc. are required to achieve a complete understanding of occupational exposure.

3. General Method Description

A sample is collected by drawing a measured quantity of air through a membrane filter by means of a battery powered sampling pump. The filter is later transformed from an opaque membrane into a transparent optically homogeneous specimen. The fibres are then sized and counted using a phase contrast microscope. The result is expressed as fibres per millilitre of air, calculated from the number of fibres on the filter and the measured volume of air sampled.

4. Sampling

4.1 Terminology

4.1.1 Occupational Sampling

All sampling must be so conducted that the results are representative of the worker exposure to asbestos fibres under typical working conditions for a full shift. Sampling procedures must not interfere with the activities of the worker.

4.1.2. Worker Breathing Zone

In order to estimate worker exposure, samples must be taken in the workers' breathing zone.

The workers' breathing zone consists of a hemisphere of 300 mm radius extending in front of the face, and measured from a line bisecting the ears.

4.1.3 Personal Samples

Personal samples are taken within the workers' breathing zone. Usually the filter is fastened to the jacket lapel of the worker with the cowl (see Supplement) pointing downwards. The worker carries the pump on a belt or in a pocket.

4.1.4 Static Samples

Static samples are samples taken at fixed locations. They are not recommended for the measurement of personal occupational exposure to asbestos dust.

Point sources create considerable concentration gradients thus causing the results of static samples to vary considerably over short distances. However, static sampling can be useful if the dust is proven to be uniformly distributed over large areas.

4.1.5 Single Sample Duration

Single Sample Duration is the actual time during which a single sample is collected.

This duration is usually dependent upon analytical requirements (see 4.3.8).

4.1.6 Total Sample Duration

Total Sample Duration is the sum of Single Sample Durations taken during one day (see 4.2.3).

4.1.7 Reference Period

For the purpose of this method, estimates of exposure will be reported on the basis of an eight hour reference period. It is intended that exposure should be calculated as if it had taken place over eight hours.

If a worker is exposed to airborne asbestos dust for more than or less than eight hours, the measured concentration during his working period must be scaled to relate to an eight hour exposure (see 5.4.3), in order to arrive at an estimate of the workers' equivalent eight hour exposure.

4.1.8 Short Term Samples

The Single Sample Duration for a short term sample is less than one hour (see 4.3.8).

The short term sample has been defined because it is necessary to refer to that special case. Unless specified as short term, the samples are assumed to be of at least one hour duration.

4.2 Strategy

4.2.1 General Principles

Occupational exposure measurements are carried out to meet one or both of two major objectives:

1. To assess exposure relative to an occupational hygiene standard and to enable better control measures to be implemented.
2. To provide estimates of exposure for morbidity and mortality epidemiological investigations.

It is well known that dust concentrations vary widely both within a single day and from day to day. Most regulations and hygiene standards require a reliable estimate of exposure on a particular day. It is more useful for epidemiology to spread the sampling effort over a number of days, i.e. less will be known about a single day, but more about the average exposure over a working lifetime. Since sampling must often serve both purposes, the sampling schemes presented in this method emphasize the single day estimate.

It must also be recognised that variations in individual working practices result in a distribution of exposure values within any job group. Consequently data from one person cannot be assumed to be representative of the total job group. Any transfer of data must, therefore, be validated by appropriate relative measurements.

4.2.2 Sampling Schemes

There are a number of different sampling possibilities, some of which are listed for guidance in the following table. As they vary in the degree of usefulness and precision in estimating exposure, the table *must* be interpreted in association with the qualifying conditions and cautions presented in sections 4.2.3 and 4.2.4.

In planning a sampling scheme, it is important to determine:

- the Estimation Period during which the exposure is estimated,
- the total Sample Duration,
- the Number of Samples.

To assess a worker's full shift exposure every effort must be made for the samples to relate to a whole working day. Care must be taken to ensure that the sampling period is not biased by abnormal conditions.

Short term samples should be taken at random (statistically) throughout the whole working day. If samples cannot be selected from the entire working day, the measurement results are valid only for the duration of the period from which the measurements were selected. However, relative measurements and reliable professional judgement can sometimes be used to make inferences about concentrations during other portions of the day. Reliable knowledge concerning the operation is essential to make such extrapolations.

Sampling Scheme	No. of Samples per shift	Total Sampling Duration
LONG TERM		
Full-shift consecutive sample(s)		
Type A	2 or more	approximately full shift
Type B	1	approximately full shift
Partial-shift consecutive sample(s)		
Type C	2 or more	2 hours or greater
Type D	1	1 hour or greater
SHORT TERM		
Random Samples		
Type E	5 or more taken randomly throughout the working day	1 hour or greater
Systematic Samples		
Type F	1 or more plus continuous relative measurement, or 2 or more taken during each separate phase of a cyclical operation	1 hour or greater

4.2.3 Total Sampling Duration and Number of Samples

Sample duration is influenced primarily by the reason for sampling, the level of fibre concentration to be measured, the concentration of non-fibrous dust and the requirements of the analytical method. This may result in more than one single sample being required. The total sample duration should never be less than one hour.

Sections 4.3.6 and 4.3.8 detail acceptable minimum and maximum loadings of fibres on the filter, which dictate the range of possible sampling times for different airborne fibre concentrations.

Samples of short duration may be necessary if high background levels of particulate matter or fibres are present which would prevent accurate analysis.

4.2.4 Reliability of Sampling Schemes
The main strengths and limitations of the various sampling schemes, types A to F listed before, are as follows:

- **Type A Sampling Scheme** (two or more samples covering the full working shift) permits the most reliable estimate of exposure to be made. When several samples are taken, the average of the errors is usually less than the single (percentage) error in a single full shift sample. Sporadic gross errors such as miscalculations, contamination, incorrect sample timing, etc. are more likely to be detected by type A than type B.
Note: Systematic errors must still be taken into account in the normal manner — e.g. flowrate inaccuracy, etc.
- **Type B Sampling Scheme** (one full shift sample) is not as reliable as type A, because gross errors can escape detection unless evidence from previous sampling is available on which to base a judgment.
- **Type C Sampling Scheme** (two or more samples covering part of the full shift, i.e. two or more hours but less than full shift) can be satisfactory if the partial shift is representative of the full shift.

- **Type D Sampling Scheme** (one sample, one or more hours but less than full shift) similar to type C except that gross errors may escape detection.
- **Type E Sampling Scheme** (5 or more short term samples, taken randomly throughout the full shift) may give an acceptable indication of exposure but is generally more wasteful of resources and is the least precise of the above schemes. Note that an even poorer estimate results when the "average" dust concentration increases or decreases markedly throughout the day. This scheme should be applied with caution.
- **Type F Sampling Scheme** (several short term systematic samples taken during each separate phase of an operation) can be used by experienced industrial hygienists to characterize a workplace. This approach should not be used indiscriminately, particularly by persons not completely familiar with the process. Nor should it be used to estimate time-weighted-average exposure unless the results are verified by continuous relative measurements or other methods (see 4.4.2).

4.3 Technique

4.3.1 Filter

Membrane filters (mixed esters of cellulose or cellulose nitrate) of 1.2 micrometre pore size with printed grids and a diameter of 25 mm should be used. See Supplement for specifications of suitable filters.

4.3.2 Filter Holder

It is necessary to use an open faced filter holder fitted with a protective cowl (see Supplement).

The cowl helps to protect the filter from accidental contamination. A metallic cowl is preferred to a plastic one because of the possible risk of fibre loss due to electrostatic charge. Filter holders must be thoroughly washed before re-use.

Due to the design of the filter support utilized in some filter holders a secondary supporting membrane should be used.

The purpose of this secondary membrane is to ensure an even distribution of air passing through the primary membrane.

4.3.3 Storage and Transport

Fixatives must not be used.

Experience has shown that fixing fibres to the filter surface with cytological or other types of fixatives is unnecessary and should not be done.

Filters should be transported in closed holders which should only be opened immediately before use and sealed immediately after.

An alternative is to transfer the filter to a petri dish in the following way: In a dust-free area, using forceps, carefully remove each used filter from its holder taking care to grasp it on its unexposed edge. Place the filter, dust side up, in a plastic petri dish or similar container. Fasten the filter to the bottom of the dish with one or two pieces of adhesive tape attached to the unexposed edge. After transportation, the filter can be removed easily from the dish with a surgical scalpel.

Pack the filter holders or petri dishes into a rigid container with sufficient soft packing material to prevent both crushing and vibration of the filter. Samples should be unambiguously labelled and caution is necessary to ensure that filters cannot be accidentally re-used. The filters should not be marked for this purpose because of the risk of damaging the filter.

4.3.4 Sampling Pump

A portable battery operated pump must be used for personal sampling. The capacity of the battery must be sufficient to operate continuously over the chosen sampling time. The flow must be free from pulsation.

As a minimum and tentative criterion there must be no visible vibration of a rotameter float when this flowmeter is connected to the filter holder.

Although some pumps are equipped with pulsation dampers, an external damper may have to be installed between the pump and the filter.

Never run the pump without a filter.

Connecting tubing must be constriction-proof and the connections leakproof.

4.3.5 Flow Rate

The flowrate should be adjusted to one litre/minute, i.e. approximately 4 cm/s face velocity.

The flowrate should be checked at least before and after sampling. If the difference is greater than 10 per cent from the initial flow rate, the sample must be rejected.

If an external flowmeter is used to determine the flowrate of the pump, care must be taken to ensure that the flowmeter does not cause *unknown* changes to the flowrate. Measurement of the "sampling train" flowrate using a soap-film flowmeter, with and without the external flowmeter, is one satisfactory method of determining any change in flowrate.

The flowmeter used should be able to measure flowrate to an accuracy within $\pm$ five per cent of the true flow (95 per cent confidence limits).

See Appendix B for flowrate calibration.

4.3.6 Acceptable Fibre Loadings on Filters

• Minimum Loading

The minimum filter loading should exceed 50 fibres/mm² (i.e. approximately 40 fibres/100 Walton-Beckett graticule areas). In special circumstances (e.g. when an indication of concentration with low precision is acceptable) it is permissible to lower the acceptable fibre loading to 20 fibres/mm² (i.e. approximately 15 fibres/100 Walton-Beckett graticule areas).

The lowering of the acceptable fibre loading gives at best, barely acceptable coefficients of variation. The limitations as described in section 6.5 should also be considered when measuring very low fibre concentrations.

• Maximum Loading

Experience shows that the filter loading should not exceed a maximum of five fibres/graticule area (average value of all counted fields) for the majority of sampling situations.

This may need to be reduced to an average of about one fibre per graticule area when mixed dusts of agglomerates are present, and can sometimes be doubled when only fibres are present. Average filter loadings exceeding 10 fibres/graticule area should be rejected.

4.3.7 Blanks

For each batch of filters used for sampling, and for every 25 filters in the batch, select one unused filter which has been subjected to the same treatment as for normal samples, but without having had air drawn through it, or having been attached to the worker. If this "blank" yields fibre counts greater than three fibres/100 graticule areas, the entire sampling and analytical procedure should be examined carefully to find the cause of the contamination.

Single Sample Duration			
C_{expected} fibre/ml	$t_{\text{recommended}}^{(1)}$	$t_{\text{maximum}}^{(2)}$	$t_{\text{minimum}}^{(3)}$
0.5	3 hours	8 hours	40 minutes
1	1.5 hours	4 hours	20 minutes
2	45 minutes	2 hours	10 minutes
5	20 minutes	1 hour	4 minutes*
10	10 minutes	30 minutes	2 minutes*
20	4 minutes*	10 minutes	1 minute*

When the blank count exceeds three fibres/100 graticule areas, and also exceeds 10 per cent of the actual sample fibre count/100 graticule areas, the samples represented by the blank are not considered acceptable for assessment of worker exposure. However, the determination may still be useful for indicating compliance with the hygiene standard (e.g. if the estimated exposure is less than that permitted by regulations even with the contamination then this is a conservative estimate of compliance).

For example — the fibre count of a blank filter was 15 fibres/100 graticule areas (i.e. 0.15 fibres/area) while the sample yielded 108 fibres in 90 graticule areas (i.e. 1.20 fibres/area).

$$\frac{\text{Blank count}}{\text{Sample count}} \% = \frac{.15}{1.20} \times 100 = 12.5\%$$

As this percentage exceeds 10 per cent, the sample is rejected. Furthermore, because the blank count exceeded three fibres/graticule area the cause of contamination must be found and corrected.

4.3.8 Recommended Single Sample Duration

Taking into account the filter loading considerations as detailed in section 4.3.6, the sampling duration for each sample may be determined by

application of the following simple formula:

$$t = \frac{A}{a} \cdot \frac{L}{C_{\text{exp}}} \cdot \frac{1}{r}$$

t = Single Sample Duration
 L = required filter loading in fibres/graticule area.
 A = effective filter area mm²
 a = graticule area mm²
 r = flow rate ml/min.
 C_{exp} = average fibre concentration expected to occur during the Single Sample Duration (fibre/ml)

To provide guidance in the selection of Single Sample Duration, the following table lists recommended durations based on two fibres/graticule area. If it is not possible to use these values, the minimum and maximum durations allow a choice to be made whilst still remaining within the constraints of 4.3.6.

*Note: (1) 2 fibres/graticule area
 (2) 5 fibres/graticule area
 (3) 0.4 fibres/graticule area equivalent to 50 fibres/mm²*

** A measured concentration of less than 20 fibres/ml should be discarded because it has little significance if the sampling time is less than 10 minutes.*

Sampling time should be measured accurately.
The timers or counters installed in some pumps are not always reliable.

4.3.9 Sampling Record

All data necessary for the determination of the fibre concentration must be recorded, along with the sampling details. Furthermore, as much data as is available, which can be of value for epidemiological studies, should be included (see Appendix D).

5. Evaluation

5.1 Sample Preparation

5.1.1 Cleaning Slides and Equipment
Clean conditions should be maintained at all times.

A dirty preparation area may result in sample contamination and erroneous results.

- *Clean slides with lens tissue or industrial paper tissue and lay them on a clean surface, e.g. lens tissue sheet. It is good practice to clean each coverslip with lens tissue immediately before use to ensure that the surfaces are free from contamination.*
- *Wipe scalpel and forceps with lens tissue and place them on a clean surface, e.g. lens tissue. When mounting a series of filters, the mounting tools must be wiped clean before dealing with each sample.*

5.1.2 Filter Sample Cutting
Mounting of the total filter is preferred.

If it is necessary to cut the filter, all cutting should be done with a scalpel using a rolling action. Do not use scissors. It is recommended that the smallest piece mounted be wedge-shaped, approximating to one quarter or one third of the filter.

5.1.3 Mounting the Sample
For mounting use the acetone-triacetin method only as described in Appendix A.

Warning

Acetone mounting should be carried out only in a fume hood or fume cupboard. On no occasion should it be used in the vicinity of an open flame.

5.2 Optical Requirements

5.2.1 Microscope Equipment

It is recommended that the following specification be used to select a microscope suitable for asbestos dust counting. Because microscopes with identical "specifications" can give quite different performances, it is necessary that the performances of proposed and existing microscopes be assessed by means of "Detection Limit Test Slides" (see Appendix F). It is also important that newcomers consult with experienced workers before selecting microscopes for asbestos dust determination.

Light Source — Koehler illumination is required.

It is preferable for the illuminator to be built-in but an external lamp with a plain mirror can be satisfactory. A variable light intensity control is necessary for both methods of illumination.

Substage Assembly — An Abbé or achromatic phase-contrast condenser incorporated into a substage unit is required.

There must be a means of centering each condenser annulus with respect to the phase plate in the corresponding objective and a means of focussing the condenser.

Stage — A built-in mechanical specimen stage fitted with slide clamps and x-y-displacement is required.

Objectives — A rotating nose-piece fitted with 10x and 40x parfocal phase-contrast achromatic objectives is required.

The 40x objective must have a numerical aperture (NA) of 0.65, achromatic. It should have a phase ring of not less than 65 per cent and not greater than 85 per cent absorption. Either positive or negative phase-contrast is suitable.

Eye-piece — Binocular eyepieces of the compensating type are recommended. They should be chosen to give a total magnification of between 450x and 500x, preferably 500x. At least one eyepiece must permit the insertion of a graticule and preferably be of the focussing type. The use of body magnification changers is not recommended.

Graticule — The graticule recommended for this method is the Walter-Beckett circular eyepiece graticule.

Its actual diameter when using the 40x phase objective and an appropriate eyepiece should be 100 micrometres plus or minus 2 micrometres. See Appendix E for graticule specification, source of supply and ordering information.

Accessories

CENTRING TELESCOPE or Bertrand Lens is essential for checking that the phase rings in the condenser are centred with respect to those in the objective.

A green filter is necessary to ensure the best phase contrast conditions because the optics are designed for this wavelength.

STAGE MICROMETER — Must be subdivided into 10 micrometre intervals and preferably be one millimetre long.

Microscope Slides — Should be of the best quality.

COVERSLIPS of thickness to which the microscope is designed (normally 0.17 mm thickness) are essential. Incorrect coverslip thickness will detract from the quality of the final image.

5.2.2 Microscope Adjustment Principles
Follow the manufacturer's instructions while observing the following guidelines:

The image of the light source must be in focus and centred on the condenser iris or annular diaphragm for true Koehler illumination.

The object for examination must be in focus.

The illuminator field iris must be in focus, centred on the sample and opened only to the point where the field of view is illuminated.

The phase rings (annular diaphragm and phase shifting elements) must be concentric.

The eyepiece graticule must be in focus.

For more detailed information see Appendix G.

Microscope adjustments must be a daily routine.

5.2.3 Eyepiece Graticule Calibration
Each combination of eyepiece, objective and graticule must be calibrated with a stage micrometer. Should any of the three be changed, the combination must be recalibrated. For some microscopes, calibrations will change for observers with different interpupillary distances (see Appendix E for eyepiece graticule calibration procedures).

5.2.4 Microscope/Observer Performance Assessment
Because past experience has shown that significant differences in counts occur due to differences in microscope quality, setting up and cleanliness, it is necessary that laboratories following this method should maintain contact with the AIA.

As mentioned in section 5.2.1, sets of detection limit test slides are available which will assist in the regular assessment of microscope and observer performance. A practical detection limit relative to the test slides, Code-No. 5 or 6 (0.26 or 0.22 μm spheres) should be achieved.*

*In the meantime another recommendable Test Slide (HSE) is also available (see Supplement). Using this HSE — Test Slide Block 5 should be achieved.

Exchange of microscope slides for comparison with experienced laboratories will help to ensure that valid results are being generated.

5.3 Counting and Sizing Fibres

5.3.1 General

Airborne asbestos dust collected on membrane filters appears in a wide variety of forms ranging from simple single fibres to very complex configurations of fibres or aggregates. When presented with these, the microscopist could experience difficulty in defining and counting the fibre content of a dust sample. The following notes (and drawings in Appendix H) have been prepared to assist and guide the observer in the assessment and interpretation of asbestos dusts collected on membrane filters.

5.3.2 Low Power Scanning
With a total magnification of 100x to 150x (i.e. 10x objective) scan the entire filter area.

The margin normally covered by the filter holder gasket should be free of dust and fibres. All viewing fields should have similar appearances with respect to total dust loading. If the observed fields show marked differences in loading, or gross aggregation of fibres or dust, the filter must be rejected.

5.3.3 Graticule Field Selection
After a satisfactory low power scan, change the microscope objective to 40x phase and focus on the dust plane. *Ensure that the phase rings remain concentric. While most of the fibres and dust will be found on the upper surface of the filter, it will be necessary to focus below (say up to 10 micrometres) and slightly above the surface.*

When counting and sizing, constant use of the fine focus is necessary because of the small depth of focus of a 40x objective (i.e. two to three micrometres).

Counting fields should be chosen at random throughout the entire area of the filter or filter segments.

If the grid of a filter obstructs the view, move the stage to another field.

Do not count fields that lie within 3 mm of the filter edge and within 2 mm of the cutting line.

5.3.4 Laboratory Working Conditions
The working practices and the working environment in a laboratory may influence systematically the accuracy of the actual counting. Some differences may appear when inter-laboratory comparisons are made which are due merely to different laboratory lighting conditions, different seating and computing arrangements, etc. Different practices of recording data may also cause some disagreement between the counters, due to the rate of fatigue of the eyes.

The detailed writing of data involves the re-focussing of the eyes after each field whereas continuous registering with electrical or mechanical counters involves only a single period of continuous concentration.

This problem of ergonomics briefly stated here can only be dealt with when all the other parameters of the method are fixed.

5.3.5 Counting Criteria

5.3.5.1 Accuracy is important, and full use should be made of known dimensional standards. Estimate the length of curved fibres along the curve of the fibre (i.e. true length).

5.3.5.2 A countable fibre is defined as any object having a maximum diameter less than 3 μm and a maximum length greater than 5 μm and a length:diameter ratio greater than 3 : 1, and which does not appear to touch any particle with a maximum diameter greater than 3 μm . A countable fibre with both ends within the graticule area shall count as one fibre; a countable fibre with only one end within the area shall count as half a fibre.

5.3.5.3 Graticule areas for counting shall be chosen at random within the exposed area of the filter.

5.3.5.4 An agglomerate of fibres which at one or more points on its length appears to be solid and undivided but which at other points appears to divide into separate strands is known as a split fibre. Any other agglomerate in which fibres touch or cross one another is known as a bundle.

5.3.5.5 A split fibre is regarded as a single countable fibre if it meets the definition in 5.3.5.2, the diameter being measured across the undivided part, not the split part.

5.3.5.6 Fibres in a bundle are counted individually if they can be distinguished sufficiently to determine that they meet the definition in 5.3.5.2. If no individual fibres meeting the definition can be distinguished, the bundle is a countable fibre if the bundle as a whole meets the definition in 5.3.5.2.

5.3.5.7 If more than one-eighth of a graticule area is covered by an agglomerate of fibres and/or particles, the graticule area must be rejected and another counted.

5.3.5.8 At least 100 fibres shall be counted with a minimum of 20 graticule areas examined. No more than 100 graticule areas need to be examined.

5.3.5.9 All relevant information must be recorded (see Appendix I for an example of a dust counting form).

5.4 Calculation of Dust

Concentration and Worker Exposure

When the following calculations are applied, the limitation imposed upon the data by the sampling and fibre counting methods must not be disregarded. Results should not be interpreted or reported with false precision.

5.4.1 Single Values

The fibre concentration for each Single Sample Duration is determined according to the following formula:

$$c = \frac{A}{a} \cdot \frac{N}{n} \cdot \frac{1}{r} \cdot \frac{1}{t} \quad (1)$$

where:

c = concentration (fibres/ml)

N = total number of fibres counted

n = number of graticule areas observed

A = effective filter area (mm²) (see Appendix C)

a = graticule counting area (mm²) (see Appendix E)

r = flowrate of air through filter (ml/min)

t = Single Sample Duration (minutes)

5.4.2 Time Weighted Average Values

When several samples of different sampling durations are taken calculate the time weighted average values from the single values as follows:

$$C_{TW} = \frac{\sum C_i \cdot t_i}{\sum t_i} = \frac{C_1 t_1 + C_2 t_2 + \dots + C_n t_n}{t_1 + t_2 + \dots + t_n} \quad (2)$$

C_{TW} = time weighted average concentration (fibres/ml)

c_i = single value of concentration (fibres/ml)

t_i = Single Sample Duration (minutes)

Σt_i = Total Sample Duration

n = total number of samples

If the Single Sample Durations (t_i) referred to above are of equal duration, then equation (2) is simplified as follows:

$$C_{TW} = \frac{\sum C_i}{n} = \frac{C_1 + C_2 + \dots + C_n}{n} \quad (3)$$

5.4.3 Equivalent eight hour Exposure Value

If the shift of the worker exposed to airborne asbestos dust is more than or less than eight hours, the average concentration during the full shift must be multiplied by a factor (f) to yield the Equivalent eight hour Exposure Concentration (C_{eq}), as follows:

$$f = \frac{\text{full shift time (hours)}}{8 \text{ hours}}$$

$$C_{eq} = f \cdot C_{TW} \text{ (full shift)}$$

Where C_{TW} (full shift) is the time weighted average concentration for the full working shift. This is equal to the calculated C_{TW}, provided that representative conditions apply as described in Section 4.2.2.

Example 1:

Daily shift duration 12 hours
Time-weighted-average for the full shift of 1.2 fibres/ml.

Using equation (4): $f = \frac{12}{8} = 1$

Using equation (5): C_{eq} = 1.5 x 1.2 = 1.8 fibres/ml

Example 2:

Daily shift duration of 5 hours* with a corresponding shift average of 1.2 fibres/ml.

Using equation (4): $f = \frac{5}{8} = 0.625$

Using equation (5): C_{eq} = 0.625 x 1.2 = 0.8 fibres/ml

*This means that the worker was known to have zero exposure to asbestos outside of his 5-hour shift.

5.4.3.1 Calculation of "C_{eq}" for various Sampling Schemes

Types A, B, C and D

1. Calculate single value concentration(s) for the sample(s) using equation (1).

2. Calculate time-weighted-average (C_{Tw}) concentration using the above single value(s) and respective Single Sample Duration(s) in equation (2) (or (3) if applicable).

3. Calculate C_{eq} by using the procedure at 5.4.3.

5.4.3.2 Calculation of "C_{eq}" for Sampling Scheme E

Type E

When 5 or more short term samples are taken randomly throughout a full shift, the time-weighted-average concentration can be estimated as follows:

1. Calculate the natural logarithm of each concentration: $y_i = \ln c_i$, i.e. $y_1 = \ln c_1$, $y_2 = \ln c_2$ and so on. If any concentration is less than 0.1 fibres/ml, replace it with 0.1 fibres/ml for the above calculation.

2. Calculate the arithmetic average of the logarithmic concentrations:

$$\bar{y} = \frac{\sum y_i}{n} = \frac{y_1 + y_2 + \dots + y_n}{n}$$

3. Calculate the empirical logarithmic standard deviation (s_i) of the logarithmic concentrations (sampling/analytical random errors and environmental fluctuations are included)

$$s_i = \sqrt{\frac{1}{n-1} \left[\sum y_i^2 - \frac{1}{n} (\sum y_i)^2 \right]}$$

or

$$s_i = \sqrt{\frac{1}{n-1} \left[y_1^2 + y_2^2 + \dots + y_n^2 - n(\bar{y})^2 \right]}$$

4. The estimate of the average airborne concentration is calculated as follows:

$$C_{Tw} = \text{Exp} \left[\bar{y} + \frac{s_i^2}{2} \right]$$

Note: The above calculations are used because available evidence shows that random intra-day variations are best described by a log-normal distribution.

5. Using C_{Tw} from above, calculate C_{eq} as in section 5.4.3.

5.4.3.3 Calculation of "C_{eq}" for Sampling Scheme F

Type F

1. Calculate single value concentrations for the samples using equation (1).

2. Calculate the times (T_i) for each individual working phase ensuring that the sum of these phase times equals a full shift.

3. Calculate the time-weighted-average concentration using the phase times (T_i) instead of the Single Sample Duration (t_i) in equation (2).

4. Calculate C_{eq} as in Section 5.4.3.

Note: The above calculations for the different sampling schemes do not imply identical reliability in the estimation of the equivalent 8 hour exposure value (C_{eq}), (see 4.2.3 and 4.2.4).

6. Sampling and Analytical Errors

6.1 General

Errors introduced into the estimation of airborne asbestos dust comprise sampling and analytical errors, each of which has a systematic and random component. The application of standard procedures and a reproducible routine is the only way of controlling most of the many sources of error inherent in the membrane filter method. The following list describes some of the common sources of error.

6.2 Systematic Errors

6.2.1 Sampling

Flowrate.

Sampling time.

Non-representative or biased sampling.

Contamination — deliberate or accidental.

6.2.2 Analytical

Effective filter area.

Counting area.

Filter mounting.

Microscope and observers.

Contamination.

6.3 Random Errors

6.3.1 Sampling

Flowrate variability.

Random fluctuations of the airborne dust cloud.

6.3.2 Analytical

Fibre distribution on the filter.

Non-random deposition of dust on the filter leads to gross errors, the magnitude of which cannot be estimated. Twenty or more fields must be counted to ensure that minor divergence from randomness does not bias the result.

Poisson errors.

As only small samples of the fibres deposited on the filter are counted, errors arise in the estimation of the total number of fibres on the entire filter face. Theoretically, the Poisson distribution defines the variation in fibre counts resulting from viewing randomly selected counting fields on the filter. If a minimum of 100 fibres is counted, and if a Poisson distribution were appropriate to the counting results, the relative standard deviation of the fibre counts would be ± 10 per cent. It has been shown experimentally that the actual distribution of fibre counts can depart from that of Poisson, in which case the standard deviation may be greater.

6.4 Overall Accuracy

Because of the nature of the membrane filter method, it is not possible to know the "true" airborne fibre concentration of a given dust cloud. For this reason it is not possible to assess the likely accuracy of the method. Even the precision (or repeatability) of the method is difficult to quantify because of systematic errors which tend to arise both intra- and inter-laboratory. Taken as a whole by "randomly" selecting observers and laboratories, these systematic errors take on a random nature such that it may be possible in future to provide estimates of empirical precision (i.e. the closest approach possible to a statement of accuracy for a method with no known "true" values).

Much work has been done in an attempt to arrive at these estimates, and to date only partial conclusions have been reached. One of these describes the theoretical Poisson distribution (see section 6.3.2) as contributing a 95 per cent confidence interval of ± 20 per cent for a total of 100 fibres counted, up to about ± 35 per cent for only 40 fibres counted in 100 graticule areas.

Other sources of random and systematic errors add significantly to the uncertainty in estimating the airborne asbestos dust concentration.

6.5 Limitations of the Membrane Filter Method and Presentation of Results

With the parameters specified in this method, i.e. one litre/minute flowrate and a minimum filter loading of 15 fibres per 100 graticule areas, the theoretical lower detection limit for an eight hour sample is 0.02 fibres/ml; however, the practical limit is much higher.

It is generally accepted that blank, unused filters can frequently give a reading of several countable fibres per 100 graticule areas. These "fibres" may be unidentified contaminants on the filter, or artifacts from the clearing process which have the appearance of fibres.

It must be recognised that neither counting more fields nor increasing sampling duration overcomes the problem of background dust, when asbestos is a minimum constituent in the overall dust cloud.

There is at present insufficient information available to determine at what level the reliability of the method becomes so poor that results have little meaning. It is clear that this will not be a single value, but will be a range depending upon at least the relative and absolute fibre concentration. There appears to be general agreement amongst those experienced in the field, that these limits lie somewhere in the range of 0.1 to 0.5 fibres/ml depending on a variety of conditions. In view of this situation, and the inherent variability of the method, all calculated values of less than 0.1 f/ml should be reported only as "less than 0.1 fibre/ml". All higher values should be rounded off to the first decimal place, and to two significant figures.

Appendix A

Acetone-Triacetin-Mounting Procedure

Warning

Acetone mounting should be carried out only in a fume hood or fume cupboard. On no occasion should it be used in the vicinity of an open flame.

A hot plate, or waterbath, or heating mantle, complete with energy regulator, or even an infant's bottle warmer can be used to heat the acetone. An effective method is an infra-red lamp. The lamp can be moved closer to, or further from the flask so that the acetone can be boiled gently.

As illustrated in the diagram below, it is advisable to use a simple condensing column to ensure that a bare minimum of acetone vapour escapes.

The free opening in the tap must have diameter of at least 6 mm, otherwise the acetone vapour cannot escape in a sufficient quantity when using an open condensing column.

When not in use, the acetone vapour outlet should be plugged.

Heat the acetone to boiling and wait until a moderate quantity of acetone vapour is emerging from the outlet.

Place the filter dust side up on a clean microscope slide at room temperature — electrostatic forces usually keep the filter on the slide.

Ensuring that no liquid acetone drops on the filter (by wiping the outlet periodically with a tissue), hold the slide with clean forceps directly in the acetone vapour stream approximately 15 to 25 mm from the outlet for three to five seconds. At the same time move the filter slowly across the outlet to ensure even coverage until the filter is transparent. Too little vapour will fail to render the filter transparent, while too much vapour (especially drops of liquid acetone) will destroy the filter by dissolving it or shrinking it beyond use. The slide must not be prewarmed, as the acetone vapour must condense on the slide for correct clearing.

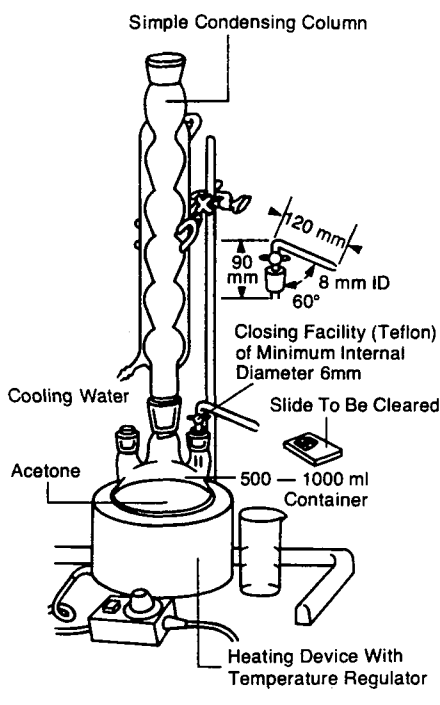
Using a hypodermic syringe with a 22 gauge needle, place one to three drops of glycerol triacetate (Triacetin) on the acetone cleared filter. To avoid the development of a "skin" over the Triacetin, immediately lower at an angle (see diagram below) a clean coverslip onto the Triacetin. The coverslip should not be pressed onto the membrane.



Too much Triacetin (as indicated by excess liquid emerging from the edges of the coverslip) can cause the outside edge of the filter eventually to disintegrate to some degree. Insufficient Triacetin will result in uneven clearing of the granularity left from the acetone vapour clearing. Further, the refractive index of the mounted sample will not be suitable for optimum visibility of very fine Chrysotile fibres.

Heating the cleared filter to approximately 50°C for fifteen minutes accelerates the clearing process and enables analysis to proceed almost immediately thereafter. Otherwise it is necessary to delay counting for up to 24 hours until the entire filter has dissolved under the action of the Triacetin. The finished product will be stable, will not disintegrate, nor be subject to significant particle migration.

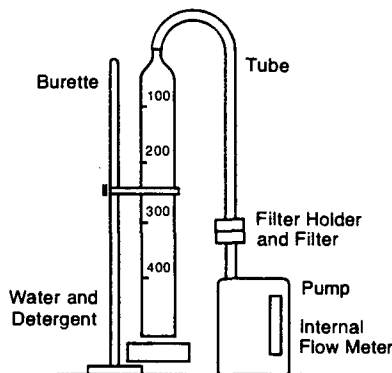
It is desirable to paint nail polish, or similar lacquer around the edge of the coverslip if the slide is to be kept indefinitely.



Appendix B

Flow Rate Calibration and Corrections

Internal and external flow meters must be calibrated with a primary calibration device. One suitable calibration procedure makes use of a soap film flow meter. The flow meters described in this section are of the variable area type (i.e. "rotameters").



6. By momentarily placing the beak against the bottom of the soap film flow meter create a bubble such that it will travel the entire length of the burette without bursting.

7. With a stop watch, measure accurately the time that the bubble requires to traverse the tube between its extreme graduated ends.

8. Repeat steps 6 and 7 at least two or more, until good repeatability of the times is achieved.

9. Average the times, and calculate the true flow (Q_c) as follows:

Note: Theoretically, the water vapour content in the soap film flow meter air should be taken into consideration in determining the "true" flow rate. However for practical purposes acceptable accuracy is maintained without this correction.

$$Q_c = \frac{V}{\tau}$$

Where Q_c = True volumetric flowrate (ml/min.) at calibration conditions

V = Volume of burette (ml)
 τ = Average time required for bubble to traverse the tube (minutes).

1. Choose an accurate burette (or similar) of 300-500 ml capacity. Attach a tube to the bottom of the burette, and then clamp it in an inverted vertical position into a stand.

2. Set up the sampling pump complete with connecting tube, filter holder and filter as that used in the field.

3. Connect the soap film flow meter. Ensure that the system is leakproof. It is advisable to rinse the burette thoroughly in water immediately prior to the test — this removes accumulated detergent and also assists in wetting the inside of the burette.

4. Switch on the pump and adjust the flowrate to 1 l/min. according to the internal flow meter (if fitted).

5. Partly fill a beaker or petri dish with water plus the minimum amount of detergent necessary to permit bubbles to be formed.

10. If the external or internal rotameter is used under different temperature conditions than those during calibration it is generally not possible to calculate the different flowrate that will inevitably result.

As all air sampling measurements are concerned only with volumetric flowrate (i.e. flowrate measured and expressed at the prevailing temperature and pressure) and not mass flowrate (i.e. flowrate corrected to standard temperature and pressure conditions) recalibration of the pump flowrate is essential if it is operated under conditions substantially different to those of calibration. Substantial implications

a difference in altitude or temperature by more than 500 m or 15°C respectively compared to the calibration conditions. For field calibration, whilst a 1 litre soap film flow meter is preferred, a 500 ml unit is more convenient and has been found satisfactory.

Example: During the calibration of a pump with an internal flow meter a soap film flow meter of 1000 ml volume gave an average of 63.4 seconds for the bubble to traverse its length.

What is the flowrate under these conditions? Using the equation in this Appendix:

$$Q_c = \frac{V}{t} = \frac{1000}{63.4/60} = 946 \text{ ml/min.}$$

The flowrate, under the temperature and pressure conditions as stated above was 946 ml/min.

Appendix C

Measurement of Effective Filter Area

One convenient way in which to determine the area of the dust deposit (i.e. the effective filter area) is as follows:

1. Place a small quantity of dark coloured dust (e.g. carbon, cement or road dust) into a 2 to 5-litre container with a lid.
2. Shake the container, remove the lid and draw air through a membrane filter and its holder until the airborne dust in the container forms an obvious deposit on the filter.
3. Remove the filter from the holder, and mount onto a microscope slide in the normal manner as described in the Reference Method.
4. Measure at least four different diameters of the resultant dust spot to within ± 0.2 mm. Amongst other methods, microprojection measurement, or the use of microscope object stage verniers have been found satisfactory.

5. Provided that the measured diameters differ by no more than 1 mm, a simple arithmetic average is sufficient to provide a good estimate of the effective filter diameter.

6. At least three individual filters must be prepared and measured as described above to give assurance that the finally calculated area is sufficiently accurate.

7. Provided that the three filter diameters differ no more than 1 mm, an arithmetic average should be taken and the area calculated in the usual manner. This area is then the Effective Filter Area to be used for calculations in this method.

8. If steps 5 or 7 produce differences greater than 1 mm, close attention should be paid to the sampling of the dust or to the filter clearing technique.

9. It is necessary to repeat the measurement of the effective filter area if the type of filter or holder, or if any aspect relating to filter clearing is changed.

10. It is advisable to repeat the entire measurement procedure every 12 months to ensure that the correct effective filter area is known.

Appendix D

Dust Sampling Record

All data necessary for the determination of the fibre concentration must be recorded in a sampling record. Furthermore as much data as available which can be of value for epidemiological studies should be included.

Sampling Details

- Instrument Type and No.
- Flowrate: initial, intermediate and final
- Duration
- Sampling scheme used
- Date, Hour
- Sampled by

Sampling Place Details

- Designation
- Harmful substances — types of asbestos, quartz, etc.
- Brief description of working process
- Variable parameters which can exercise an influence on dust formation
- Work practices
 - Working conditions: normal abnormal
 - Material: type, size, condition, etc.
 - Airflow: worker in dust airflow yes obvious influence on adjoining working places
- Methods of dust control
 - Exhaust ventilation
 - Other methods
 - Visual impression
- Number of employees for which the measuring value is representative
- Personal protection yes/no Type
- Hours per shift
- Days per week

See opposite for Dust Sampling Record

Appendix E

Part 1

Specifications of Eyepiece Graticule. Ordering Information and Calibration. The "Walton/Beckett" graticule described in this method is available from Graticules Limited, Sovereign Way, Botany Trading Estate, Tonbridge, Kent, England, TN9 1RN.

The desired diameter (d) of the circle appear as 100 ± 2 micrometres in the image plane (D) and the overall diameter of the glass disc should both be specified in millimetres when ordering. The graticule can be referred to by the Graticules Ltd. Reference No. G22. The following procedure is one of several methods for determining the diameter (d) of the circular counting area.

Dust Sampling Record

Example Only

Place of measurement date

Measuring point/Name

Code-No. text in clear block lettering

Dimension of workplace ☐ <50 m³ ☐ 50-500 m³ ☐ 500-5000 m³ ☐ >5000 m³

Exhaust ventilation ☐ yes ☐ no

Situation representative? ☐ yes ☐ no

Dust concentration ☐ above average ☐ below average

Visual impression ☐ good ☐ quite good ☐ bad

Number of employees working at this working place:

Respirators are worn ☐ yes ☐ no ☐ sometimes Type:

Draught during measurement ☐ no ☐ yes

Measured in the dustladen air flow ☐ yes ☐ no

Adjoining working places are influenced ☐ no ☐ yes Measuring point No.:

Measurement was done ☐ personal ☐ static

Sampling device atmospheric pressure mbar

Air flow rate time started time ended

Sampling scheme used

Sample No.	Sampling time (min.)	Total Flow	Working phase	Fibres/ml
Average value				

Harmful substances ☐ Chrysotile ☐ Crocidolite ☐ Amosite

☐ Quartz ☐ (other)

Other fibres ☐ Glass fibre ☐ Mineral wool ☐ (other)

1. Insert any available graticule into the eyepiece and focus so that the graticule grid is sharply in focus.

2. Set the appropriate interpupillary distance, and if applicable reset the binocular head adjustment so that the "tube" length (and thus magnification) remains constant.

3. Ensure that the 40x phase objective is in place, and that the magnification changer position (if used) is known and recorded.

4. Place a stage micrometer on the microscope object stage and focus the microscope onto the graduated lines.

5. Measure the overall object length (l_o) of the graticule grid using the stage micrometer.

6. Remove the graticule from the microscope and measure its actual overall grid length (l_a). This can be done by using a stage fitted with verniers.

7. Use the following equation:

$$\frac{l_a}{l_o} \cdot D = d = \text{diameter to be specified}$$

It is also necessary to measure the overall diameter of the glass disc.

Example: Step 5 produced an object length of a Porton graticule of 108 micrometres
Step 6 produced an actual length of 4.50 mm
Step 7
 $\frac{4.50 \text{ mm}}{0.108 \text{ mm}} \times 0.1 = 4.17 \text{ mm}$

For this example the graticule diameter was found to be 17 mm. Thus a 17 mm diameter, Type G22 "Walton/Beckett" graticule of circle diameter 4.17 mm should be specified for the above example.

To expedite manufacture of "made to order" graticules so as to avoid delay and keep down prices, graticules should be ordered in bulk if at all possible.

Graticules Limited have stated that a number of graticules requested on a single order can be invoiced separately to individual companies, and delivered separately to the same or any other set of addresses.

Part 2

Calibration of Eyepiece Graticules

1. Obtain a stage micrometer, preferably with a scale having two or 10 micrometre divisions and place on the object stage of the microscope.

2. Make sure interpupillary distance of eyepieces is set correctly.

3. Note the objective magnification and any intermediate magnification used.

4. Focus the microscope onto the graduated marks of the stage micrometer.

5. Line up the eyepiece graticule with the graduated divisions on the micrometer so that the number of whole micrometer divisions can be counted from one side of the eyepiece graticule graduations to the other.

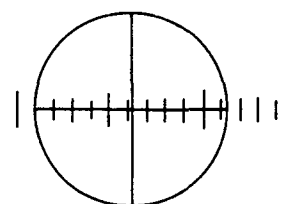
6. If less than a whole division remains, estimate this fraction to the nearest micrometer and add to the number of whole divisions of the stage micrometer after converting to micrometres.

This totalled result is the projected or object dimension of the eyepiece graticule.

Example:

1. A stage micrometer with 10 micrometre divisions was placed on the stage of a microscope.

2. The following diagram depicts the view of the superimposed eyepiece graticule and stage micrometer.



Note that 10 whole divisions span across the graticule; i.e. 10 x 10 micrometres.

3. The remainder of the 11th division estimated as being one third of a whole division, i.e. three micrometres.

Adding these together yields 103 micrometres which is the object dimension of the eyepiece graticule.

Note that if the interpupillary distance objective, intermediate magnification, even in some microscopes the eyepiece is changed then this usually changes the object dimension of the eyepiece graticule — thus necessitating recalibration.

Appendix F

Test Slides for the Determination of the Detection Limit during Phase Contrast Microscopy

Source of Supply (until commercial marketing has started):

Asbestos Institute for Occupational and Environmental Safety and Health
Görlitzer Str. 1
4040 Neuss
Germany

Footnotes

1) It has been decided to stop production of the Test Slides specified in this publication as another suitable Test Slide is now commercially available. However, the Neuss slides can still be used in compliance with this method.

2) The new recommended Test Slide is the HSE/NPL Test Slide (Mark II). For further information see Supplement

Mounting of Test Slides

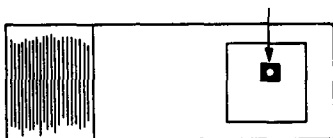
A membrane filter, positioned on a microscope slide, was treated with acetone vapour in order to produce a transparent film. Spherical Latex Particles, with a refractive index of 1.56 (similar to that of chrysotile) were diluted with alcohol. Agglomeration of the particles was minimised by ultrasonic agitation. After evaporation of the liquid, a drop of Triacetin was added to the film containing the Latex Particles and a coverslip was added to produce a normal microscope specimen slide. This process was carried out in the same manner as would be applied to a dust slide membrane filter; consequently the slide has the same optical characteristics under phase contrast microscopy as a normal Chrysotile slide.

Only particles of one size were deposited on slides 1 and 2. Due to difficulty of detecting the smaller particles contained on slides 3 to 8, particles of 0.6 μm were also added to these slides, representing approximately 10 per cent of the particulates. The larger particles are intended to assist in locating the correct specimen plane.

The slides available are as follows:

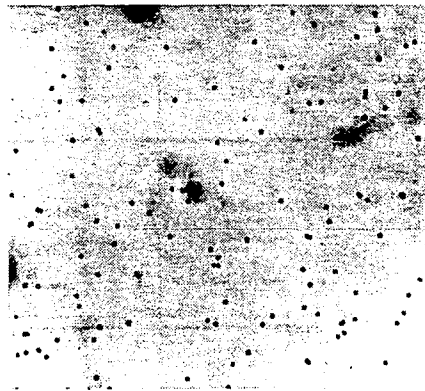
Code- No.	Particle sizes
1	0.6 μm
2	0.48 μm
3	0.36 μm + 10 per cent 0.6 μm
4	0.31 μm + 10 per cent 0.6 μm
5	0.26 μm + 10 per cent 0.6 μm
6	0.22 μm + 10 per cent 0.6 μm
7	0.18 μm + 10 per cent 0.6 μm
8	0.11 μm + 10 per cent 0.6 μm

The area most suitable for use has been delineated by a mask outline. This area only should be used for evaluation.



Application

Test observation should commence by observing slide No. 1 (0.6 μm diameter). The slide is positioned on the microscope in the normal way and positioned for observation of the marked area. When the sample is correctly placed a dense distribution of Latex Particles will be observed similar to the following picture:



Only the particles which are densely distributed and of the appropriate size are the test particles. It is not intended that the particles should be counted but a dense distribution should be detected. The same procedure is applied to each of the slides in numerical order. To assist in locating the correct specimen planes in slides 3 to 8, the microscope is first focussed on to the 0.6 μm diameter particles. A dense distribution of the test particles should be observed once the correct focus has been achieved.

The process is repeated with each slide until the slide where the test particles are no longer visible. The working detection limit is defined by the slide value on which the particles are just detectable.

NOTE: The particle loading of the slide is high. If only a small number of particles is detected in a field of view, the particles being observed are *not* the test particles.

Appendix G

Microscope Adjustment Procedure

Good quality phase contrast microscope equipment should be used as detailed in Section 5.2.1. The equipment should be maintained in first-class condition and most manufacturers operate a routine maintenance service which includes the stripping down and cleaning of all optical components and the replacement of worn traverse mechanisms. Such services should be used unless skilled maintenance services can be provided by counting-laboratory staff.

In general the following setting-up procedure should be adopted to obtain Koehler illumination and good phase contrast conditions but the detail may vary according to manufacturer's instructions and the type of equipment.

1. Place membrane filter specimen slide on microscope stage.
2. Open both the illuminator diaphragm (often referred to as the field iris) and the substage condenser diaphragm. (Note — at this stage the phase annuli should not be inserted. These are usually based in a rotating drum fitted into the substage condenser unit.)
3. Raise condenser to its upper limit, usually within 1 mm of lower face of specimen slide.
4. Using a convenient level of illumination and 10x objective, focus the specimen.
5. Close down the illuminator diaphragm and focus this in the field of view by lowering and raising the condenser. Centre the diaphragm and re-open to fill the field of view.
6. Observe the back focal plane of the objective, using either a Bertrand lens fitted to the body of the microscope or by removing the eyepiece and using an auxiliary telescope.

7. Observe image of bulb (removing the diffusing disc if one is fitted) and centre the bulb filament — focussing the bulb if possible with the adjustment provided. The image of the bulb filament should fill the back focal plane of the objective. Re-insert the diffusing disc if appropriate. (Note — if the bulb cannot be focussed adjust to give uniform bright illumination.)

8. Insert the correct phase annulus into the condenser system and centre this using the appropriate adjusting screws so that the phase plate in the objective and the image of the annulus coincide exactly. Adjust *slightly* the condenser focussing if this is necessary. Ensure that the bright annulus image does not extend beyond the phase ring.

9. Revert to normal viewing and change to 40x objective with no phase annuli in the condenser system. Close down the field diaphragm and refocus this by appropriate adjustment of the condenser. Re-centre if necessary and re-open to fill field of view.

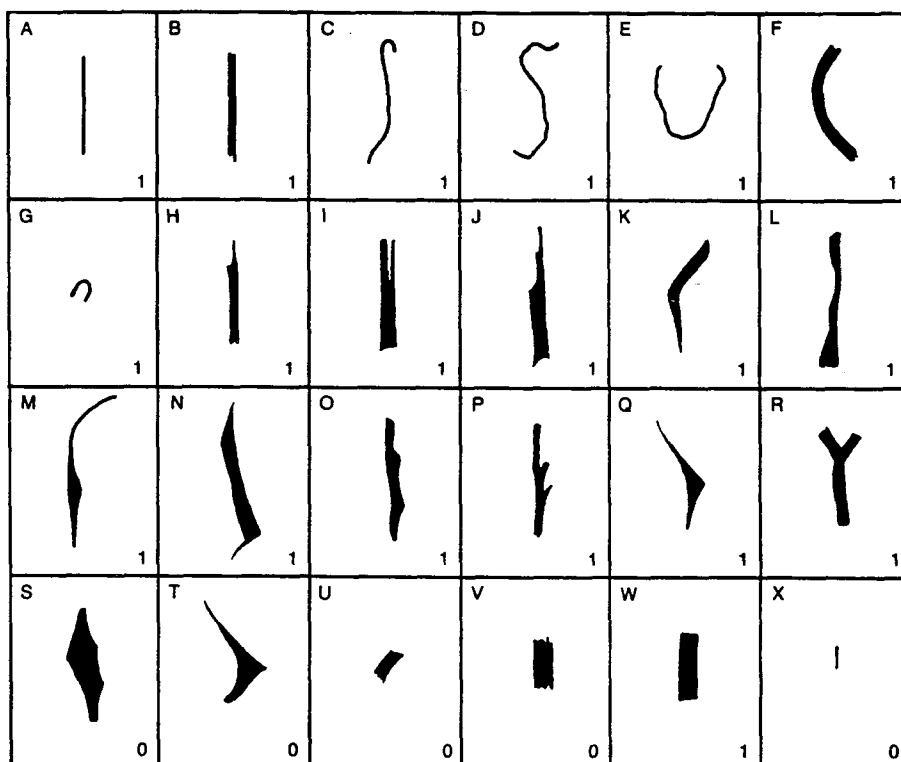
10. Repeat stages 6 and 8 after inserting the phase annulus appropriate to the 40x objective.

11. Revert to normal viewing.

Appendix H

Drawings of Various Asbestos Fibres

Note: All drawings are the same scale i.e. one micrometer = 1 mm. The number in the right bottom corner of each drawing indicates the number of fibres (as defined) counted.



Scale:

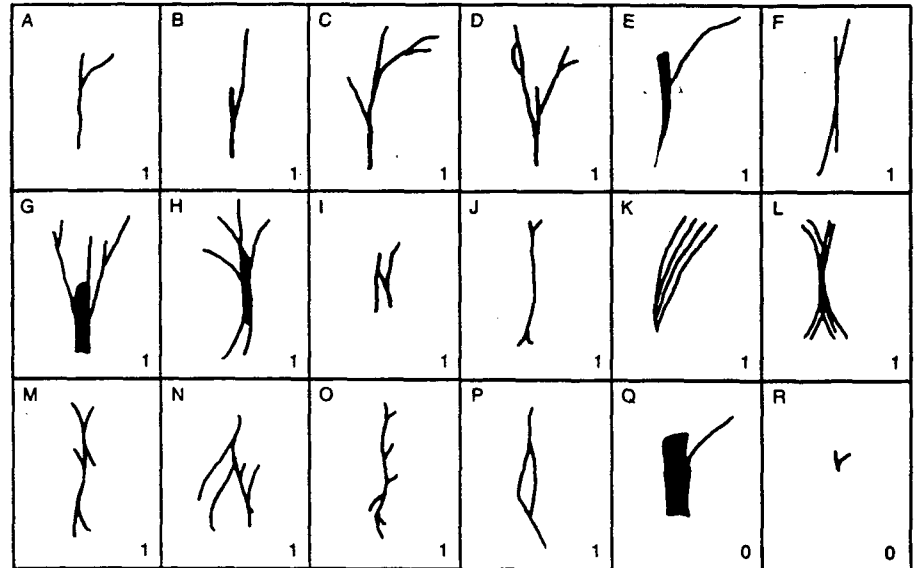
5µm

(a) Single fibres

These are the simplest of the fibres to identify and count. They are the most common of measurable fibres as seen on the membrane filter. Amosite and crocidolite fibres generally assume a straight needlelike form. Chrysotile fibres, while sometimes straight, often assume a curved or curly outline. Fibres which appear irregular and perhaps "unfibre-like" are counted if they conform to the basic requirements of fibre definition.

(b) Split fibres

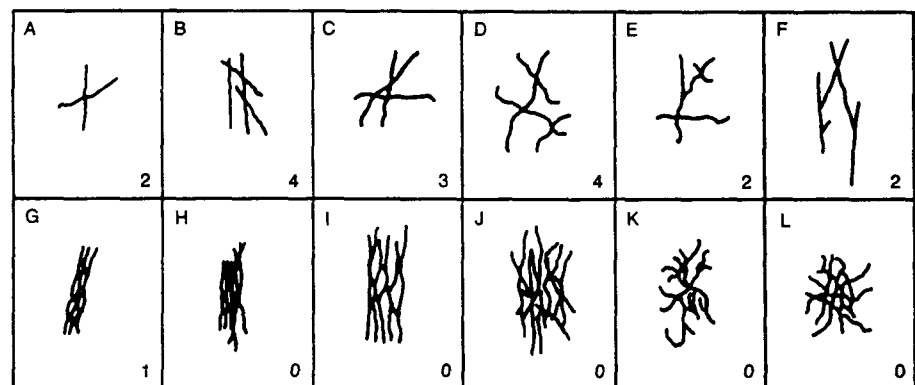
These appear generally as a fibre or fibres splitting away from a single stem.



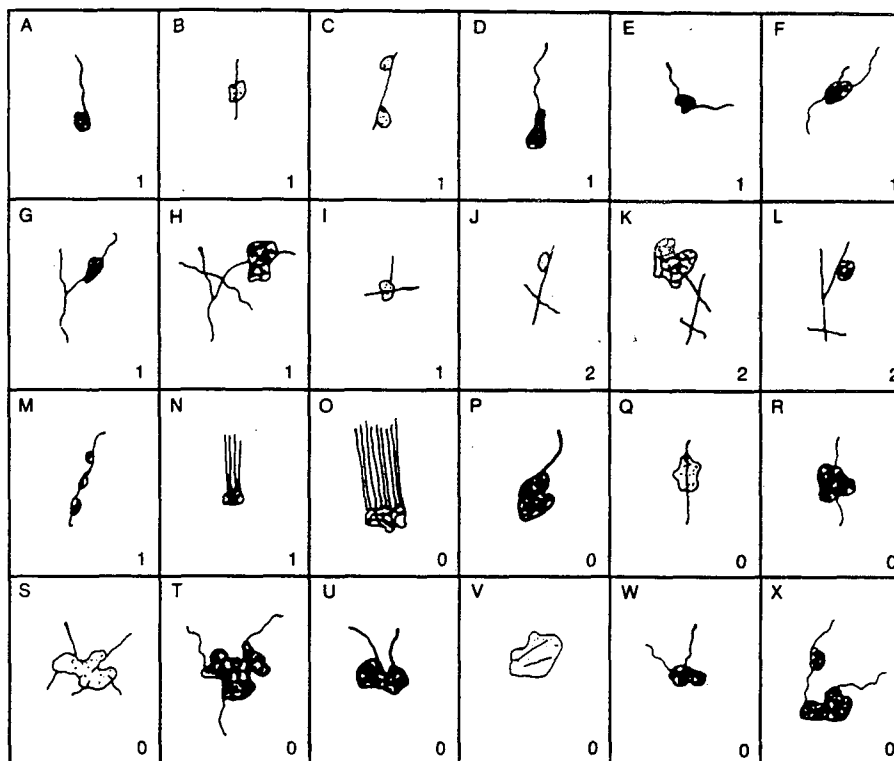
Scale:
5µm

(c) Grouped fibres

These are formed when fibres overlap, intertwine or pack together. The simplest form is when two fibres overlap and cross each other. In this case each fibre in the group appears as a discrete entity. In more complex form fibres lie nearly parallel and appear to originate from the same bundle.



This group consists of fibres attached to, or embedded in particulate matter. This latter material could be parent asbestos rock, or resins, cement, silicates, etc. as used in manufactured products. Under the microscope some fibre, especially chrysotile, appears to project from the particulate matter with only part of the fibre seen. Other fibres (often amosite) are seen as embedded in the particulate matter.



Scale:
5 μm

Dust Counting Record (Example only)

X-background not okay

Area: mm²

$$c = \frac{\Sigma n_f}{\Sigma n_{cf}} \cdot \frac{1}{V} \cdot F = \boxed{} \text{ fibres/ml}$$

fibres	number of fields

Example:

Sample No.:

[illegible]

$$C = \frac{\sum n_f}{\sum n_{cf}} \cdot \frac{1}{V} \cdot F = \underline{\hspace{2cm}} = \boxed{\hspace{1cm}} \begin{matrix} \text{fibres} \\ \text{ml} \end{matrix}$$

$N =$ $c =$ concentration in fibres ml
 $\Sigma n_f =$ total number of fibres counted
 $n =$ $\Sigma n_{cf} =$ number of fields counted
 $A =$ effective filter area (mm²)
 $a =$ area of the counting field (mm²)
 $V =$ total flow (ml)
 $F = \frac{A}{a}$ (constant factor)

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Supplement

It is intended that this Supplement will give guidance on the availability of the various items of equipment necessary to implement the AIA asbestos dust measurement procedures. This Supplement will be reprinted at certain intervals so that information on the equipment can be updated.

Filter

Membrane filter (mixed ester cellulose or cellulose nitrate) — 25 mm diameter — pore width 1.2 μ m — with grid

Suppliers

Gelman Instrument Company,
Laboratory Products Division,
600 South Wagner Road,
Ann Arbor, Michigan 48106, U.S.A.
Product-no. 46000

Glasrock Medical Services Corp.,
Filtration Division,
7380-A Bohannon Road,
Fairburn, Georgia 30213.
Cat.-no. 1093

Millipore Corporation,
Bedford, Massachusetts 01730, U.S.A.
Order-no. RAWG 02500

Filter Holder and Cowl

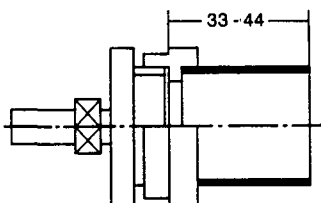
Filter holder — 25 mm diameter

Supplier

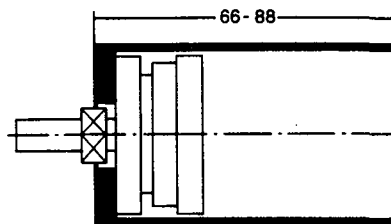
Gelman Instrument Company,
Laboratory Products Division,
600 South Wagner Road,
Ann Arbor, Michigan 48106, U.S.A.
Product-no. 1107

For measurement procedure apply cowl.
Cowl for above filter holder is not available. Manufacture is possible according to following sketches:

Sketch 1



or Sketch 2



Filter holder (monitor) — 25 mm diameter

Supplier

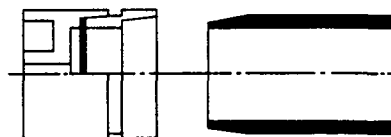
Glasrock Medical Services Corp.,
Filtration Division,
7380-A Bohannon Road,
Fairburn, Georgia 30213.
U.K. agents: Rotheroe & Mitchell Ltd.
Cat.-no. 1508
(3-piece assembled with cowl and filter;
see section **Filter** for specification)

Supplier

Millipore Corporation,
Bedford, Massachusetts 01730, U.S.A.
Order-no. MR WG 025 AO (with filter;
specification see Section **Filter**)
Order-no. M0000 25 AO
(cowl only)

For measurement procedure apply cowl.
Cowl for above filter holder is available according to following sketch:

Sketch 3



Pumps

Due to pulsation-free operation and easy portability, preference is given to Personal Air Sampler Type C 2000

Supplier

Rotheroe & Mitchell Ltd.,
14 Aintree Road, Perivale,
Middlesex, UB6 7LJ, England

Further acceptable pumps are:
Super Sampler BDX 44 as well as BDX 30

Supplier

Bendix Corporation,
Lewisburg Plant,
Drawer 831,
Lewisburg, West Virginia, U.S.A.

Personal Dust Sampler
T 13055 (preferred), T 13051/2

Supplier

C. F. Casella & Co. Ltd.,
Regent House, Britannia Walk,
London N1 7ND, England

High Flow Sampler Model P 2500

Supplier

E. I. du Pont de Nemours & Co. (Inc.),
Fabrics and Finishes Department
Applied Technology Division
Brandywine Building 4300
Wilmington, Delaware 19898, U.S.A.

MSA-Pump Type G

Supplier

Mine Safety Appliances Company,
400 Penn Center Boulevard,
Pittsburgh, Pennsylvania, U.S.A.
Catalogue-no. 456058

Asbestos International Association
68 Gloucester Place,
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22 October 1979
Amended 1 January 1982

An alternative Detection Limit Test Slide is now commercially available, as follows: HSE/NPL Test Slide (Mark II) for the determination of detection limit when using phase contrast microscopy.

Available from:
PTR Optics,
Unit D9,
Cross Green Approach,
Cross Green Industrial Estate,
Leeds,
Yorkshire,
United Kingdom

Description

The standard test slides consist of identical epoxy replicas (with a refractive index of 1.58) of a Master Slide produced and certified by the National Physical Laboratory (U.K.). The epoxy replicas are mounted on a glass slide 75 x 25 x 1.2 or 75 x 25 x 0.8 mm and covered by a coverslip 0.17 mm thick with a layer of another resin with a refractive index 1.49 in between. The test objects consist of a series of seven blocks of grooves of length 8.5 mm filled with a resin of refractive index 1.49 in a medium of refractive index 1.58. The grooves have a V-shape profile and have a depth-to-width ratio of about 0.1. The blocks are separated by gaps 20 micrometres wide. A set of four deep marker grooves is placed on either side of the array and a further two sets of two marker grooves spaced at an interval of 120 micrometres intersect the array at right-angles. The zone of the test objects to be used is delineated by the rectangle bounded by these marker grooves. This zone can easily be located, as the field of view in which it is found is engraved on the coverslip. This is illustrated in Figures 1 and 2.

The widths of the grooves within each block and the calculated phase change (in degrees) associated with the maximum path difference in the light rays passing through the test objects are in Table 1.

Method of Use

Set up the microscope for phase contrast microscopy as recommended for the membrane filter method.

Locate Block 1 (the coarsest set) of the test objects and move the slide to observe adjacent blocks. Determine the block of the finest grooves that can be seen. It is unlikely that all seven

blocks of grooves will be detected using optical phase contrast techniques, even on the best research microscope. On the basis of present information, a satisfactory system will detect Block 5

Full details are supplied with the slide

1 January 1982

Table 1

Widths of Test Objects and Calculated Maximum Phase Change Induced in

Light Rays passing through Test Objects of HSE/NPL Test Slide.

Block Number	Groove Width (micrometres)	Maximum Calculated Phase Change (in degrees) for light rays $\lambda = 530$ nanometres passing through test objects
1	1.08	6.6
2	0.77	4.7
3	0.64	3.9
4	0.53	3.2
5	0.44	2.7
6	0.36	2.2
7	0.25	1.5

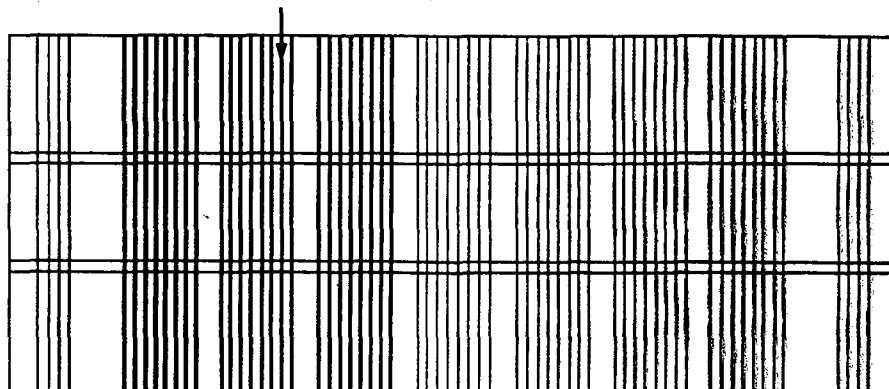
HSE/NPL Test slide for phase contrast microscopy

Fig. 1 Test slide (76 x 25 mm)

epoxy resin replica and cover slip



Fig. 2 Enlarged field of view 20 lines per set (85 mm high)



As of October 1, 1980

The following listed consultants, all of whom are members of the American Industrial Hygiene Association, state that they are available for consulting services in industrial hygiene. The specific specialties applicable to each are identified by the *code numbers* shown in bold type at the end of the listings. For convenience in relating available consultants to a specific area, main listings are geographical, followed by specialties and alphabetical cross-references. The American Industrial Hygiene Association provides these listings as an informational service, accepting no responsibility for the performance of the consultants listed and making no representation regarding their competence as consultants.

Consultant's Specialty	Code No.
Air Pollution	1
Audiometry	2
Biological Monitoring	3
Ergonomics	4
Industrial Hygiene — Comprehensive Plant Studies and/or Analyses ..	5
Industrial Hygiene Chemistry	5A
Meteorology	6
Noise Control	7
Occupational Medicine	8
Product Safety — Labeling	9
Radiological Control	10
Respirator Protection	10A
Safety Specialist	11
Toxicology	12
Training Instruction	13
Ventilation	14
Waste Disposal	15
Water Pollution	16

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Industrial Hygiene Consultants

Industrial Hygiene Consultants, Alphabetical Listing

Complete listings appear under geographic locations shown.

A

Accredited Industrial Hygienists . TX
Aetna Technical Services, Inc. . CT
Ahearn, William C., CIH . AZ
Alexsis Risk Management, Inc. . IL
Allan, Ralph E., CIH . CA
Amdur, Marvin L., M.D., CIH . NY
American Hazard Control Consultants, Inc. . NJ
Anderson-Nichols & Company, Inc. . MA

B

Bacci, Geoffrey, CIH . IL
Baldeck, Charles M., Ph.D., CIH . OH
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Banks, Oneil M., Ph.D., CIH . MD
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Benjamin, Charles T., CIH . PA
Berlandi, Francis J., Ph.D., CIH . MA
Berry, Clyde M., CIH . IA
Blum, Dwain E., Ph.D., CIH . CA
Bolduc, Jacques, P.E. . Canada
Bolt Beranek and Newman Inc. . MA
Booz, Allen & Hamilton Inc. . MD
Boston, Lester E., CIH . CA
Botsford, James H. . PA
Boylan, George W., Jr., CIH . MA
Burson, James, CIH . GA
Butler, Janis C. . KS
Byers, Dohrman H., CIH . MI

C

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Caplan, Knowlton J., P.E., CIH . MN
Carlitz, Irwin H. . PA
Carmel, Matthew M. . IL
Carroll, Kevin M. . NY
Cesarotti, Dennis J., CIH . IL
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Clayton Environmental Consultants, Inc. . GA, MI, TX
Coffman, Larry . FL
Cohen, Kenneth S., Ph.D., P.E., CIH . CA
Colver, William H. . PA

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Cook, J. Lindsay, CIH . IL
Cooper, W. Clark, M.D., CIH . CA
Covert, Roy J., CIH . TN
Craft, Bobby F., Ph.D., CIH . UT

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Dauch, Jack E. . OH
Deese, Donald E., CIH . TX
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Dharmarajan (raj), V., Ph.D., CIH . LA
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ESA Laboratories . MA
Einert, Christine, M.D., CIH . CA
Enviro Control, Inc. . MD, VA
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Environmental Research Group, Inc. . MI
Environmental Science & Engineering, Inc. . FL

F

Falcon Customer Services, Inc. . CA, IL, MA, MI, MO, NJ, PA, SC, TN, TX
Feiner, Benjamin, CIH . NY
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Fitch, John J., CIH . IN
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Frank, Leslie D. . Canada

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Jacobs, W. Joseph . PA
Jurgiel, John A., CIH . MO
Jurinski, Neil B., Ph.D., CIH . VA

K

Kamon, Eliezer, Ph.D. . PA
Kane, John M. . KY
Keller, John G., Ph.D. . NC
Kemron Environmental Services . MI
Kennedy, James L., CIH . MD

Keplinger, M.L., Ph.D. IL
Kirschner, Leon, CIH IL
Knutson, Gerhard W., Ph.D., CIH MN

L

Labernik, Fred C., P.E., CIH MN
Landry, Edward B., C.S.P., P.E. DC
Larsen, Donald J., CIH MN
Lawton, George M., M.D. VA
Lee, Jeffrey S., Ph.D., CIH UT
Lewis S. Goodfriend &
Associates NJ
Linch, Adrian L., CIH PA
Long, James E., Sc.D. MN
Lumsden, John C., CIH NC

M

MacDonald, William E., Jr.,
Ph.D., CIH MD
Manna, Charles D. NY
Marano, Donald E., P.E., CIH UT
Markowicz, Michael A., CIH IL
McClure, Charles Ray VA
McFee, Donald R., Sc.D., CIH IL
McGuire, Joseph L., Ph.D. MI
McKee, Ronald S., CIH TX
McKichan, John D., CIH FL
McVeigh, James F., CIH NJ
Menkel, Bruce E., P.E., CIH OH
A.F. Meyer & Associates,
Inc. LA, NJ, VA
Midwest Research Institute MO
Miller, Robert W., CIH TX
Moisan, Raymond, P.E. Canada
Morgan, James F., CIH PA

N

National Loss Control
Service Corp. IL
Neilson, Arthur PA
Nelson, James H., Ph.D., CIH UT
Neukuckatz, Ernest, CIH MA
Nifong, Gordon D., Ph.D., CIH FL
Null, David H., Ph.D., CIH CA

O

Oberg, Maurice C., Sc.D., CIH CA
Occupational Health Services MN
Occusaft, Inc. IL

Oglesby, Frank L., CIH TN
Ostergaard, Paul B. NJ

P

Padden, David A., F.A.I.C. MI
Pattison, Jeffry A. OH
Peterson, Jack E., Ph.D., P.E.,
CIH WI
Port, Eli A. IL
Port, Eugene A., P.E., CIH CA
Pritchard, John A. NM

R

Radian Corporation TX, UT, VA
Rappaport, Stephen M., Ph.D.,
CIH CA
Reed, Kenneth P. KY
Research Triangle Institute NC
Rogers, Jack C., P.E., CIH CA
Rose, Vernon E., D.P.H., CIH AL
Rubin, Daniel F., M.D. CA

S

Salazar, Alfredo, P.E., CIH CA
Salot, Stuart E., Ph.D., CIH CA
Schall, E. Lynn, CIH NJ
Schirripa, James T., CIH NY
Schneider, Meier, P.E., CIH CA
Schultz, Sherryl A., CIH SC
Scott Wetzel Services, Inc. OR, WA
Seifert, Harry E., P.E., CIH SC
Sheriff, Robert E., CIH NJ
Singh, Jaswant, Ph.D., CIH MI
Smith, Ralph G., Ph.D., CIH MI
Sobol, Oscar J., CIH FL
Soule, Robert D., CIH PA
Speicher, H. Wilbur, CIH PA
Spielman, Howard B., P.E., CIH PA
Springborn Laboratories, Inc. CT
Stanton, George B., Jr., P.E., C.S.P.,
F.R.S.H., CIH NJ

Stevens, Charles H., P.E., CIH MI
Stevens, Charles H., P.E., CIH PA
Stewart, Albert E., C.S.P., P.E.,
CIH MO
Stewart, James H., CIH CA
Stoddard, David L., CIH TI
Stokinger, Herbert E., Ph.D. OH
Stone, Raymond B. GA
Summersett, John F. KY
Swanson, Jon R., Ph.D. MN

T

Taylor, Henry M., Jr., P.E.,
C.S.P., CIH VA
Teitelbaum, Daniel T., M.D. CO
Thompson, Robert N., Ph.D., CIH VA
Thorpe, Marianna J. MA
Toca, Frederick M., Ph.D., CIH MA
Todd, Alan S., CIH PA
Tracor Jitco, Inc. MI
Trommershausen, A.J., CIH CA
Twitty, Jeffrey J. VA

U

United Technology and
Science Inc. Canada

V

Voborsky, Robert C., CIH WA

W

Wagner, Richard D., Jr., CIH CA
Wanta, Raymond C. MA
Webber, Alonzo M. FL
White, Otto, Jr., CIH NY
Whitman, Newton E., CIH FL
Willson, Robert D., CIH OH
Wingelet, Dale C., Ph.D. CO
Wrenn, McDonald E., Ph.D. UT
Wright, Usha, C.S.P., CIH NJ
Wrzesien, Peter Canada

Y

Yu, Kin CA

Employee Education Programs

JM Asbestos Inc.

2000, rue Peel
Bureau 750
Montréal, Québec, Canada
H3A 2W5

Chemical Name & Synonyms:
Chrysotile Asbestos
Trade Name & Synonyms: Asbestos
Chemical Family: Fibrous Mineral
Silicates
Formula: $Mg_3(Si_2O_5)(OH)_4$

1. Hazardous Ingredients TLV

Paints, Preservatives & Solvents	(Units)
Pigments, Catalyst, Vehicle, Solvents, Additives and Others	N/A

Alloys and Metallic Coatings	
Base Metal, Alloys, Metallic Coatings, Filler Metal plus Coating or Core Flux, Others	N/A

Hazardous Mixtures of Other Liquids, Solids or Gases

Chrysotile	Approx. 100%
Asbestos Fiber	

(*For TLV—See Section V)

2. Physical Data

Boiling Point (°F.), Vapor Pressure (mm Hg.)	N/A
--	-----

Vapor Density (Air=1), Solubility in Water	N/A
--	-----

Appearance and Odor: White Fibrous dry material—no odor

Specific Gravity ($H_2O=1$)	2.4-2.6
-------------------------------	---------

Percent volatile by volume (%)	N/A
--------------------------------	-----

Evaporation rate (_____ = 1)	N/A
------------------------------	-----

3. Fire and Explosion Hazard Data

Material is non-flammable. No fire or explosion hazard.

4. Health Hazard Data**Threshold Limit Value**

OSHA Exposure Limits Effective July 1, 1976. The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air.

Ceiling Concentrations. No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air.

[Refer to OSHA Standard for Exposure to Asbestos Dust, 29 CFR 1910. 1001 paragraphs (b)(2) and (b)(3).]

Emergency and First Aid Procedures

Avoid breathing excessive dust when handling, dumping and mixing. See caution label on bag.

5. Reactivity Data

Stability	Stable
Incompatibility (materials to avoid)	N/A
Hazardous Decomposition Products	None
Hazardous Polymerization	Will not occur

6. Spill or Leak Procedures**Steps to be taken in case material is released or spilled**

Vacuum clean spillage. Repair broken bags. If sweeping is necessary, wet down spillage. Use approved respiratory equipment when required.

Waste Disposal Method

Disposal of waste in accordance with OSHA Standard for Exposure to Asbestos Dust, 29 CFR 1910. 1001 and EPA National Emission Standards for Hazardous Air Pollutants 40 CFR 61.

7. Special Protection Information**Respiratory Protection**

Use respirators as recommended by the OSHA Standard for Exposure to Asbestos Dust, 29 CFR 1910. 1001 paragraph (d).

Ventilation

Control with mechanical dust collection equipment to within TLV. (See American National Standards Institute booklet, Z9.2—1971).

Other Protective Equipment

Use special clothing as required by the OSHA Standard for Exposure to Asbestos Dust, 29 CFR 1910. 1001 paragraph (d).

8. Special Precautions**Precautions to be taken in handling and storing**

Maintain good housekeeping practices. Vacuum clean waste and place in closed containers.

Other precautions

Caution label on Bag: Contains Asbestos Fibers—Avoid Creating Dust—Breathing Asbestos Dust May Cause Serious Bodily Harm. Smoking greatly increases the risk of serious bodily harm.

While the information and recommendations set forth herein are believed to be accurate as of the date hereof JM Asbestos Inc. Makes No Warranty with Respect Thereto and Disclaims All Liability from Reliance Thereon.

JM Asbestos Inc.

Asbestos, Québec, Canada J1T 3N2
(819) 879-5431
Telex 05-836157

**Asbestos — Manufacturing Plants,
Mines and Mills**

2-20 f/cc:

3M Models 9900, 9910, 9920 (single
use)

American Optical Models
R4000, R5000, R6000 (small, medium
and large)
R30 filter (reusable)

Willson Model 1210
R10 filter (reusable)

MSA Comfo, II (small, medium and large)
Type F filter

Willson Model 560
R60 filter

20-200 f/cc:

3M system W-289
Powered air purifier

200 f/cc:

Type C Supplied-Air Units,
Full face piece

American Optical Company
Safety Products Division
Southbridge, MA 01550

Mine Safety Appliances Company
400 Pennsylvania Center Blvd.
Pittsburg, PA 15235

3M Company
3M Center
St. Paul, MN 55101

Scott Aviation
Division of ATO, Inc.
Lancaster, NY 14086

Willson Safety Products
P.O. Box 622
Reading, PA 19603

Virtually every plant, laboratory or warehouse which handles asbestos in its variety of forms has a central dust collection system which plays an important part in the effort to comply with federal, local and corporate environmental regulations. These systems comprise the backbone of every company's clean air program, and invariably represent large investments. Unfortunately, most central dust collection systems do not reach one-hundred percent of the dust-creating activities in the building. Further, with air sample test standards becoming more stringent, what was an adequate dust control system two years ago may have become inadequate by now. The solution many firms have turned to is the portable vacuum cleaner.

The Nilfisk model GS 83 vacuum cleaner, manufactured in Copenhagen, Denmark, by A/S Fisker & Nielsen, and sold and serviced in more than fifty countries, has found wide acceptance in the Asbestos Industry because of its exclusive combination of durability, versatility and adaptability.

It was designed for sustained heavy-duty cleanup of large amounts of dust and debris. Despite its large recovery capacity of 1½ bushels (.05 cubic meter), the GS 83's narrow width permits its use in restricted areas. It stands 40" (101.6 cm) high and is 32" (81.3 cm) long. It weighs 135 pounds (61.2 kg) without accessories, but large rubber wheels make it easy for an individual to move it about with one hand.

The GS 83 is powered by three Nilfisk GSE 110-volt or 220-volt, heavy-duty universal motors. They move approximately 235 cubic feet of air per minute (6.7 cubic meters) through the standard 2" (5.1 cm) orifice. With this tri-motor arrangement, there is little danger of excessive amperage surge at startup. These motors drop into cavities in the container top and can be removed for service by simply loosening two clips.



In many plants, noise level tests are made as part of the overall environmental program. With decibel readings in the low seventies on the A-scale, the GS 83 can scarcely be heard in a factory environment.

An oversize cloth filter bag having 15 square feet (1.4 sq m) of filter area resists clogging even under conditions of sustained operation and large amounts of fine dust. An exclusive system of steel hoops (shown in the cutaway below) attached to the bag allows the operator to shake the filter free of fine dust and clinging debris, while retaining the dust in the hermetically-sealed container and avoiding exposure to the dust collected within the machine. Periodic agitation of the filter greatly reduces loss of efficiency caused by filter clogging.

In asbestos processing, clog-resistance is only one aspect of filtration. A vacuum cleaner must also be capable of retaining whatever material it recovers without discharging it in its exhaust stream. Therefore, a second filter consisting of a felt motor cover is available. This microfilter, when installed on each of the three motors, is capable of an average retention efficiency of 99.5% down to a particle size of 2 microns.

A third filter has recently been developed to retain 99.97% of all dust down to the 0.3-0.5 micron particle size range. This exhaust-filter mounts onto the exhaust port of each motor, and will retain even the dust created by normal carbon brush deterioration. A leading U.S. processor of asbestos recently obtained air sample tests indicating significantly fewer than 0.5 fiber per cubic centimeter present in the exhaust air of the GS 83.

**Cutaway of the Nilfisk GS 83
Vacuum Cleaner**

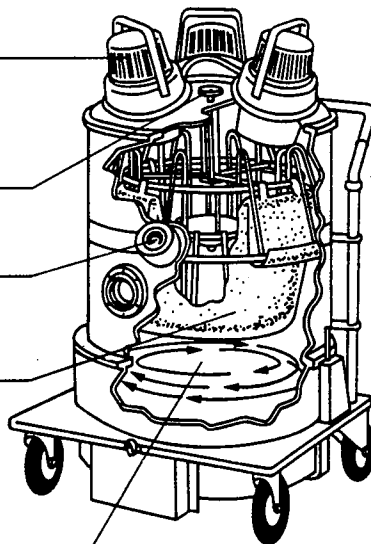
Extended-life motors feature protection from overheating.

Exclusive external purging handle allows operator to clear filter without the danger of secondary exposure to collected dust.

Optional manometer alerts operator that filter needs purging.

Extra-large filtering surface ensures a more even airflow and eliminates premature clogging.

Debris collects in a heavy gauge, sealable polyliner for safe disposal.



To empty the GS 83, the operator turns off the motors, shakes the filter agitating handle on the top of the machine and waits a moment for the fine dust to settle in the container. Then, using his toe, he raises the pedal bar at the rear of the machine, allowing the dust container to drop gently to the floor and away from the motor-filter housing. The housing is wheeled away from its position above the collected debris, and the dust container is ready for emptying, thereby eliminating the need to lift the heavy motor assembly off the container.

Many plants are lining the containers of their GS 83 machines with heavy gauge, polyethylene liners and are disposing of the waste in a completely dust-free manner.

There are more than fifty accessories in 1½" (3.8 cm) or 2" (5.1 cm) hose diameters from which to choose. When equipped with a fixed floor nozzle (see photo) the GS 83 will clean a 30" (76.2 cm) wide swath in open areas on wood or concrete floors, at walking speed. When not in use, the fixed floor nozzle is hung on the machine, thus reducing unnecessary abrasion of its working surfaces. For less accessible floor areas (between machines, pallets, supporting columns, etc.), wheeled floor nozzles are generally used with a hose and wand 2" (5.1 cm) in diameter. The smaller 1½" (3.8 cm) diameter wands and accessories are used primarily in overhead cleaning situations where light weight becomes important. In either case, ball-joint swivel connectors at three points in the hose-wand assembly eliminate typical hose-cracking problems. Protection rings can be placed on the hoses to prevent wear when they are dragged along rough, irregular floors.

For equipment and machinery cleaning, a variety of rubber cones and other nozzle shapes are available. For overhead cleaning of pipes, walls, joists and lights, light-weight aluminum or etronite extension wands are employed.

These are used in conjunction with flat nozzles for beams, joists, vents and walls, and half-moon-shaped nozzles for pipes and round beams. Nozzles with serrated edges are used for heavy dust accumulations. Brushes are best suited for clinging, oily or sticky overhead dust. A 90°-angle joint allows the operator to reach dust which has settled on the top of pipes, beams and vents and which is not easily accessible. To keep all accessories close at hand, an accessory storage box can be hung from the handle at the rear of the machine.

In plants of the Asbestos Industry, Nilfisk GS 83 vacuum cleaners are performing in almost every department from raw material storage to end-product shipping. Their ability to handle coarse trimmings as well as the finest dusts makes them valuable adjuncts to central collection systems in meeting the most stringent clean air requirements.

Nilfisk of America, Inc.
224 Great Valley Parkway
Malvern, PA 19355
215-647-6420

**Shielded Hand Tool Systems
Control Dust**

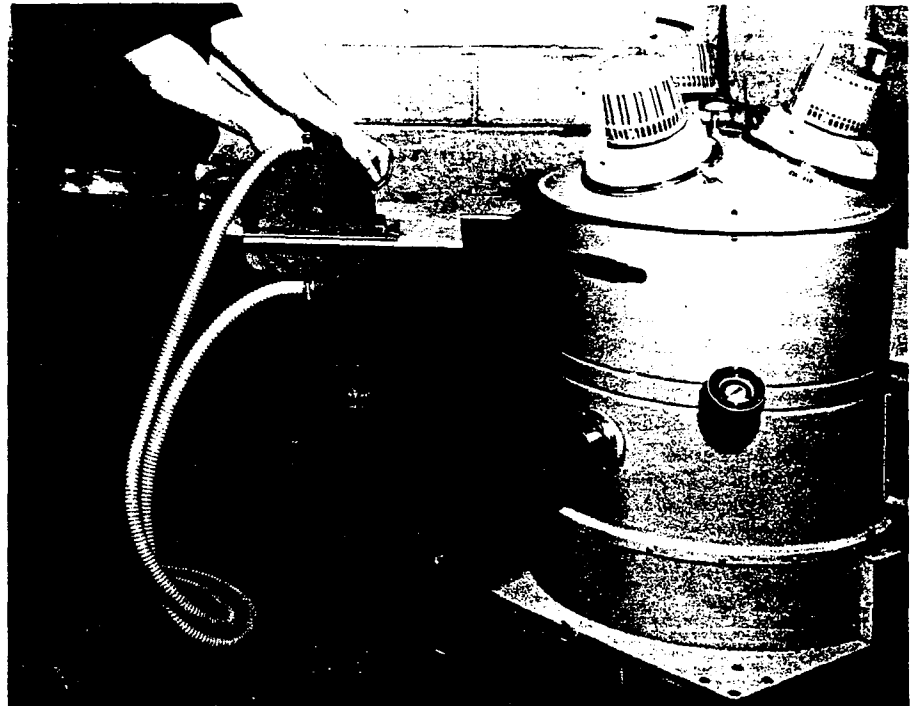
Nilfisk of America, Inc., Malvern, Pennsylvania, and Pilot Manufacturing Company, Torrance, California, are now offering complete Shielded Hand Tool Systems for controlling dust generated by the power hand tools most commonly used in the field fabrication of asbestos-cement sheets and similar products.

Each tool system consists of a portable, high efficiency, vacuum dust collector, a hand tool equipped with an especially designed dust collecting enclosure and suitable vacuum hoses connecting the two.

The key to successful, dust-free operation of any power hand tool lies in the provision of an enclosure which effectively confines any dust generated by the tool, preventing its dissemination into the surrounding atmosphere and permitting its removal by a suitable vacuum cleaning device while, at the same time, permitting the utmost freedom for manipulation of the tool by its operator.

The tools offered as part of the Nilfisk and Pilot systems incorporate shield concepts and initial development by Johns-Manville Corporation, Denver, Colorado, modified and manufactured by Pilot Manufacturing. Shielded tools presently available include two circular saws (one for flat sheets and the other for corrugated sheets), a jig saw and a hand-held power drill. Because of intense interest in dust-free means for field fabrication of asbestos products, the three companies devoted considerable time and substantial sums of money in developing the shields, resulting in what appear to be the most effective, practical devices of their kind yet produced, anywhere.

The above photograph shows a circular circular saw provided with the shield developed for processing flat sheet products. It will be noted that there are actually two shields, one above and the



other below the sheet being sawed. They are connected by a metal support whose thickness is such that it can slide through the kerf of the saw cut. The shields are adjusted to make intimate contact with the sheet being sawed. This arrangement permits fully shielded sawing to any point on a sheet of any standard length and width and having a maximum thickness of $2\frac{5}{16}$ inches (5.9 cm). The unit is joined, via hoses, to a Nilfisk Model GS 83 vacuum dust collector.

The shield for the circular saw used for corrugated sheets is similar in concept but is of a more intricate design in that it incorporates an ingenious arrangement of seals which continuously conform to the corrugated contour of the sheet and effectively prevent escape of dust generated by the saw. The saw, so equipped, will cut corrugated sheets of standard U.S. configuration having an overall thickness up to $1\frac{3}{4}$ inches (4.5 cm).

The shielded jig saw will cut flat sheets up to $\frac{3}{4}$ inches (1.9 cm) in thickness. The shield for the hand-held drill completely surrounds the drill bit and is spring-loaded, making contact with the workpiece as the drill progresses through the sheet.

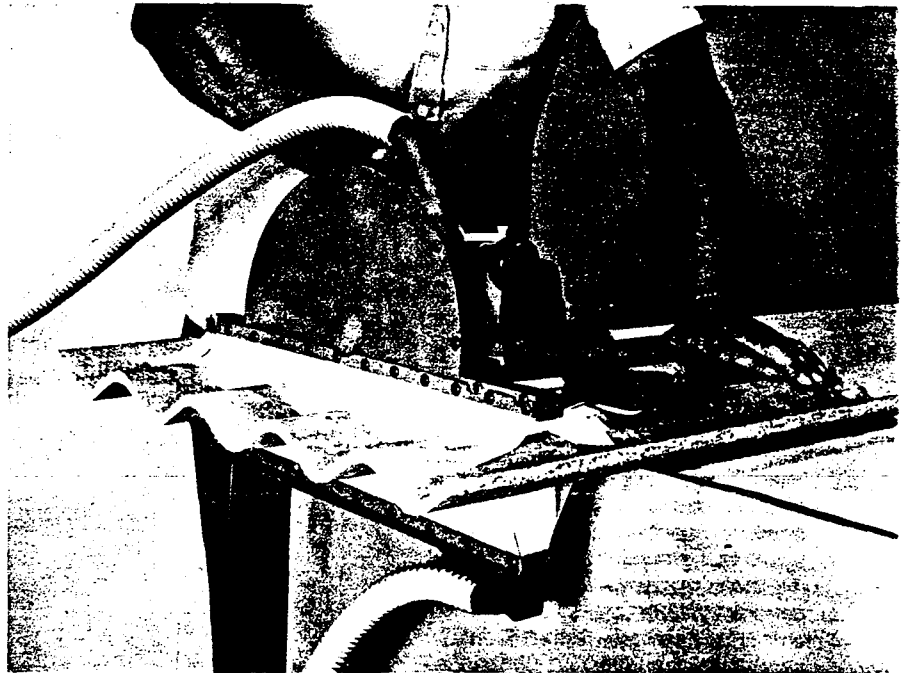
The Nilfisk and Pilot systems for circular saws include the Nilfisk Model GS 83 vacuum dust collector, while the systems for jig saws and power drills utilize the Nilfisk Model GS 81 collector. All systems being offered are designed to meet or exceed OSHA asbestos dust control standards.

Nilfisk of America, Inc.
224 Great Valley Parkway
Malvern, PA 19355
215-647-6420

Corrugated Sheet Circular Saw
For Cutting U.S. Made Corrugated to
10mm Thick

Model 898

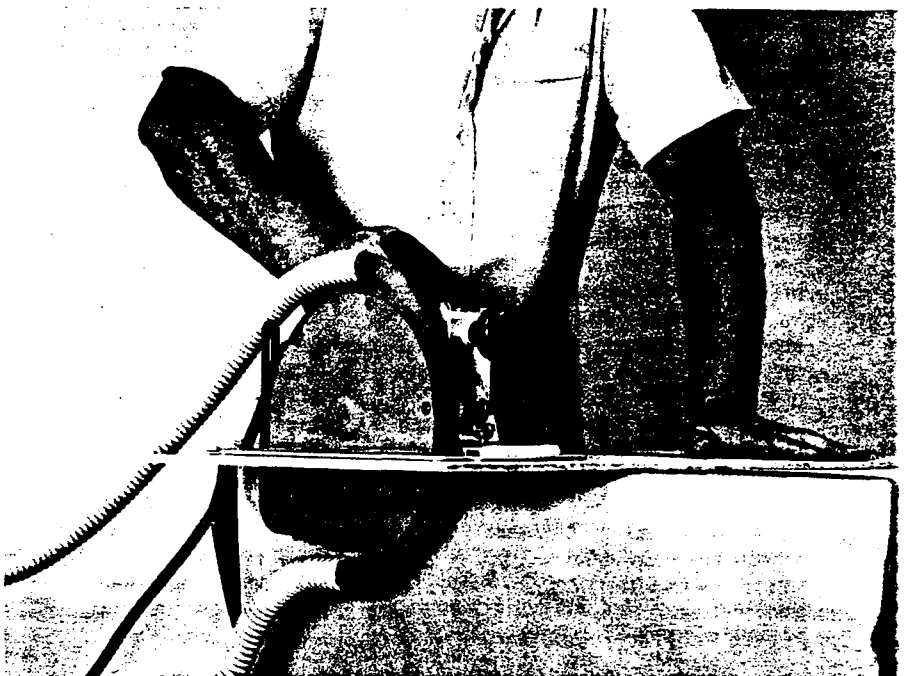
Circular saw designed especially for cutting corrugated asbestos sheet to 10mm ($\frac{3}{8}$ ") thick. Unique flexible skirting conforms both above and below sheet to corrugated contours for efficient dust collection. Includes top dust shield, adjustable bottom shield, 2 each 1½" I.D. flexible vacuum hoses, hose clamps and Wye connector, and 10" diameter Silicon Carbide blade. For longer life, Diamond Blades are also available: only Pilot Diamond Blade part number 275334 is recommended for use with this tool.



Flat Sheet Circular Saw
For Cutting Flat Sheet to 60mm Thick

Model 888

Circular saw specifically engineered for cutting flat asbestos sheet to 60mm. ($2\frac{5}{16}$ ") thick. Includes top dust collection shield, adjustable bottom collection shield, 2 each 1" I.D. flexible vacuum hoses, hose clamps and Wye connector, and 7" diameter Silicon Carbide blade. For longer life, Diamond blades are also available: only Pilot Diamond Blade part number 275333 is recommended for use with this tool.



Specifications

Models	888	8881	898	8981
Volts:	110	220	110	220
Amps:	10	5	10	5
Speed/RPM:	5500	5500	5500	5500

Vacuum System Requirements: (All Above Models)CFM — 176 minimum (5.0 m³/min)

Inches Water — 59 minimum (149.7 cm)

Certified for use with asbestos.

Vacuum System Recommended:

Pilot No. 275526 (110 volts) or No. 275528, (220 volts). Both units have 69 liter tank capacity, and are furnished complete with microfilters, exhaust filters, manometer, frame, disposable tank liners, and 10 feet (3.0 m) of 2 inch intake hose.

Caution: These tools are to be used only with vacuum systems certified for use with asbestos, and when used in accordance with the manufacturer's operating instructions, are designed to maintain asbestos fibre level below OSHA limits as stated in Title 29 Section 1910.1001 of the Code of Federal Regulations.

Wheeler-Pilot International

P.O. Box 3128

Torrance, CA 90510

Cable: PILOOTOOLS (213) 371-1238

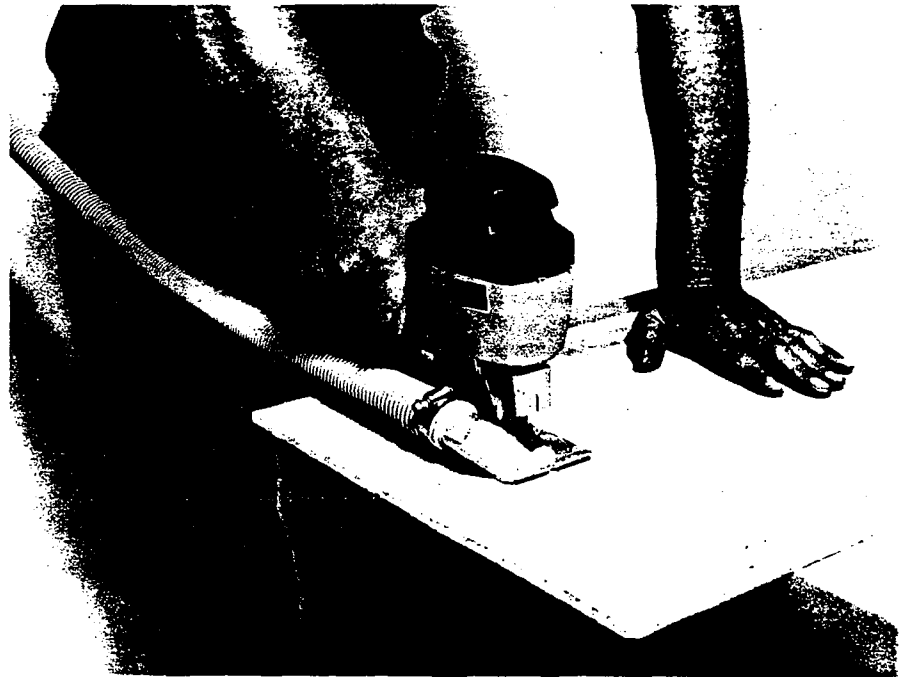
Telex 65-3486

Answer Back PILOOTOOLS TRNC

Heavy Duty Saber Saw
For Cutting Flat Sheet to 20mm Thick

Model 878

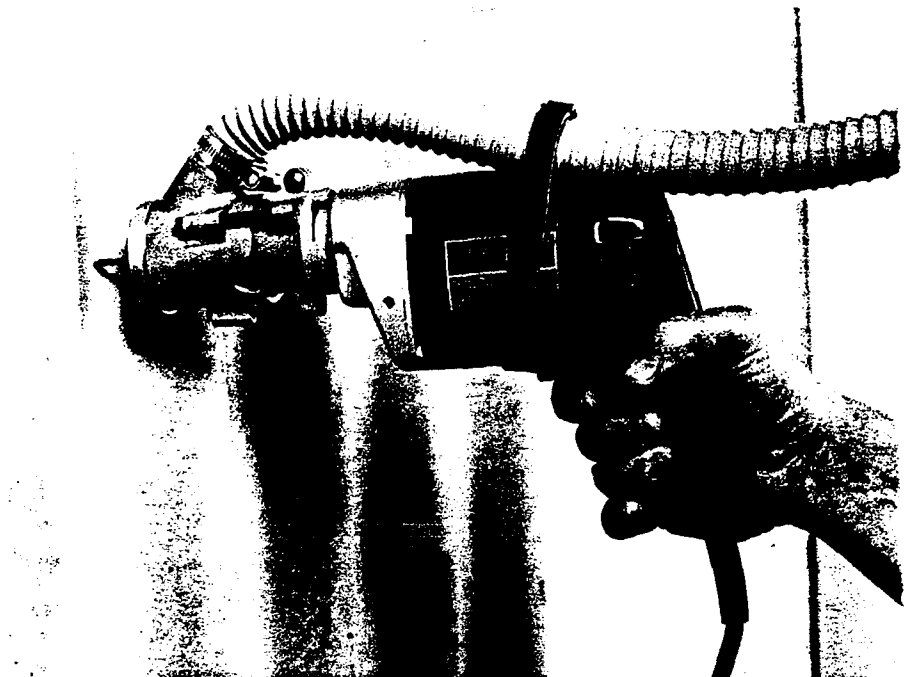
Heavy Duty, 2 speed, orbital action Saber Saw for one or two hand operation in installation or removal operations on horizontal and vertical flat asbestos sheets up to 20mm ($\frac{3}{4}$ ") thick. Includes saw, blade — encircling dust collection shield, 1" I.D. flexible vacuum hose and clamp.



Countersink Drill

Model 868

Variable speed, reversible $\frac{3}{8}$ " drill for all types of asbestos sheets. Dust collection shield encircles the drill bit to contain dust and permit vacuum evacuation. Dust shield is spring loaded to facilitate drilling to various depths. Includes drill motor, chuck key, shielding and flexible 1" I.D. vacuum hose, hose retainer and clamp, and $\frac{9}{64}$ " drill and countersink combination bit.



Specifications

Models	878	868
Volts:	110	110
Amps:	4.5	3.2
Speed/SPM:	2100—3100	To 750 RPM

Vacuum System Requirements (Both Above Models):CFM — 65 minimum (1.8 m³/min)

Inches Water — 59 minimum (149.7 cm)

Certified for use with asbestos

Vacuum System Recommended:

Pilot No. 275527 (110 volts) or No. 275529 (220 volts). Both units have 20 liter tank capacity and are furnished complete with microfilter, exhaust filter, disposable tank liners, and 10 feet (3.0 m) of 1½ inch intake hose.

Caution: These tools are to be used only with vacuum systems certified for use with asbestos, and when used in accordance with the manufacturer's operating instructions, are designed to maintain asbestos fibre level below OSHA limits as stated in Title 29 Section 1910.1001 of the Code of Federal Regulations.

Wheeler-Pilot International

P.O. Box 3128

Torrance, CA 90510

Cable: PILOTOOLS (213) 371-1238

Telex 65-3486

Answer Back PILOTOOLS TRNC

**Recommended Control
Procedure No. 2**

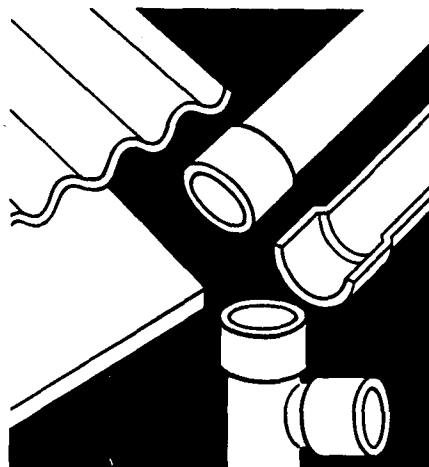
Contents

- 1. Products Covered by These Recommendations**
- 2. Basic Requirements for Working with Asbestos and Asbestos-Cement Products**
- 3. Operations to Which These Recommendations May Apply**
- 4. Recommended Procedure for the Control of Dust in the Use of Asbestos Cement Products**
- 5. Suitable Equipment**
- 6. Waste Disposal**
- 7. Medical Supervision**
- 8. Further Information**

1. Products Covered by These Recommendations

All building materials and their ancillaries made of asbestos-cement such as:

Slates, Sidings or Shingles
Corrugated and Profiled Sheets
Flat Sheets
Pipes
Moulded and Extruded Products.



2. Basic Requirements for Working with Asbestos and Asbestos-Cement Products

Harmful effects on health from working with asbestos may arise from inhaling excessive quantities of fine asbestos dust. The effectiveness of control measures is normally assessed by measuring the average amount of such dust over a working period. For practical purposes, such measurements may be taken for part of a working day (e.g. one hour) if this can be regarded as representative of the full period.

Where concentrations above prescribed levels are unavoidable by technical improvement, operatives should be provided with personal protective equipment.

In asbestos-cement products the normal asbestos content can vary from 10 to 15 per cent and this asbestos is locked in the binder. The hard product does not release free respirable fibre under

normal handling conditions. The only occasion when such fibres may be released into the atmosphere in significant numbers is when high-speed cutting or other abrasive action is carried out without the provision of proper controls.

3. Operations to Which These Recommendations May Apply

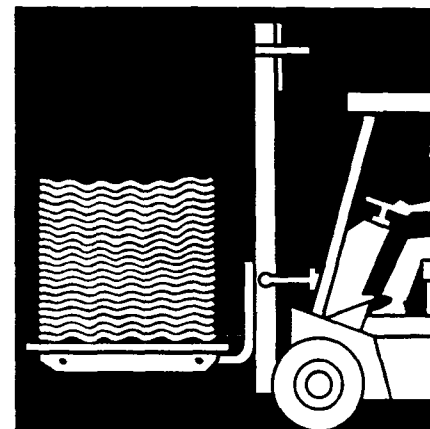
Working on asbestos-cement products:
Cutting and Machining
Sanding
Drilling
Filing
Cleaning.

4. Recommended Procedure for the Control of Dust in the Use of Asbestos-Cement Products

4.1 Remember the three main rules for eliminating unnecessary risks:
Avoid creating dust and use hand or slow-running tools which only produce coarse dust or chips, rather than those which cut by abrading the material, thus generating inhalable dust;

When it is necessary to use abrasive or high-speed tools, these should be fitted with dust extraction equipment;

Use vacuum cleaning equipment to collect dust and chips or sweep using a dust suppressant.



4.2 Handling, stacking, transporting, warehousing.

4.2.1 Manufacturer's standard asbestos-cement products do not need special precautions, since no fabrication of the products is involved.

4.3 Work under factory or workshop conditions.

4.3.1 Purpose-designed dust extraction equipment should be fitted to every power-sawing, drilling, sanding or milling machine to eliminate dust and loose swarf created by such operations. High-velocity, low-volume equipment should be used for portable tools; industrial vacuum cleaners are often adaptable for such purposes. Low-velocity, high-volume systems are generally most suitable for fixed machine applications.

4.3.2 Wherever possible, sheets should be cut singly, but whatever cutting method is used care should be taken to avoid leaving excess dust on cut edges. Ensure that dust and loose material is removed from all surfaces of sheets (especially if pack-cutting methods are used), by vacuum-cleaning before stacking. Where considerable fabrication is involved, surface and/or edge sealing with special solutions could also be considered as a means of ensuring that machined products are entirely free from surface dust.

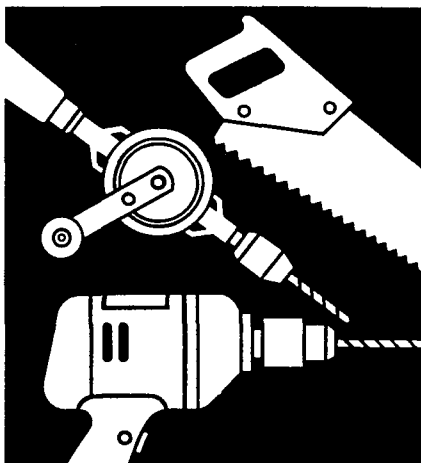
4.3.3 Loose swarf and dust should be removed from the work place by vacuum cleaning. Where this is not possible, the material should be thoroughly wetted before removal.

4.3.4 There will be some operations such as maintenance of dust filters, etc., where it is necessary for personnel to be provided with protective clothing and respiratory protection. Detailed recommendations as to type of respirators and clothing, for training in use, for laundering and for changing and storage accommodation is contained in the special AIA publication covering this matter (in preparation).

4.4 Site work

4.4.1 Many asbestos-cement products, including slates, shingles and pipes, are generally used as standard products and do not require machining on site. However, most jobs will require a certain amount of field fabrication. In this case, some form of control may be necessary.

4.4.2 For hand operations, or short time and intermittent use of slow-running tools in the open air, special precautions are not normally required.

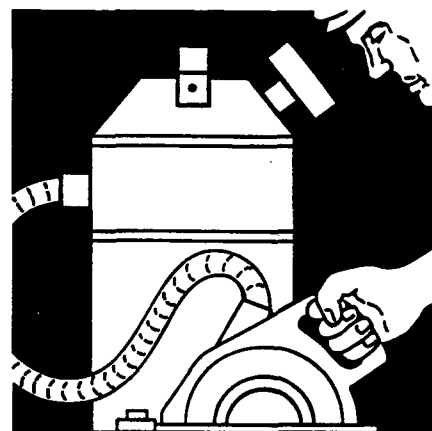


4.4.3 When long continuous runs are carried out extraction equipment should be used with the machines, as in workshop conditions. Sometimes, tools for wet machining can be used.

4.4.4 Specialized tools have been developed, by co-operation between the asbestos industry and equipment manufacturers, which can perform a variety of machining operations without producing harmful quantities of asbestos dust. Use of this equipment together with sound work practices have been shown to prevent the generation of dust above specified limits.

4.4.5 Working-areas should be kept free from cutting-dust by means of a cleaning attachment available for use with the

installed exhaust ventilating system, or by using portable industrial vacuum cleaning machines suitable for use with asbestos materials. If these are not available, floors should be thoroughly wetted and/or spread with damp sawdust before sweeping.

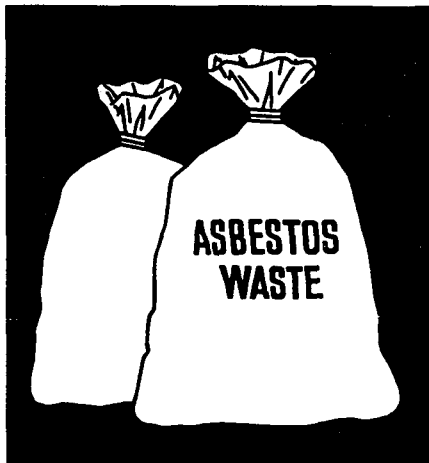


5. Suitable Equipment

- Dust Extraction
- Vacuum Cleaning
- Specialized Tools
- Personal Protective Equipment

Full details of suppliers of suitable equipment which has been tested for use with products together with advice on the design and specification of such equipment may be obtained from AIA or from the Association's members. They will be pleased to supply names and addresses of national suppliers of such equipment.

6. Waste Disposal including the dust from dust extraction and filtration systems, process waste, should be collected in containers such as impermeable plastic bags and sealed so that harmful quantities of dust cannot escape.



6.1 These containers should be removed and disposed of in such a manner that dust does not escape during transit, and the material when deposited is prevented from being released into the environment.

6.2 It is recommended that any deposit of dusty asbestos waste material should be covered after its deposit with earth or suitable inorganic material, and in places where there is no foreseeable likelihood of it being subsequently disturbed.

6.3 The addition of water at an appropriate point in the collection of fine dust or waste can be employed to eliminate dust emission or greatly to simplify the disposal process.

7. Medical Supervision

Persons who are employed in the manufacture or use of asbestos-containing materials for which the preceding precautions are necessary, should be subject to regular medical supervision.

7.1 New employees in such situations should be given a pre-assignment medical check consisting of clinical examination, full-size chest X-ray and if possible a lung-function test, so that any defects likely to prejudice their condition can be identified. The advice of a suitable qualified and experienced physician should be sought.

Further enquiries to the medical advisors to the Asbestos International Association would be welcomed.

7.2 A satisfactory health condition should be a condition of employment — people should not be employed who have a medical history of chest illness or a previous employment history in occupations where there is known to be a high dust hazard. Physical abnormalities which prevent the effective use of respiratory equipment where this would be necessary would also be a bar to employment.

7.3 Subsequent to engagement, regular medical checks should be carried out at not more than two-yearly intervals.

7.4 Where possible, long-term medical surveillance should be continued for employees or ex-employees who have been subject to the foregoing procedure.

7.5 It is desirable that records of employment, exposure and medical examinations should be retained as long as possible and at least 20 years after cessation of employment.

7.6 All asbestos workers should be cautioned about the added risk of cigarette smoking.

8. Further information

The foregoing recommendations are naturally general in their form and are based upon the experience and practice of the members of the Asbestos International Association and consist with the recommendations of the ILO meeting of experts, whose report was published in December 1973. More detailed recommendations appropriate to the use of different types of asbestos containing materials or products are being prepared in a series of advisory publications by AIA. Further information is also available concerning sources of supply of technical equipment, personal protective equipment, etc. Enquiries for further information will be dealt with to the best of its resources by the Asbestos International Association.

April 1978

**Insert to Recommended
Control Procedure No. 2**

Introduction

The Asbestos International Association has carried out detailed tests identifying methods and tools currently available for working with Asbestos Cement products on site so that dust is reduced to the minimum practicable level. The choice of the most appropriate tools for use in each country will depend on custom and practice and on national regulations. Further details can be obtained from AIA Member Associations as listed.

Swarf and off-cuts which arise from these operations should be disposed of as described in AIA — RCP2 and RCP3.

Contents

**Asbestos Cement
Building Products**

Section 1 — Hand-operated tools

Section 2 — Power tools without dust extraction equipment (tools to be used in the open air or for intermittent periods indoors are marked (*))

Section 3 — Power tools with dust extraction equipment

Section 4 — Dust extraction equipment

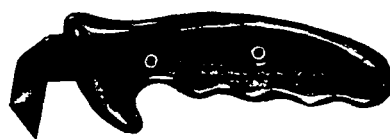
**Asbestos Cement Pipes
(Tools without dust extraction equipment)**

Section 5 — Low-speed dry-operating tools

**Annex
Testing Procedure**

1. Hand-Operated Tools

Commercial information on these tools may be obtained from national asbestos cement producers



1.1 Scriber

- Mitring corrugated sheets
- Longitudinal cuts in corrugated sheets
- Cutting flat sheets up to 6 mm



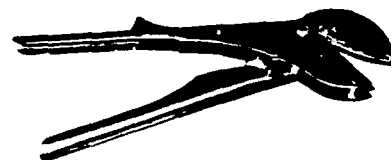
1.2 Hand Saw

- Up to 20 mm non-compressed AC products
- Up to 6 mm compressed AC products



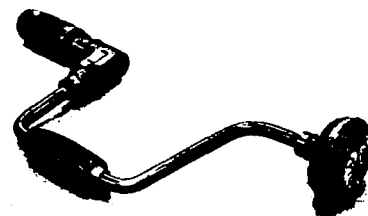
1.3 Nippers

- Trimming sheets (after scribing) up to 8 mm



1.4 Hand Clippers

- Cutting up to 6mm non-compressed sheets
- Cutting up to 3 mm compressed sheets



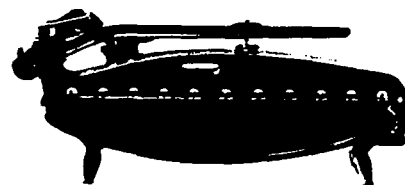
1.5 Hand Drill

- For drilling all AC products using standard metal drills or carbide-tipped drills



1.6 Horse and Slater's Hammer

- Holing and cutting slates on the roof



1.7 Parallel Shears

- Cutting slates and flat sheets up to 900 mm long
- Punching holes up to 8 mm thick



1.8 Hand Rasp

- Edge finishing

2. Power Tools Without Dust Extraction Equipment

(Tools to be used in the open air or for intermittent periods indoors are marked (*))



2.1 Draenert Shear — Model 1014

DRACO 1013/02/E

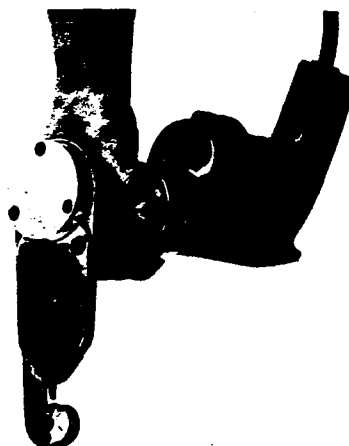
Description: Specific tool (Nibbler)

Use:

- For cutting flat sheets up to 6 mm
- For radius cuttings, ≥ 150 mm

Manufacturer:

Max Draenert,
Gutenbergstrasse 15-17
7301 Deizisau/Esslingen/Neckar,
West Germany



2.2 Danklip — Model B L G

Description: Specific tool (Nibbler) using the motor of an electric drill (BOSCH 1113)

Power: 340 W

Speed: 570 rpm

Use:

- For cutting corrugated sheets up to 8 mm

Sole distributors:

Dansk Eternit-Fabrik A/S,
P.O. Box 763,
DK 9100 Aalborg,
Denmark
Telephone: (08) 12 11 22
Telex: 6 97 24 Eterni DK



2.3 Danklip — Model PL

Description: Specific tool (Nibbler) using the motor of an electric drill (BOSCH 1113)

Power: 340 W

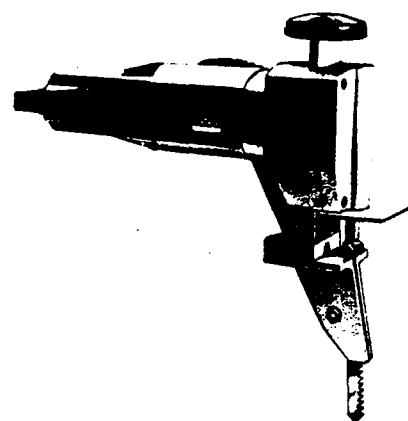
Speed: 570 rpm

Use:

- For cutting flat sheets up to 10 mm

Sole distributors:

Dansk Eternit-Fabrik A/S,
P.O. Box 763,
DK 9100 Aalborg,
Denmark
Telephone: (08) 12 11 22
Telex: 6 97 24 Eterni DK



(*) 2.4 Fein Jig Saw — Model AST 636

Description:

Power: 280 W

Speed: 1600 strokes/min

- With guiding device
- With tungsten carbide-tipped teeth blade (Ref. Biedron HL 130)

Use:

- For mitring corrugated sheets
- For cross-cutting corrugated sheets
- For longitudinal cutting corrugated sheets
- Hole cutting and cutouts (radius 50 mm and more)

Manufacturers:

Driving engine:
C. & E. Fein GmbH,
Postfach 172,
7000 — Stuttgart,
West Germany

Asbestos International Association

Special guiding device:
Heymann,
Berghäusenschweg 35,
404 — Neuss,
West Germany

Special blade:
Biedron KG,
Am Sonnenberg 23,
4630 — Bochum 5,
West Germany

Distributor:
Wirtschaftsverband,
Asbestzement E.V.,
P.O. Box 110620,
D-1000 Berlin 11,
West Germany
Telephone: 030-34 85 411
Telex: 0181221



(*) 2.5 Millers Falls Super Saw — Model SP 550 K

Description:
Power: 590 W
Reciprocating speed: 2500 strokes/min
Blades: G 1034 and G 6034

Use:
• For mitring and cross-cutting corrugated sheet

Manufacturer:
Ingersoll-Rand Tool Co.,
Millers Falls Tool Division,
South Deerfield,
Massachusetts,
U.S.A.

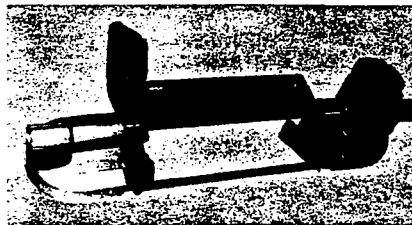
Distributor for Europe:
Messrs. Protofram Ltd.,

Badminton Trading Estate,
Yate,
Bristol,
U.K.
Telephone: 0454 319548

Other blades: Carbide-tipped blade
Cat. No. 88797 3½ in. X 6T

Manufacturer and distributor for United States:
The Henry G. Thompson Co.,
Branford,
Connecticut,
U.S.A.

Distributor for all other countries:
Milford Saws Ltd.,
Unit 2,
Overthorpe Road Industrial Estate,
Banbury,
Oxon., U.K.
Telephone: 0295 52405



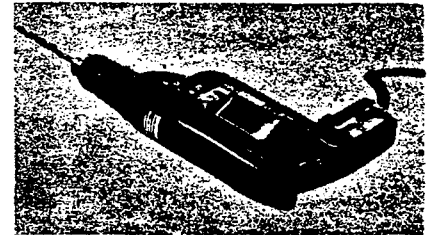
(*) 2.6 Hand-guided Band Saw — Model Rotabest

Description:
Power: 380 W
Speed: 60 m/min
With tungsten carbide blade (4 teeth/inch)

Use:
• For mitring corrugated sheets in stacks up to 250 mm overlapping
• For cutting to length AC extruded materials

Sole distributors:
Wirtschaftsverband,
Asbestzement E.V.,
P.O. Box 110620,
D-1000 Berlin 11,
West Germany
Telephone: 030 - 34 85 411
Telex: 0181 221

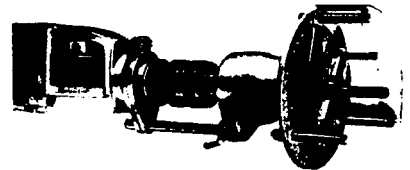
Catalog of Tools for Working with Asbestos Cement Products on Site



(*) 2.7 Power Drill

Any conventional power drill with standard metal drills or carbide-tipped drills

Use:
• For drilling all AC products (for overhead drilling use suction device noted in 3.7)

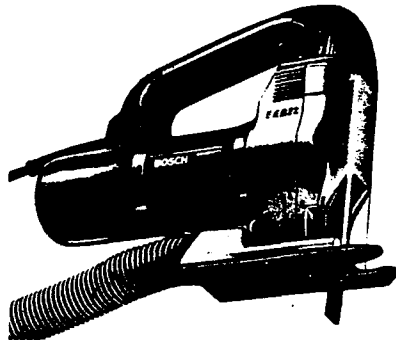


(*) 2.8 Hole Cutter Ref. No. 480

Use:
• For making circular holes in sheets up to 10 mm thick

Manufacturer:
J. C. and Alb. Zenses,
Werkzeugfabrik,
Raspelweg 10,
Postfach 15 01 58,
5630 RS-Haddenbach,
West Germany

3. Power Tools with Dust Extraction Equipment

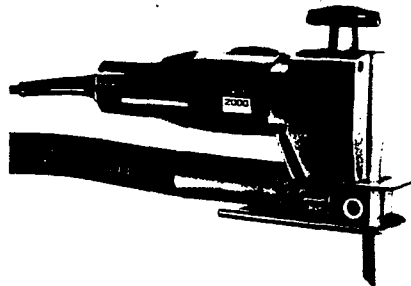


3.1 Bosch Pendulum Jig Saw — Model 1578

Description:
Power: 320 W
Speed: 3000 stroke/min
With tungsten carbide-tipped blade ref. T 130 and hood included

Use:
• For hole cutting and cutouts (radius 50 mm and more)
• For flat sheets up to 10 mm thick

Manufacturer:
Robert Bosch GmbH,
Max Lang Strasse 40-46,
7022 Leinfelden,
West Germany
Telephone: 07-11/79 031
Telex: Bosch Leinfelden 07 255 858

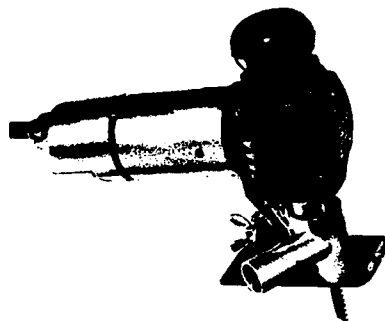


3.2 Fein Jig Saw — Model AST 636

Description:
Power: 280 W
Speed: 1600 strokes/min with diamond blades ref. 63503 or tungsten carbide-tipped blades ref. T 130 (BOSCH) and hood ref. 96 602

Use:
• For hole cutting and cutouts (radius 50 mm and more)
• For flat sheets up to 10 mm thick

Manufacturer:
C. & E. Fein GmbH,
Postfach 172,
7000 Stuttgart,
West Germany



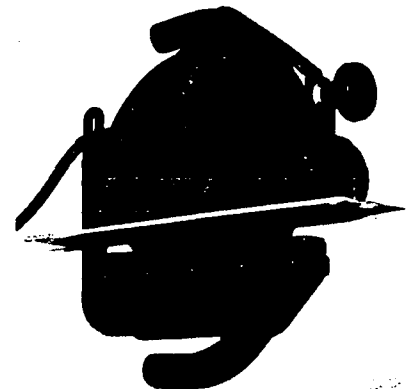
3.3 Wheeler-Pilot Jig Saw

Description:
Model No. 858, 120 V — 600 W
Model No. 8581, 200 V — 600 W
(Power unit by Black and Decker)
Speed: 2100/3100 strokes/min
With tungsten carbide-tipped blade
Ref. Black and Decker No. 31006

Use:

- For hole cutting and cutouts (radius 50 mm and more)
- For flat sheets up to 20 mm thick

Manufacturer:
Wheeler-Pilot International,
20433 Earle Street,
Torrance, California 90503,
U.S.A.
Telephone: (213) 371-1238
Telex: 653 486



3.4 Wheeler-Pilot Circular Saw

Description:
Wheeler-Pilot Model 888: 120 V, 11.5 amp, 5500 rpm Black and Decker circular saw with dust collection hood and 7 in. silicon carbide blade.

Wheeler-Pilot Model 887: 120 V, 11.5 amp, 5500 rpm Black and Decker circular saw with dust collection hood and 7 in. diamond blade.

Wheeler-Pilot Model 8881: 220 V, 5.75 amp, 5500 rpm Black and Decker circular saw with dust collection hood and 7 in. silicon carbide blade.

Wheeler-Pilot Model 8871: 220 V, 5.75 amp, 5500 rpm Black and Decker circular saw with dust collection hood and 7 in. diamond blade.

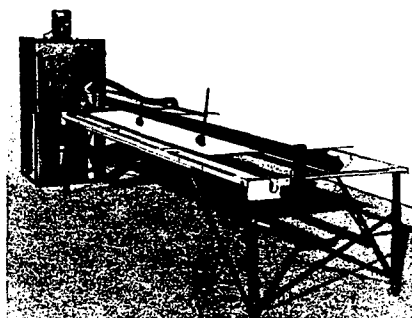
Asbestos International Association

Use:

- For cutting flat sheets up to 60 mm thick

Manufacturer:

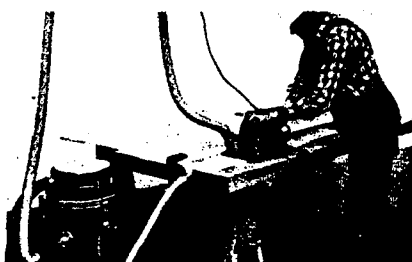
Wheeler-Pilot International,
20433 Earle Street,
Torrance, California 90503,
U.S.A.
Telephone: (213) 371-1238
Telex: 653 486



3.5 Mafell Cutting Unit — TT 320

Description:

Mafell type B 65 TT
Cutting depth: 62 mm
Cutting length: 3200 mm
Disc speed: 5100 rpm
Power: 980 W



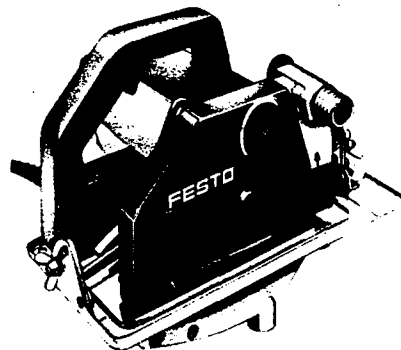
Vacuum unit type S 1 DB
Electric power: 1500 W
Vacuum: 2.9 kPa
Airflow: 526 m³/h
Filter area: 50000 cm²

Use:

- In the plant or on site for cutting flat sheets up to 20 mm thickness

Manufacturer:

Mafell — Rudolf Mey KG.,
Postfach 21,
7239 Aistaig/Neckar,
West Germany



3.6 Festo Cutting Unit

Description:

Consisting of circular saw ref. AUT 42 S with special hood
Precision slider ref. AUP 6
Guide 1,25/2,00/2,75 m length ref. AUPG
Diamond blade ref. 6770 (or carbide-tipped blade)

Use:

- For cutting flat sheets up to 20 mm thick

Manufacturer:

Festo GmbH,
Ulmer Strasse 48,
7300 Esslingen/Neckar,
West Germany

3.7 Suction Device for

Conventional Power Drill
With standard metal drills or carbide-tipped drills

Catalog of Tools for Working with Asbestos Cement Products on Site



3.7.1 Ref. 'Cape' Hood (Portable Drill Nozzle Kit)

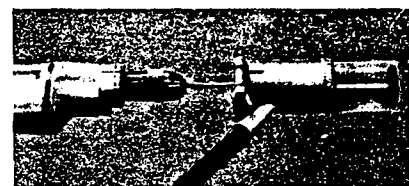
Will adapt to drill bearing housing from 37 mm to 44 mm diameter

Use:

- For drilling all AC products up to 12 mm thick

Sole distributor:

Cape Boards and Panels Ltd.,
Iver Lane,
Uxbridge,
Middlesex,
U.K.
Telephone: 89 37111



3.7.2 Ref. Suction Device Roeck

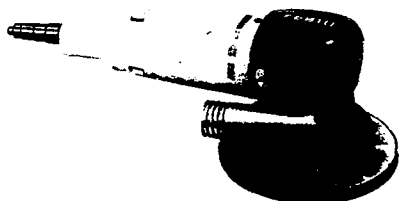
Will adapt to drill bearing housing from 35 mm to 53 mm diameter

Use:

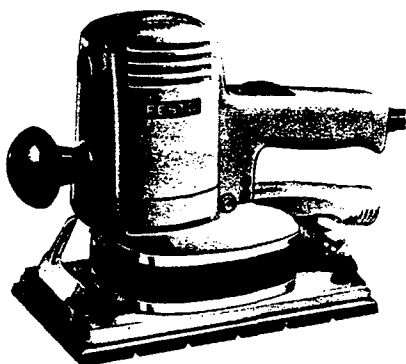
- For drilling all AC products up to 60 mm thick

Manufacturer:

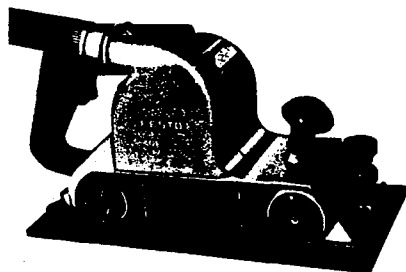
Roeck,
Feldstrasse 42,
46000 Olten,
Switzerland



3.8 Festo Eccentric Sander — Model WST



3.9 Festo Vibrating Sander — Model RTT-S2



3.10 Festo Belt Sander — Model BUZ.S

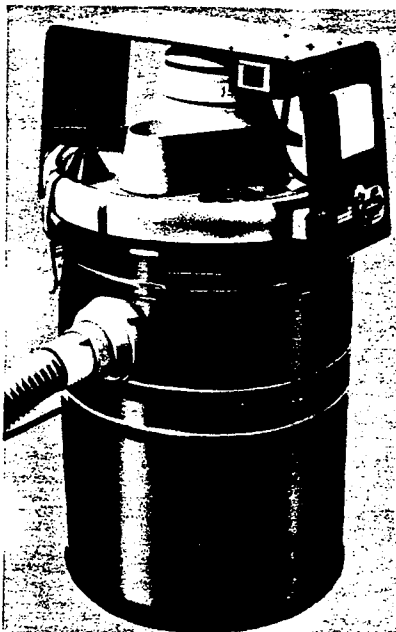
Ref.: With suction hood
Abrasive paper

Use:

- For finishing all AC products

Manufacturer:
Festo GmbH,
Ulmer Strasse 48,
7300 Esslingen/Neckar,
West Germany

4. Dust Extraction Equipment



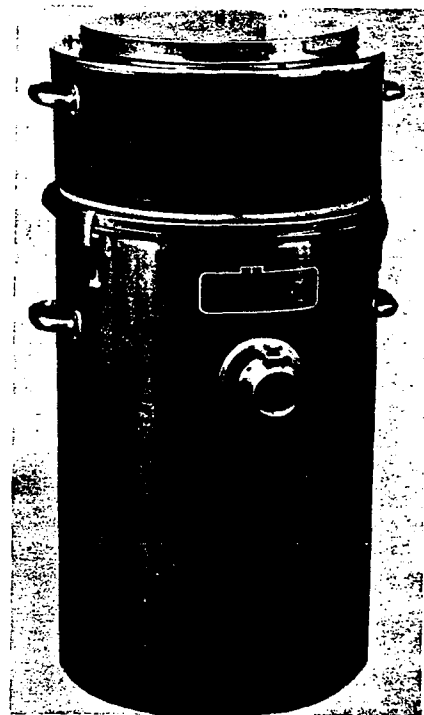
4.1 WAP — Model MIS

Ref. power: 700/800 W
Vacuum: 16 kPa
Airflow: 96 m³/h
Filter area: 7140 cm²
Filter type: Paper bag and filter

Use:

- Equipment for tools
- Equipment for cleaning the site

Manufacturer:
Guido Oberdorfer,
WAP-Maschinen,
Werkstrasse 22,
7919 Bellenberg,
West Germany



4.2 Pullman — Model JB 503

Ref.: With 3 motors
Power: 1900 W
Vacuum: 17.6 kPa
Airflow: 338 m³/h
Dust collection bags
Dust filters
Exhaust filters

Use:

- Equipment for tools
- Equipment for cleaning the site

Manufacturer:
For Europe —
Pullman Scandinavian AB,
Vällingbyvägen 183-187,
Box 100,
S-162 12 Vällingby,
Sweden
Telephone: 08-879285
Telex: 17 339

For U.S.A. —
Pullman/Holt Products,
10702 46th Street,
Tampa,
Florida 33617,
U.S.A.
Telephone: (813) 971-2223
Telex: 052 821



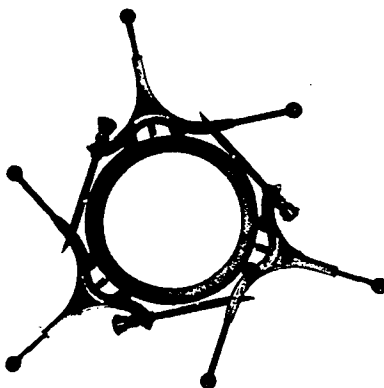
4.3 Nilfisk — Model GS 83
Ref.: With 3 motors type GS
Power: 2100 W
Vacuum: 18.5 kPa
Airflow: 378 m³/h
Filter area: 14300 cm²
Dust container
Dust filters
Exhaust filters

Use:
• Equipment for tools
• Equipment for cleaning the site

Manufacturer:
Nilfisk A/S,
Agenavej 16-18
DK-2670 Greve Strand,
Denmark
Telephone: (02) 909055

Nilfisk of America, Inc.
224 Great Valley Parkway
Malvern, PA 19355
U.S.A.
(215) 647-6420

**5. Asbestos Cement Pipes.
Low-Speed Dry-Operating Tools**



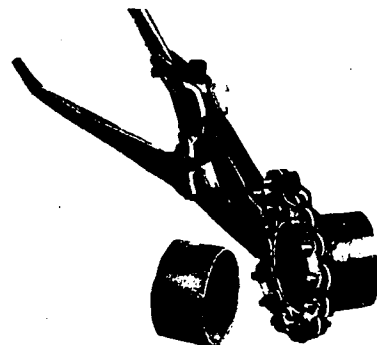
5.1 Reed Pipe Cutter — Model ACC
Hand operated

Ø	mm	Ref.
2- 6 in.	60-186	ACC 2-6 (2 parts)
4- 8 in.	125-241	ACC -2 (2 parts)
4-16 in.	125-480	ACC -3 (3 parts)
8-24 in.	203-889	ACC -4X (4 parts)

With carbide-tipped blades

Use:
• For cutting all classes of AC pipes

Manufacturer:
Reed Manufacturing Co.,
P.O. Box 1321,
Erie, Pennsylvania 16512,
U.S.A.
Telephone: (814) 452-3691
Telex: 914 540

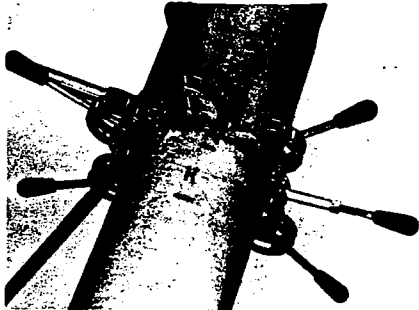


5.2 Wheeler-Pilot Chain Cutter
Operated by hand or by hydraulic pressure

Ø
2 in.- 6 in. Model 490-6 (ratchet)
2 in.- 8 in. Model 490-8 (ratchet)
2 in.- 6 in. Model 590-6 (handle)
2 in.- 8 in. Model 590-8 (handle)
2 in.-12 in. Model 2290-12 (hydraulic)
4 in.-16 in. Model 3890-18 (hydraulic)
6 in.-24 in. Model 5591-24 (hydraulic)
Cutting wheels mounted in a chain

Use:
• For cutting all classes of AC pipe

Manufacturer:
Wheeler-Pilot International,
20433 Earle Street,
Torrance, California 90503,
U.S.A.
Telephone: (213) 371-1238
Telex: 653 486



5.3 Wheeler-Pilot Tools Pipe Cutter — Model 4

Hand operated

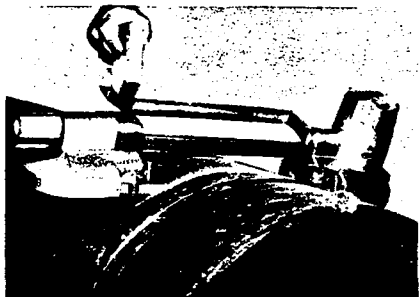
Model 4		Model 7	
Ø	Ref.	Ø	Ref.
3 in.- 6 in.	4.206	3 in.-8 in.	7.410
3 in.- 8 in.	4.208		
3 in.-10 in.	4.210		
3 in.-12 in.	4.212		
3 in.-14 in.	4.214		
3 in.-16 in.	4.216		
3 in.-18 in.	4.218		
3 in.-20 in.	4.220		
3 in.-24 in.	4.224		

With carbide-tipped blades

Use:

- Engineered to make both square and angle cuts above ground, on site for all classes of AC pipes

Manufacturer:
Wheeler-Pilot International,
20433 Earle Street,
Torrance, California 90503,
U.S.A.
Telephone: (213) 371-1238
Telex: 653-486



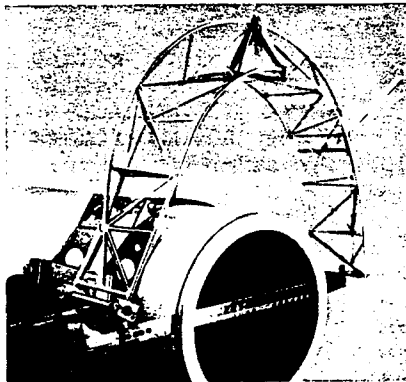
5.4 Hand-guided Band Saw — Model Rotabest

Description:
Power: 380 W
Speed: 60m/min.
With tungsten carbide blade
(3 teeth/inch)

Use: For cutting AC pipes

- Wall thickness 45 mm up to 600 mm diameter
- Wall thickness 35 mm up to 800 mm diameter

Sole distributors:
Wirtschaftsverband,
Asbestzement E.V.,
P.O. Box 110620,
D-1000 Berlin 11,
West Germany
Telephone: 030 34 85 411
Telex: 0181 221



5.5 Fein Jig Saw — Model A Stx 649

Description:
Driving engine —
Power: 750 W
Speed: 350 strokes/min

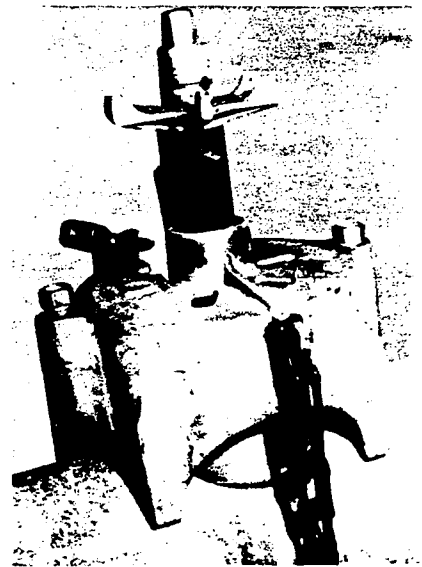
Basic equipment —
With 650 mm sawing blade and small
holding device

Extension —
Guiding device, holding device, front
plate, tension chain and 980 mm
sawing blade

Use:

- For cutting AC pipe with diameters 100 - 350 mm (basic equipment)
- Diameters 350 - 600 mm (extension)

Sole distributors:
Wirtschaftsverband,
Asbestzement E.V.,
P.O. Box 110620,
D. 1000 — Berlin 11,
West Germany
Telephone: 030 - 34 85 411
Telex: 0181 221



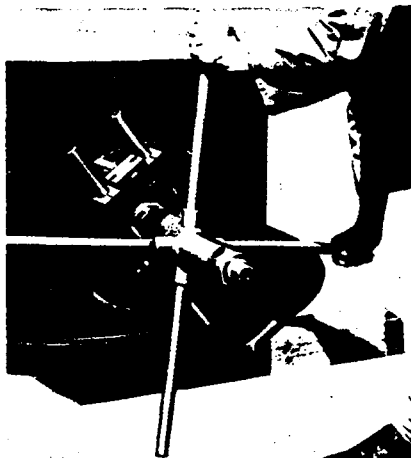
5.6 Wheeler-Pilot — Hole HC-2 Series

Description:
Diameters of cutting shells available
(inches)
3, 4, 4½, 5, 5¼, 5½, 6, 6½, 7, 8
Standard chain permits hole cutter to
be used on 6 - 18 in. diameter pipe.
Cutter can be used on pipe diameter
above 18 in. by extending the chain.
Cutting shells equipped with
carbide-tipped cutting teeth
Power: manual, gasoline, pneumatic
or electric drill

Use:

- Cutting holes in all classes of AC pipe

Manufacturer:
Wheeler-Pilot International,
20433 Earle Street,
Torrance, California 90503
U.S.A.
Telephone: (213) 371-1238
Telex: 653 486



5.7 Hole Cutter SB 60

Description:

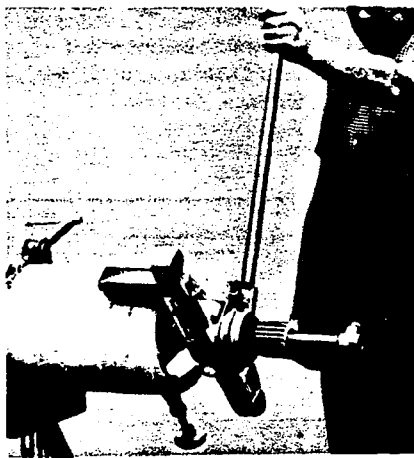
Operated by hand or by electric power
Driving engine speed: adjust to 120
rpm

Use:

- Cutting hole with diameters from 160 to 625 mm in all classes of AC pipe

Sole distributors:

Wirtschaftsverband,
Asbestzement E.V.,
P.O. Box 110620,
D. 1000 — Berlin 11,
West Germany
Telephone: 030 - 34 85 411
Telex: 0181 221



5.8 Wheeler-Pilot Tools — Field Lathe

Ø Ref.

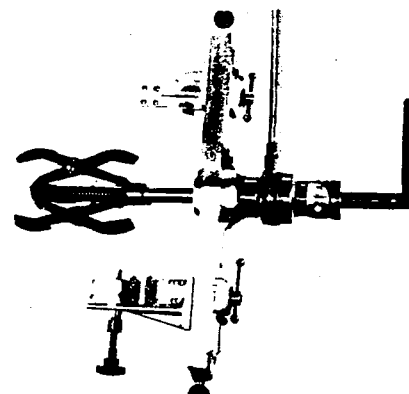
3 in. - 8 in. Model A
4 in. - 12 in. Model B
8 in. - 20 in. Model C
4 in. - 16 in. Model F
14 in. - 30 in. Model G (15-33 in. OD)
27 in. - 44 in. Model H (30-50 in. OD)
With manually operated ratchet or
with electric or pneumatic power
drives

Use:

- For machining all classes of AC pipe

Manufacturer:

Wheeler-Pilot Manufacturing
Company,
20433 Earle Street,
Torrance, California 90503,
U.S.A.
Telephone: (213) 371-1238
Telex: 653 486



5.9 Reed Field Lathe

Ø	Ref.
3- 8 in.	75- 200 mm ACL 3-8
3-12 in.	75- 300 mm ACL 3-12
6-16 in.	150- 400 mm ACL 6-16
14-39 in.	350-1000 mm ACL 1000
14-51 in.	350-1300 mm ACL 1300

With manually operated ratchet
included standard or with electric or
pneumatic power drives.

Use:

- For machining all classes of AC pipes.

Manufacturer:

Reed Manufacturing Co.,
P.O. Box 1321,
Erie, Pennsylvania 16512,
U.S.A.
Telephone: (814) 452-3691
Telex: 914540

Annex

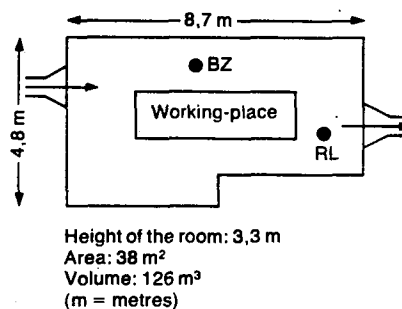
Testing Procedure

In order to test under the most severe conditions and also to ensure reproducibility, all work on asbestos cement products during the test is carried out in a closed room.

For tools normally used in the open air, a low airflow of less than 0.1 metres per second in the working-zone is introduced by suction. In this way account is taken of the normal dispersal of airborne dust on site in very calm conditions so that the test results obtained are unlikely to be exceeded at any time.

Each test is of one hour's duration. Room level (RL) reading is recorded prior to commencement of the test measurement. Whilst work is being carried out on the asbestos cement products, samples are taken in the workers' breathing-zone (BZ) and in the room itself.

The AIA Test Room is located at:
Asbestos Institute for Occupational
and Environmental Safety and Health
Görlitzer Strasse 1,
4040 - Neuss 1,
West Germany



Sampling and evaluation are in accordance with the AIA Reference Method for the determination of airborne asbestos fibre concentrations at the workplace by light microscopy (Membrane Filter Method) (See AIA Publication *Recommended Technical Method No. 1 RTM1*). The operating time for each tool and product involved is recorded.

July 1981.

Work Practices for Asbestos-Cement Products

Introduction

The Occupational Safety and Health Act in the United States and similar laws in Canada and other countries were enacted to ensure so far as possible, every worker a safe and healthy work place. This legislation is far reaching. It covers millions of employees and nearly every employer, including those involved in utility duct and pipeline construction.

In keeping with the spirit and intent of these laws, the asbestos-cement pipe industry is cooperating with labor by disseminating information regarding the potential hazards of exposure to airborne asbestos and the means of reducing such potential hazards through good work practices.

Good work practices is what this book is all about. The recommendations that appear on the following pages are the result of field testing and were developed through study.* They are intended as general rule guides to achieve safe and clean job site conditions when working with asbestos-cement (A/C) pipe products. Since field conditions will vary, adherence to these work practices will not necessarily guarantee compliance with national, state or local regulations. Questions relating to compliance should be directed to appropriate regulatory agencies.

The (A/C) Pipe Producers Association believes this will be helpful to engineers, superintendents, contractors, foremen and laying crews in understanding and explaining established procedures for the safe handling of A/C pipe products.

*See "Asbestos Exposures During the Cutting and Machining of Asbestos-Cement Pipe", report prepared by Equitable Environmental Health Inc., March, 1977 and "News from TAC", reporting on a survey by the Occupational Hygiene Unit of the North of England Industrial Health Service, TAC Construction Materials Ltd., February, 1977.

Asbestos and Health

As you are aware airborne asbestos fiber has been identified as a possible health hazard. Very few things to which we are exposed are "zero risks". But like the automobile, electricity and x-rays, there are non-harmful ways to use potentially harmful things.

Generally, asbestos-cement (A/C) pipe products contain less than 20% asbestos. The asbestos fibers are not free, but encapsulated or "locked-in" the cement binder like reinforcing rods in concrete. The distinction between "free" and "bound" asbestos is extremely important. First of all, it determines the probability of fiber release, which in turn, directly relates to the probability of risk. More importantly, it explains clearly and simply why A/C pipe is a non-harmful use of asbestos.

Experience has shown that minimizing exposure to airborne asbestos dust is the only effective method of preventing asbestos-related diseases. Recommended work practices are the best assurance of providing exposure safeguards for yourself and your employees.

Summary of OSHA Asbestos Standard

The Occupational Safety and Health Act was signed into law on December 29, 1970, and became effective on April 28, 1971. On December 7, 1971, the Secretary of Labor issued a temporary standard for exposure to asbestos dust. As required by the Act, a permanent standard for asbestos exposure was promulgated six months later.

Under the current standard, it is the employer's responsibility to assure that exposure of employees to airborne concentrations of asbestos fibers does not exceed the following "permissible exposure levels":

- Eight hour time weighted average: Two fibers, longer than 5 micrometers, per cubic centimeter.
- Ceiling concentrations: Ten fibers, longer than 5 micrometers, per cubic centimeter.

In October, 1975, OSHA proposed a revision to the current standard which would reduce the eight hour time-weighted average exposure to 0.5 fibers per cubic centimeter. In their notice, OSHA stated that a separate "construction industry standard" would be issued to cover workers who handle asbestos-containing products. This work practice booklet will be revised as necessary to reflect any changes the construction industry standard may necessitate.

The work practices recommended in this booklet are based on data for "peak dust concentrations" representing short time periods of maximum exposure. Field cutting and machining operations involving A/C pipe are normally infrequent and of short duration. Using these recommended work practices, it is improbable that field personnel would be exposed in a typical working day to levels exceeding the eight hour time-weighted average.

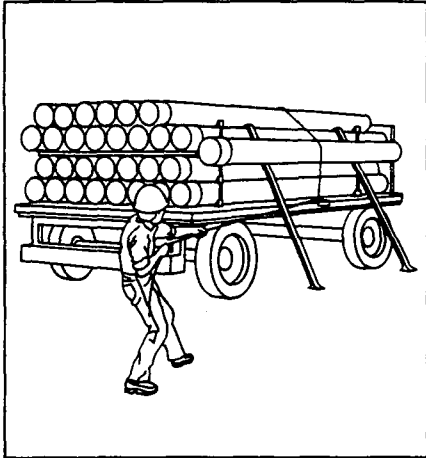
Products and Operations

Types of A/C Pipe Products covered by these work practices include:

- "Class" Pressure Pipe
- "Transmission" Pressure Pipe
- Pressure Sewer Pipe
- Gravity Sewer Pipe
- Building Sewer Pipe
- Storm Drain Pipe
- Perforated Underdrain Pipe
- Electrical Conduit
- Air Duct

Operations to which these work practices apply include:

- Shipping, Receiving and Handling
- Cutting
- Machining
- Hole Cutting
- Tapping
- Coupling Removal
- Housekeeping and Waste Disposal



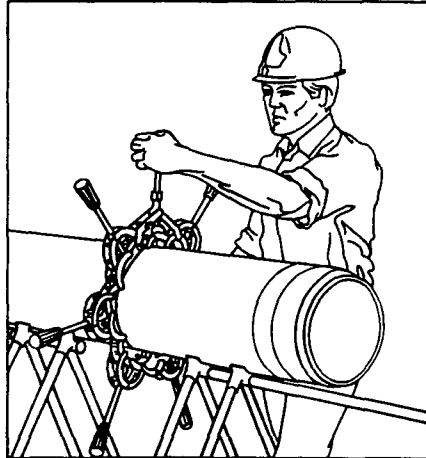
Shipping, Receiving, Handling and Assembly*

A/C pipe is shipped clean from the factory and carefully loaded using methods acceptable to the carrier. Loading, unloading, stringing out and assembling A/C pipe are essentially dust-free operations. Even in enclosed spaces, airborne asbestos fiber levels from pipe handling operations are far below existing and proposed occupational standards.

All hand and mechanical unloading operations should be carried out in accordance with the manufacturer's manuals.

A/C Pipe Products: All
Size Range: All

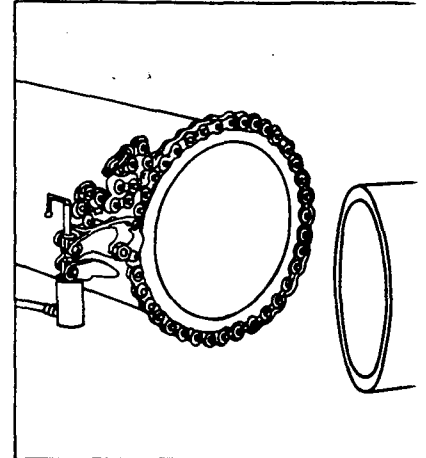
*Exposure data not currently available. Recommendations based on exposure data for operations believed to be comparable.



Cutting with Carbide Blade Equipment

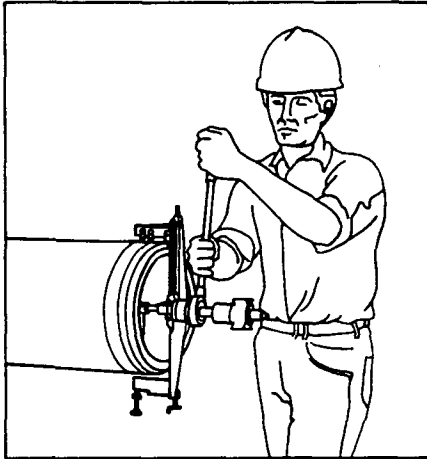
Blade cutters consist of a frame adjustable to the circumference of the pipe and a number of outboard, self-tracking rollers that align one or more carbide-tipped cutting blades. Blade cutters are typically hand-operated. Due to the relatively low mechanical input and clean cutting action, significant amounts of airborne asbestos dust are not produced.

A/C Pipe Products: All
Size Range: 3" through 24"
(7.6 through 61.0 cm)



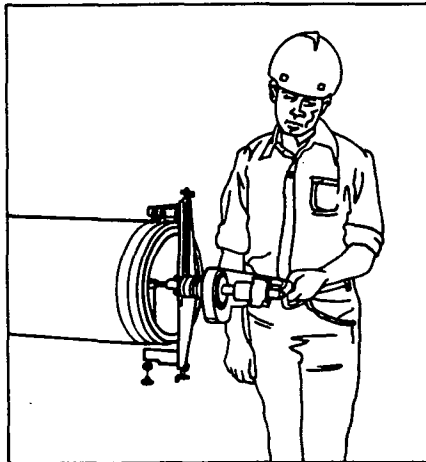
Cutting with Snap Cutting Equipment: Snap cutters or "squeeze and pop" equipment operates by means of cutting wheels mounted in a chain wrapped around the pipe barrel. Hydraulic pressure, applied by means of a remote electric or manually-operated pump, simultaneously squeezes the cutting wheels into the pipe wall until the cut is made.

A/C Pipe Products: All
Size Range:
• Pressure Pipe—3" through 24" (7.6 through 61.0 cm)
• Pressure, Gravity and Building
• Sewer; Storm Drain; Air, Electrical and Telephone Duct—3" through 36" (7.6 through 91.4 cm)



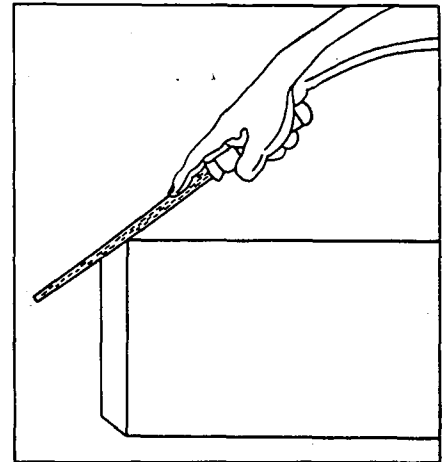
Machining with a Manual Field Lathe
Manual field lathes are designed to end-trim and re-machine rough pipe barrels to factory-machined end profiles. The lathe consists of an adjustable, self-aligning arbor inserted into the pipe bore (which acts as a mandrel upon which the turning handle operates), a screw-fed turning frame, carbide machining blades and manual (hand or Ratchet) turning handles.

A/C Pipe Products: All
Size Range: All



Machining with a Power Field Lathe
Power field lathes, like manual lathes, are designed to end-trim and re-machine rough pipe barrels to factory-machined end profiles. The lathe consists of an adjustable, self-aligning arbor inserted into the pipe bore (which acts as a mandrel upon which the turning handle operates), a screw-fed turning frame, carbide machining blades and electric or pneumatic power drive.

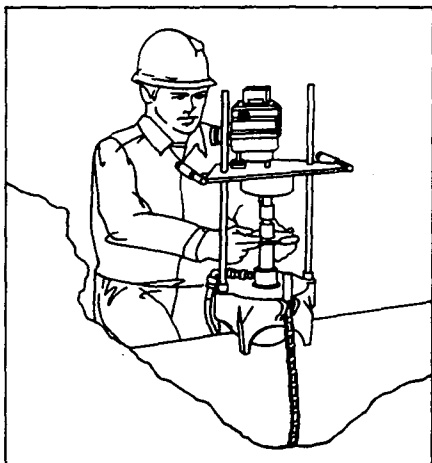
A/C Pipe Products: All
Size Range: All



Machining with a Manual Rasp*
Short lengths of A/C pipe (MEE'S & MOAS) can be cut for pipe closures, repairs and to locate fittings exactly. Field cut ends may be rebeveled with a coarse wood rasp to form a taper approximating the same profile as the factory-beveled end.

A/C Pipe Products: All
Size Range: All

*Exposure data not currently available. Recommendation based on exposure data for operations believed to be comparable.

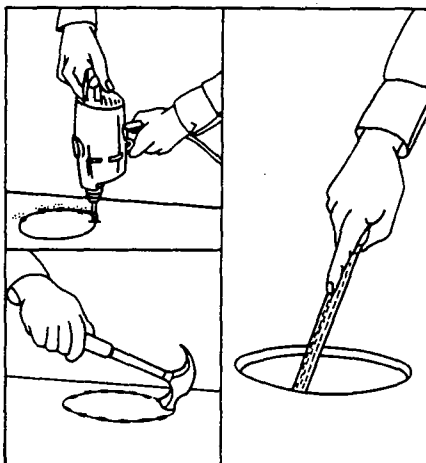


Hole Cutting with Shell Cutters

For field connections into A/C pipe, clean, even entry cuts may be accomplished by means of shell cutting equipment. Shell cutters consist of a hole cutter housing mounted on the pipe, a carbide or diamond-tipped hole cutter and a manual ratchet, pneumatic, electric or gasoline drive to power the cutting head.

When cutting holes in A/C pipe products, all dust and cuttings should be removed from the pipe or duct interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. *Do Not Blow Out with Compressed Air or Dry Sweep.*

A/C Pipe Products: Pressure, Gravity and Building Sewer; Air Duct
Size Range: All

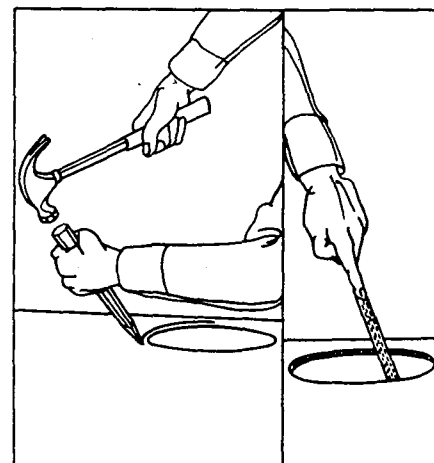


Hole Cutting with a Drill and Rasp*

Field connections may be made with a heavy duty electric drill and rasp. Using a carbide-tipped drill, a series of closely-spaced holes are first drilled around the hole outline. The disc is knocked free with a hammer and the edges of the hole are dressed with a coarse wood rasp.

When cutting holes in A/C pipe products, all dust and cuttings should be removed from the pipe or duct interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. *Do Not Blow Out with Compressed Air or Dry Sweep.*

A/C Pipe Products: Pressure, Gravity and Building Sewer; Air Duct
Size Range: All



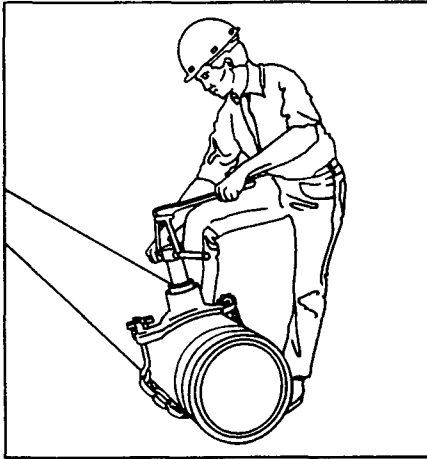
Hole Cutting with a Chisel and Rasp

Holes may be cut into A/C pipe with a hammer and a chisel. The edge of a plumber's wood chisel is used to cut completely around the hole outline, about 1/4" from the prescribed line. The operation is repeated and the cut deepened until through. The edges of the hole are then dressed with a coarse wood rasp.

When cutting holes in A/C pipe products, all dust and cuttings should be removed from the pipe or duct interior after the cutting operation. Removal may be accomplished by flushing with water, wet mopping or vacuuming prior to placing in service. *Do Not Blow Out with Compressed Air or Dry Sweep.*

A/C Pipe Products: Pressure, Gravity and Building Sewer; Air Duct
Size Range: All

*Exposure data not currently available. Recommendation based on exposure data for operations believed to be comparable.



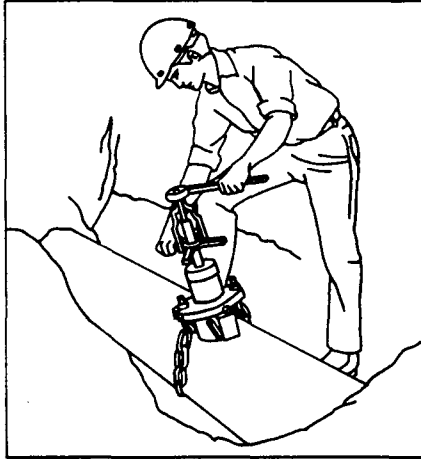
Non-Pressure Tapping*

Non-pressure or "dry" tapping for service connections may be performed in or above the trench. The equipment is affixed to the pipe by the means of a chain yoke. Separate drills and taps or a combination tool drills and taps the pipe wall. Corporation stops or other connections may then be affixed to the pipe.

To minimize the fouling of valves, regulators, meters, etc. with chips and unnecessary addition of asbestos to drinking water, all dust and cuttings should be removed from the pipe interior by flushing with water, wet mopping or vacuuming prior to placing in service. *Do Not Blow Out with Compressed Air or Dry Sweep.*

A/C Pipe Products: Pressure Pipe
Size Range: All

*Exposure data not currently available. Recommendation based on exposure data for operations believed to be comparable.



Pressure Tapping*

Pressure or "wet" tapping for service connections is performed in the trench while the pipe is under pressure. The equipment (manual or power driven) is affixed to the pipe by means of a chain yoke. A combination boring and inserting bar drills and taps the pipe wall and inserts a corporation stop or pipe plug. The pressure chamber, which protects against water leakage, also catches the asbestos-cement chips, so this is essentially a dust-free operation.

To minimize the fouling of valves, regulators, meters, etc. with chips and unnecessary addition of asbestos to drinking water, provisions should be made for downstream flushing or use of tapping equipment with positive purge or "blow-off" features.

A/C Pipe Products: Pressure Pipe
Size Range: All

*Exposure data not currently available. Recommendation based on exposure data for operations believed to be comparable.

Housekeeping and Waste Disposal

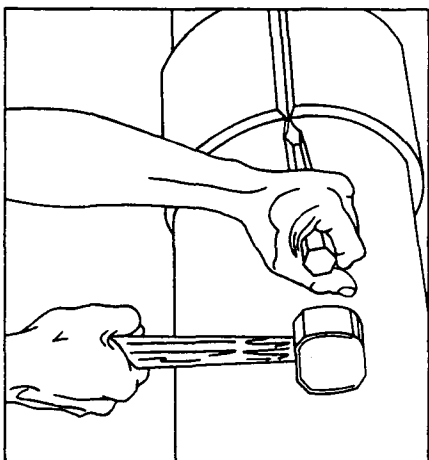
Housekeeping is an important part of any safe construction operation. It is even more essential when airborne dust created by the lack of good housekeeping has the potential for harm to employees or others.

Equipment: All external surfaces of equipment should be maintained free of dust accumulations that might, if dispersed, create asbestos fiber concentrations above permissible limits.

Waste Disposal: Asbestos-cement chips and cuttings from the field operations described in this booklet should be disposed of in a manner that will not contribute airborne asbestos dust to the atmosphere. Where cutting and machining operations are performed at the construction site, the chips should be placed in the trench and buried in the pipeline.

Where operations are performed at a central location such as a contractor's or distributor's yard on a more or less continuing basis, the chips and cuttings may be collected and mixed wet with cement and made into non-friable forms. These forms may be used in the trench as supports for cast iron fittings and valves, as appropriate. Otherwise, chips and cuttings should be collected in sealed bags or closed containers impermeable to asbestos dust. *Loose Material Should Never Be Swept.* When vacuum equipment is available, it should be used. Water or other dust suppressants should be applied in those circumstances where sweeping is unavoidable. *Do Not Blow Waste Material with Compressed Air.*

No visible emissions to the atmosphere may result from the collection of any asbestos-containing material. Wastes should be disposed at a site operated in accordance with the requirements or applicable national, state or local laws.

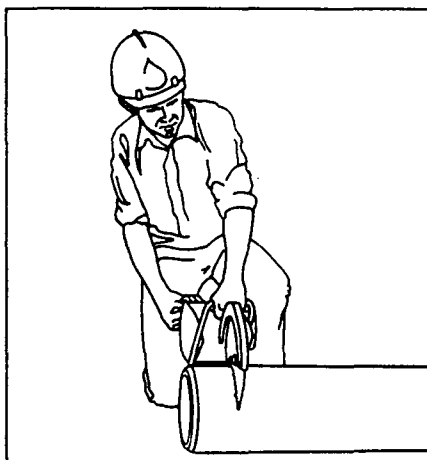


Coupling Removal with a Hammer and Chisel*

Replacement of damaged pipe necessitates excavation, exposure and removal. Coupling removal may be accomplished by gradually splitting the coupling lengthwise, using a chisel and ball-peen hammer. After the top of the coupling has been split, a crowbar or similar tool is used as a lever to split the bottom of the coupling.

A/C Pipe Products: All pipe with A/C couplings
Size Range: All

*Exposure data not currently available. Recommendation based on exposure data for operations believed to be comparable.



Dry Cutting with an Abrasive Disc is Not Recommended

Power driven saws with abrasive discs (masonry blades) should not be used for dry cutting or beveling asbestos-cement pipe. Abrasive disc cutters produce concentrations of airborne asbestos dust which exceed OSHA permissible levels.* *This Work Practice is Therefore Specifically Not Recommended.*

A/C Pipe Products: All
Size Range: All

*Data not currently available regarding effect of local exhaust ventilation/dust collection equipment or other engineering modifications on asbestos fiber concentrations.

A/C Pipe Producers Association

Members

Regular, Associate and Affiliate*

Regular Members

Asociacion Mexicana de
Fabricantes de Productos
de Asbesto Cemento A.C.
Mexico 1, D.F.
Mexico

Asbestos de Mexico*
Tlalnepantla
Mexico

Eureka Group*
Mexico 1, D.F.
Mexico

Mexalit, S.A.*
Mexico 1, D.F.
Mexico

Atlas-Turner, Inc.
Montreal, Quebec
Canada H1N 1W1

Capco Pipe Company, Inc.
Birmingham, Alabama
U.S.A.

Certain-Teed Corporation
Valley Forge, Pennsylvania
U.S.A.

J-M Manufacturing Co., Inc.
Stockton, California
U.S.A.

Associate Members

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Products Ltd.
Hyderabad
India

James Hardie & Company, Pty.,
Ltd.
Sydney, New South Wales
Australia

Kuwait Asbestos Industries
Kuwait

Syndicate de l'Amiante-Ciment
Paris
France

Eternit France*
Triel-sur-Seine
France

Everitube*
Paris la Defense
France

A/C Pipe Producers Association

1600 Wilson Boulevard
Suite 1308
Arlington, Virginia 22209

Work Practices for Friction Products

Friction Products



October 1978

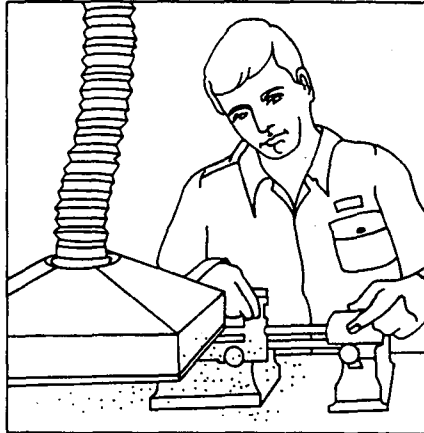
Asbestos and Friction Materials

Most molded friction materials contain about 50% asbestos — some woven materials over 90%. In molded materials, resin binders prevent the release of asbestos fibers during normal handling. Woven friction materials, normally used only in construction and industrial applications, must be handled with care to avoid creating dust as the asbestos fibers are less firmly bound into the product.

Potentially hazardous airborne concentrations of asbestos dust can be created by improper cleaning and handling of worn brake and clutch assemblies, uncontrolled machining operations and poor housekeeping.

Breathing excessive quantities of asbestos fiber can cause respiratory disease and cancer. Smoking greatly increases the risk of lung cancer among asbestos workers. Prevention of asbestos dust exposure is the only known method of eliminating asbestos-related disease among those working with asbestos containing products.

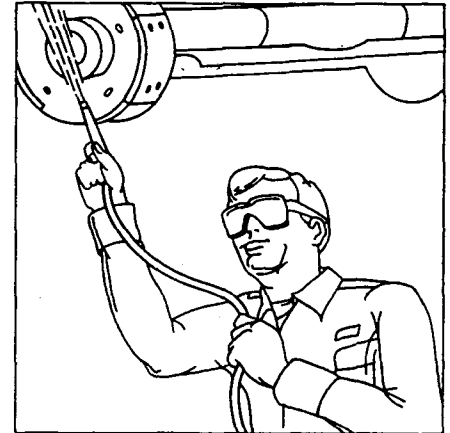
Proper work practices offer the best assurance of providing exposure safeguards for workers removing, installing and machining asbestos containing friction materials.



Use Dust Collection Equipment When Machining

The purpose of this booklet is to provide practical guides for brake and clutch service mechanics in the handling and processing of asbestos containing friction materials and in the maintenance and repair of brake and clutch assemblies on which the materials are installed.

Adherence to the recommended work practices will reduce employee exposure to airborne concentrations of asbestos dust and will assist employers in complying with government regulations. This area is regulated by federal, state and local authorities. We caution that you may not rely on strict adherence to the work practices recommended herein as assuring compliance with these regulations, because they are subject to amendment; there are on-going administrative interpretations of these regulations; and particular field conditions may vary. You should direct all questions relating to compliance with regulations to the appropriate regulatory agencies.



Do Not Use an Air Hose for Cleaning

WHY?

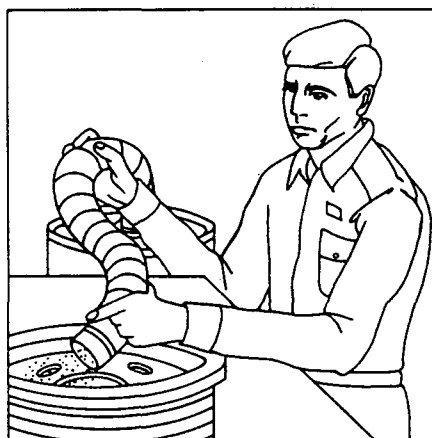
Summary of OSHA Asbestos Standard Effective July 1, 1976

Under the current standard, it is the employer's responsibility to assure that the exposure of employees does not exceed the following permissible exposure levels.

- Eight hour time-weighted average: Two fibers, longer than five micrometers, per cubic centimeter.
- Ceiling (Peak) concentrations: Ten fibers, longer than five micrometers, per cubic centimeter.

Engineering controls such as isolation, enclosure, exhaust ventilation and dust collection are the preferred methods for meeting the prescribed exposure limits. All external surfaces must be maintained free of asbestos fiber accumulation.

Respiratory protection is required whenever airborne fiber concentrations exceed either the permissible time weighted average level or the permissible ceiling concentration. Protective clothing is required whenever airborne fiber concentrations exceed the permissible ceiling level. Caution signs, change rooms and employee notification are required where asbestos fiber concentrations exceed permissible exposure limits. The standard requires that all workplaces where asbestos fibers may be released shall be monitored to determine exposure levels, and regular monitoring is required where exposure levels are expected to exceed permissible limits. Employers must maintain records of monitoring required by the standard. They must also provide or make available medical examinations for employees exposed to airborne concentrations of asbestos fibers.



Use Vacuum or Wet Methods for Cleaning

Handling New Friction Materials
Handling new disc brake assemblies, lined brake shoes, clutch facings and brake blocks purchased in individual boxed sets is unlikely to create significant airborne concentrations of asbestos dust. If the parts are purchased in bulk quantities, abrasion during shipment may result in the accumulation of dust in shipping containers. Dust should be removed by vacuuming or cleaning with a damp cloth.

Whenever possible, purchase friction materials preground and ready for installation. This may keep dust levels below OSHA maximums and eliminate the need for respiratory protection, restricted areas, regular monitoring, special clothing, change rooms and employee notification.

Removing Worn Friction Materials

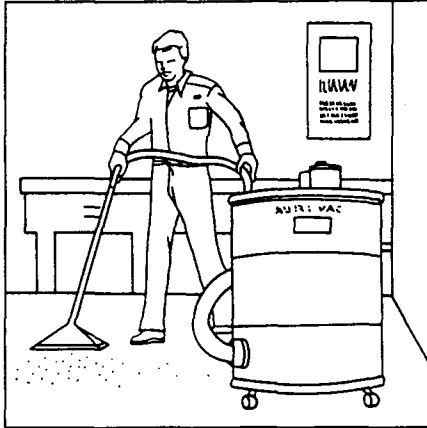
Asbestos fibers in disc brake linings, drum brake linings, blocks and dry clutch facings are locked into the product with resin binders which prevent the release of asbestos fiber during normal installation. Heat and abrasion during normal use may generate dust containing asbestos. Some dust will accumulate in brake and clutch assemblies.

When removing worn friction materials, remove the accumulated dust in the assemblies with an industrial vacuum cleaner equipped with a high efficiency system. If such equipment is not available, dust can be removed with a damp cloth. Do not use compressed air or dry brushing for cleaning. Use a NIOSH approved respirator when removing worn friction materials, or cleaning brake or clutch assemblies.

Machining Friction Materials

There is an increasing trend for manufacturers and rebuilders to provide brake lining and clutch facings pre-drilled and pre-ground in final assembly form. In the case of truck locks, various oversize thicknesses are available. However, there are some instances where field machining is necessary. This is particularly true for construction and industrial equipment applications which may require machining of blocks slab stock or roll lining.

Dust generation can be minimized or eliminated during arching of brake blocks by lathe turning at low speed rather than grinding. Whenever possible, friction materials should be cut to length with a shear rather than a saw or abrasive cut-off wheel.



Do Not Sweep in Work Area — Use the Vacuum Method

Dust Collection Methods

When asbestos-containing friction materials are machined, i.e., drilled, ground, grooved, cut or beveled, the dust created contains asbestos fibers which may become airborne unless adequate dust controls are employed. The preferred method for minimizing airborne dust from machining operations is local exhaust ventilation. A local exhaust ventilation system consists of dust collection hoods or enclosures connected by duct work or piping to a dust collection filter and a suction source.

The two operations that offer the greatest potential for generation of excessive amounts of airborne asbestos fiber are arch grinding and beveling of lined brake shoes and linings or brake blocks. Grinding machines used for these operations must be provided with

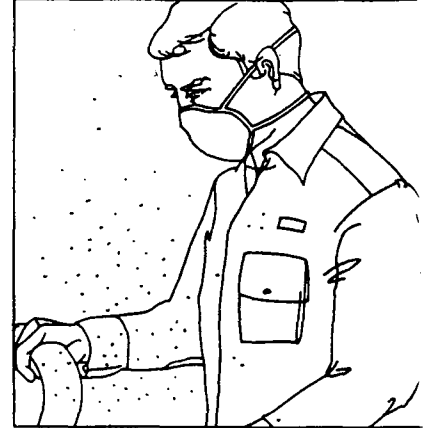
exhaust ventilation to maintain worker exposures within permissible levels. If a central exhaust system is not available, NIOSH (National Institute for Occupational Safety and Health) has stated that, at a minimum, the dust bag of the arching machine shall be removed and replaced with the hose from a high efficiency industrial vacuum.

For large volume machining operations that operate on a continuous basis, the preferred dust collection device is a fabric filter or baghouse, with a heavy-duty exhaust fan as the suction source. The dust collector must meet the air-cleaning requirements of the Federal Environmental Protection Agency Emission Standard for Asbestos. Approval must be obtained from EPA for installation and operation of each system.

Other Methods of Minimizing Dust Exposure

Whenever possible machining and repair operations should be isolated from other work areas in a restricted area to prevent unnecessary exposure of other workers. Entrances to restricted areas shall be posted with asbestos exposure warning signs as follows:

**Asbestos
Dust Hazard
Avoid Breathing Dust
Wear Assigned Protective Equipment
Do Not Remain In Area Unless
Your Work Requires It
Breathing Asbestos Dust
May Be Hazardous To Your Health**



Wear an Approved Respirator if Unable to Avoid Dust

Good housekeeping is essential in a workplace where asbestos containing materials are handled. Industrial vacuum cleaners equipped with multiple stage high efficiency filters should be used for removing accumulations of asbestos dust and waste. Never use compressed air or dry sweeping for cleaning. Water or other dust suppressants should be applied if brooms are used.

Good personal hygiene practices are important in minimizing asbestos dust exposure. Do not smoke. Wash before eating. Shower after work. Change to work clothes upon arrival at work and change from work clothes at conclusion of work. Work clothing should not be taken home. Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibres in excess of the exposure limits.

Disposal of Friction Material Dust and Waste

Dispose of vacuum cleaner waste and asbestos containing cleaning materials in plastic bags or other sealed containers, with the following warning label printed on the container:

Caution
Contains Asbestos Fibres
Avoid Creating Dust
Breathing Asbestos Dust May Cause
Serious Bodily Harm

Use a NIOSH approved respirator when servicing vacuum cleaners, dust collectors, or handling any asbestos-containing waste materials.

Asbestos-containing waste materials must be collected, processed, packaged, transported and deposited in such fashion that no visible emissions are generated to the atmosphere. All wastes must be disposed of at the sites operated in accordance with applicable laws and regulations.

Sources of Additional Information

"Standard for Exposure to Asbestos Dust"
(Code of Federal Regulations, Title 29, 1910.1001)—OSHA

"National Emissions Standards for Hazardous Air Pollutants—Asbestos and Mercury"
(Code of Federal Regulations Title 40, Chapter 1, Subchapter C, Part 61, Subparts A, B)—EPA

"Fundamentals Governing the Design and Operation of Local Exhaust Systems,"
ANSI Z9.2-1971 (\$7.00) and
"Practices for Respiratory Protection,"
ANSI Z88.2-1969 (\$5.50)—ANSI

"Industrial Ventilation Manual"
(\$8.00)—ACGIH

For other information, a user may contact the manufacturer supplying the friction materials, the Asbestos Information Association or the Friction Materials Standards Institute.

ACGIH
American Conference of
Governmental Industrial Hygienists
Committee on Industrial Ventilation
P.O. Box 16153
Lansing, MI 48901

ANSI
American National Standards
Institute
1430 Broadway
New York, NY 10018

AIA
Asbestos Information Association
1745 Jefferson Davis Highway
Arlington, VA 22202

EPA
Environmental Protection Agency
Public Information Center
401 M Street SW
Washington, DC 20460

FMSI
Friction Materials Standards Institute
East 210 Route 4
Paramus, NJ 07652

OSHA
Occupational Safety and Health
Administration
Office of Information
Washington, DC 20210

October 1978

Work Practices for Flooring Products

**Important Information for Installers of
Resilient Floor Coverings**

Introduction

The member companies of the Resilient Floor Covering Institute are manufacturers of the following forms of resilient floor coverings which may contain some asbestos:

- Sheet Vinyl
- Vinyl Asbestos Tile
- Asphalt Tile

Why Asbestos in Resilient Floor Coverings?

Asbestos fibers have been used in the manufacture of resilient floor covering products for more than 50 years. Asbestos fibers are used to provide durability to tile products. In addition, asbestos fibers in sheet vinyl backings permit these products to be installed on all grade levels. The presence of "locked-in" asbestos fibers in resilient floor coverings provides the versatility and economy for which they have been noted throughout the years.

What About Asbestos?

In the past decade much attention has been focused on the relationship between exposure to asbestos fibers and respiratory ailments. It has been determined that inhalation of free airborne asbestos fibers may be injurious to health. However, the asbestos fibers contained in the above types of resilient floor coverings are *Not Free*, but firmly *Locked-In* the product during the manufacturing process. Asbestos contained therein will not become airborne during the lifetime of the product when these products are used and maintained as recommended by the manufacturer*.

*See "Monitoring for Airborne Asbestos Fibers: Vinyl Asbestos Floor Tile" and "Monitoring for Airborne Asbestos Fibers: Sheet Vinyl Floor Covering", report prepared by SRI International, 1978-79. (Available on request from the Resilient Floor Covering Institute, 1030 15th Street, NW — Suite 350, Washington, DC, 20005.)

It is essential that certain precautions be observed, however, when installing resilient floor covering. It is the purpose of this Work Procedures Manual to provide those precautionary steps necessary to assure the safest way to accomplish the work involved.

Recommended Work Procedures

Preparation of Floors with Existing Resilient Floor Coverings to Receive New Resilient Floor Coverings

Follow the installation instructions published by the manufacturer of the new floor covering. These instructions will tell you what must be done to the existing surface before the new resilient floor covering can be installed.

Of the four general procedures listed below, Items 1 and 2 are covered by manufacturers' instructions; Items 3 and 4 are covered specifically in this Work Procedures Manual*:

Resilient Floor Covering Installed Over....

1. The Existing Surface. Follow the manufacturer's instructions for removing wax, filling in low spots, etc. *Use Wet Scrubbing. Never Sand an Existing Resilient Floor Covering.*
2. New Underlayment. Install panels on top of the existing surface (wood subfloors only) and apply new floor covering directly over this. Follow the manufacturer's instructions.
3. Partially Removed Existing Adhered Sheet Vinyl Floor Covering. See instructions below the heading "Partial Removal of existing Adhered Sheet Vinyl Floor Covering."
4. Completely Removed Existing Floor Covering

*In case of minor variations, the manufacturer's instructions should be followed.

Sheet Vinyl

See instructions below:

1. "Complete Removal of an Unadhered (Loose-Lay) or Peripherally Adhered Sheet Vinyl Floor Covering."
2. "Complete Removal of an Existing Adhered Sheet Vinyl Floor Covering."

Tile

See instructions under heading "Complete Removal of an Existing Resilient Tile Floor Covering."

Sheet Vinyl Floor Covering

Preparation of Floors with Existing Sheet Vinyl Floor Covering to Receive a New Resilient Floor Covering.

Sheet vinyl floor covering is installed in several ways:

- Unadhered or Loose-Lay.
- Adhered or Cemented.
- Peripherally adhered.

Some resilient floor covering can be installed over existing resilient floor covering under certain conditions. Be sure to follow the floor covering manufacturer's instructions, regarding the conditions and floor preparation required.

If partial or complete removal of the existing sheet vinyl floor covering is required, the following instructions are to be followed:

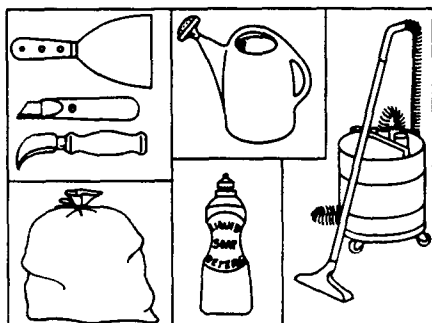


Illustration 1. Tools and supplies for sheet removal.

Supplies and Tools

(refer Illus. 1)

- Broad, stiff-bladed wall scraper, or floor scraper.
- Utility or hook knife.
- Tank type vacuum cleaner with disposable dust bag and metal floor tool (no brush).
- Large size heavy duty impermeable trash bags (or closed impermeable containers) with ties, tapes, or string to tie shut and tags for labeling.
- Hand sprayer or sprinkling can.
- Liquid dishwashing detergent or liquid wallpaper remover mixed with water to make a dilute solution (1 oz. liquid in one gallon of water).

Special Precautions



Illustration 2. Never dry sweep. If unavoidable, use water or other suppressants.

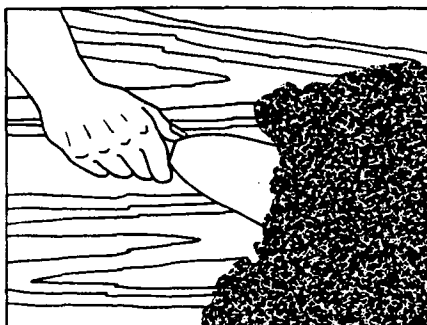


Illustration 3. Never dry scrape adhered areas of floor covering.

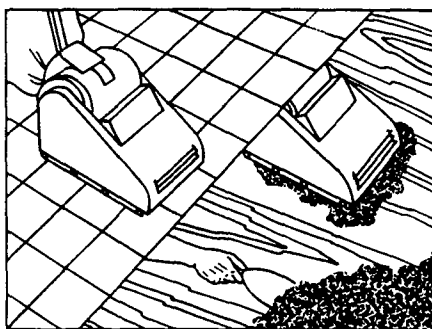


Illustration 4. Never sand an existing floor covering; nor sand or dry scrape residual felt.

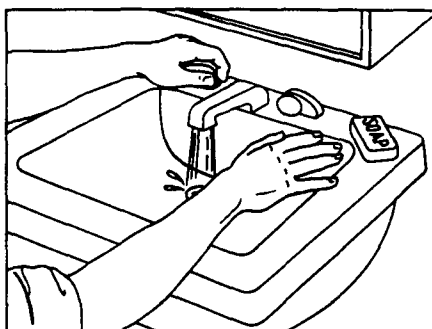


Illustration 5. Wash hands before eating and at the end of the work day.

Complete Removal of an Unadhered (Loose-Lay) or Peripherally Adhered Sheet Vinyl Floor Covering

1. Remove any binding strips or other restrictive moldings from doorways, walls, etc.

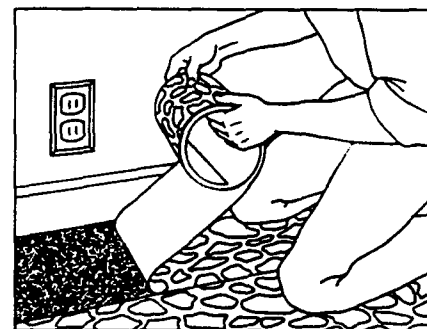


Illustration 6. When removing cut strips, roll face out into a tight roll.

2. Cut a strip the length of the floor and about 18" wide along one wall. Remove this strip, gently turn it over and roll face out into a tight roll (see Illus. 6). Tie or tape securely so it will not unroll. Place it in a heavy duty impermeable trash bag, or closed impermeable container big enough to accommodate several rolls, for disposition.

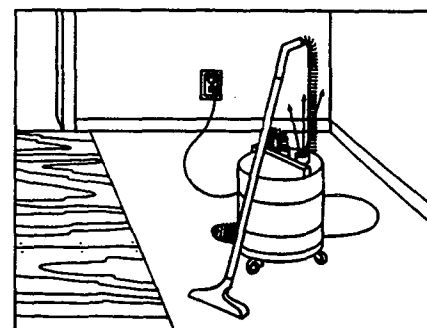


Illustration 7. Position vacuum so that exhaust air does not blow over unclean area.

3. Clean the exposed floor with a vacuum cleaner positioned so that exhaust air does not blow over the unclean area (see Illus. 7). **Do Not Dry Sweep. If Unavoidable Use Water or Other Dust Suppressants.**

4. Repeat the above, cutting, removing, rolling, disposing of one strip at a time and cleaning the newly exposed area immediately until the whole floor covering has been removed and the whole floor vacuumed clean.

5. If seams or door openings have been adhered with double faced tape, remove the tape and place in the heavy duty impermeable trash bag or closed impermeable container.

6. If any floor covering areas have been adhered with adhesive and remain stuck to the floor, they should be removed by the wet scraping method explained later. *Do Not Dry Scrape or Sand.*

7. Carefully remove the dust bag from the cleaner and place it in the trash bag.

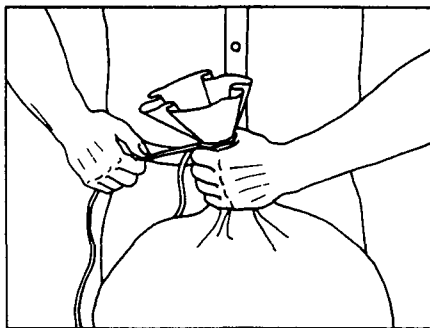


Illustration 8. Seal trash bags securely for disposal.

8. Close and seal the trash bags tightly for disposal (see Illus 8). Identify contents with a label stating — "Caution — Contains Asbestos — Dispose in an approved land fill only."

9. Install the new floor covering according to the manufacturer's instructions.

Partial Removal of Existing Adhered Sheet Vinyl Floor Covering

Most felt backed sheet floor coverings can be separated in the backing or felt layer. The felt left on the floor presents a smooth surface on which some new sheet floor coverings can be installed directly. Be sure to follow the manufacturer's instructions. Use the following procedure to partially remove the existing adhered floor covering.

Reminder: Never Sand an Existing Floor Covering

1. Remove any binding strips or other restrictive moldings from doorways, walls, etc.

2. Make a series of parallel cuts 4 to 8 inches apart through the top layers and about halfway through the backing, parallel to the wall.

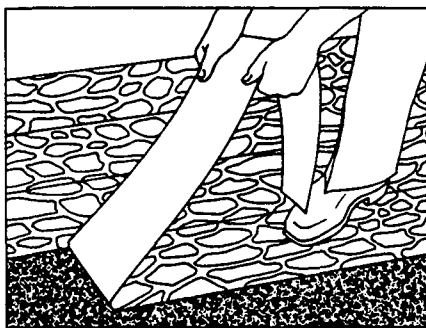


Illustration 9. Separating top layer from backing.

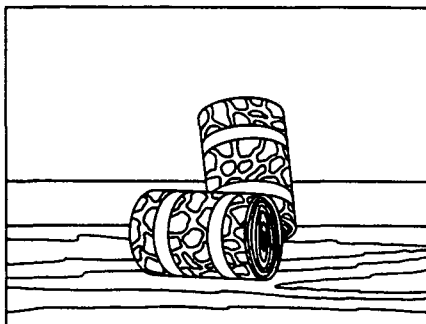


Illustration 10. Rolled up strips must be tied or taped securely.

3. Start at the end of the room farthest from the entrance door and pry up the corner of a strip, separating the back layer. Pull the top layer back upon itself slowly and evenly at the angle that permits the best separation, and half the backing and the top layers will pull free (see Illus. 9). After it is removed, roll up the strip face out into a tight roll. Tie or tape securely (see Illus. 10) and place in the heavy duty impermeable trash bag or closed impermeable container for disposal.

4. Each succeeding strip should be removed in the above manner. Avoid walking on the exposed felt as much as possible. Roll up each strip as it is removed and place it in the trash bag or closed container. Close full bags tightly and seal securely for disposal. Identify with a label stating "Caution — Contains Asbestos. Dispose in an approved land fill only".

5. Occasionally, parts of the top layers will stick to the backing. This can often be eliminated by peeling from the opposite direction. The stiff-bladed scraper will help in the stubborn areas.

6. Any high spots of felt on the floor can be levelled by wet scraping.

Reminder: Never Sand or Dry Scrape Residual Felt

Wet scraping is done as follows:

- Pour the detergent solution into the sprayer or sprinkling can.

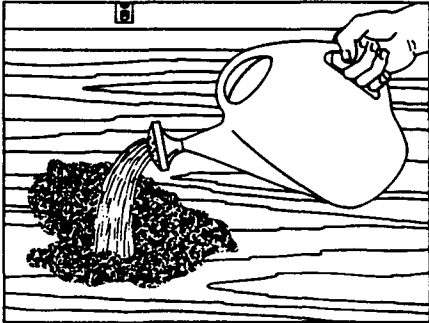


Illustration 11. Thoroughly wet dry felt before removal.

- Thoroughly wet the high felt spot with this solution. Wait a few minutes to allow the solution to soak into the felt (see Illus. below).

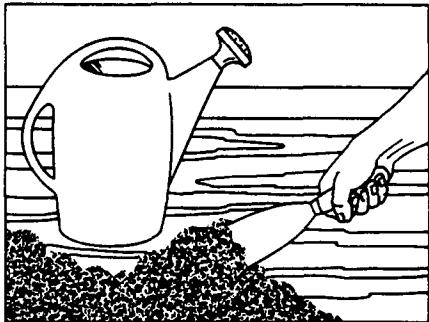


Illustration 12. After wetting felt, use stiff-bladed scraper to remove.

- Use the stiff-bladed scraper to remove the excess felt (see Illus. 12). If felt dries out, or dry felt is exposed during scraping, re-wet with more solution.
- Pick up the larger pieces by hand and place in the trash bag immediately.

7. Non-adhered felt left on the floor can be cut open and re-adhered to the floor with adhesive.

8. If small areas of backing pull free from the floor, the depression should be filled with latex patching compound, as recommended by the floor covering manufacturer.

9. Clean the floor with the vacuum cleaner using the metal floor tool. *Do Not Dry Sweep with a Broom.* Position the vacuum cleaner so that discharge air does not blow on the felt. Carefully remove the dust bag from the cleaner immediately and place in a heavy duty impermeable trash bag or closed impermeable container.

10. Close and seal trash bags tightly for disposal. Identify contents with a label: "Caution — Contains Asbestos." Dispose in an approved land fill only."

11. Do not walk over the felt unnecessarily, as this might scuff the felt and raise dust.

Install the new resilient floor covering immediately, following the manufacturer's instructions.

Complete Removal of an Existing Adhered Sheet Vinyl Floor Covering
If complete removal is required, follow these instructions:

1. Remove any binding strips or other restrictive moldings from doorways, walls, etc.
2. Make a series of parallel cuts 4 to 8 inches apart and almost through the backing, parallel to a wall.

3. Start at the end of the room farthest from the entrance door, and pry up the corner of the first strip, separating the backing layer. Pull the top layer back upon itself slowly and evenly at an angle that permits the best separation and most of the backing and top layers pull free (see Illus. 9). Remove this strip, gently turn it over and roll face out into a tight roll. Tie or tape securely (see Illus. 10) and place in a heavy duty impermeable trash bag or closed impermeable container for disposal.

4. Repeat the above on the next two strips but do not remove any more than a total of three strips at this time.

5. Remove the felt remaining on the floor in the stripped area by Wet Scraping.

Reminder: Never Sand or Dry Scrape Residual Felt

Wet scraping is done as follows:

- Pour the detergent solution into the sprayer or sprinkling can.
- Thoroughly wet the residual felt with this solution. Wait a few minutes to allow the solution to soak into the felt (see Illus. 11).

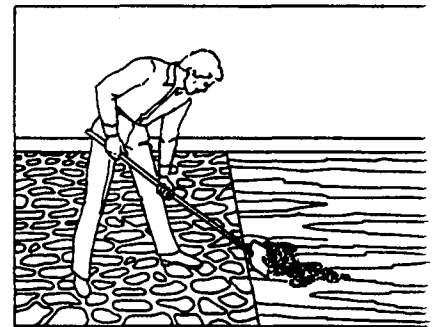


Illustration 13. Stand on the remaining floor covering, not the felt, during felt removal.

- Stand on the remaining floor covering (not the felt) and use the stiff-bladed scraper to scrape up the wet felt (see Illus. 13).

Reminder: Do Not Scrape Dry Felt

Rewet the felt if it dries out or if the dry felt is exposed during scraping. Pick up the scrapings as they are removed from the floor and place in a heavy duty impermeable trash bag or closed impermeable container. Scrape ALL felt from this floor area before proceeding further.

- Repeat the above on the next series of strips. Do only ONE three-strip area at a time. Stand on the remaining floor covering or clean floor (do not stand on the felt) to scrape up the felt.
- Repeat this operation until the felt has been removed from the whole floor. Close full bags tightly, and seal securely for disposal. Identify with a label stating "Caution — Contains Asbestos. Dispose in an approved land fill only."

6. When the whole floor has been cleaned free of felt, let it dry and vacuum up any dirt using the vacuum cleaner with the metal floor tool.

Reminder: Do Not Dry Sweep

Position the vacuum cleaner so that the discharge air does not blow on the floor being cleaned.

7. Carefully remove the dust bag from the cleaner and place in a heavy duty impermeable trash bag or closed impermeable container for later disposal.

8. When the floor is dry, it is ready to have a new resilient floor covering installed. Follow the floor covering manufacturer's instructions.

Resilient Tile Floor Covering

Preparation of Floors with Existing Resilient Tiles to Receive New Floor Covering.

Some resilient floor coverings can be installed over existing resilient tile installations. Follow the installation instructions published by the manufacturer of the new floor covering when a new resilient floor covering is to be installed on a surface presently covered with a resilient floor covering. These instructions will tell you what must be done to the existing surface before the new resilient floor covering.

Caution: Never Sand an Existing Tile Installation
(See Illus. 4).

Complete Removal of Existing Resilient Tile Floor Covering

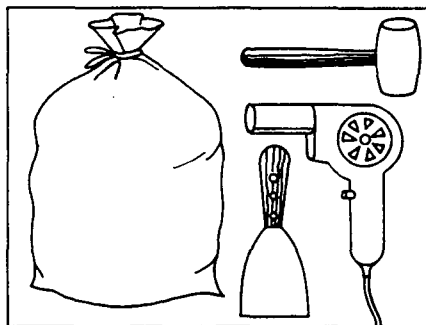


Illustration 14. Tools and supplies for tile removal.

Supplies and Tools (refer Illus. 14)

- Heavy duty wall scraper with approximately 4" (10.2 cm) blade and 6" to 8" (15.2 to 20.3 cm) handle.
- Hammer
- Commercial type hand held air blower.
- Heavy duty impermeable trash bags (or closed impermeable containers), ties and labels.

1. Those areas normally exposed to heavy foot traffic patterns usually have tiles adhered the tightest. As a matter of good practice in starting the tile removal, those sections which receive the least traffic should be the locations selected for starting the removal of the tile. Since tiles are normally in a 9" x 9" or 12" x 12" (22.7cm x 22.7cm or 30.5cm x 30.5cm) dimension, it should be the goal to remove individual tiles as a complete unit.

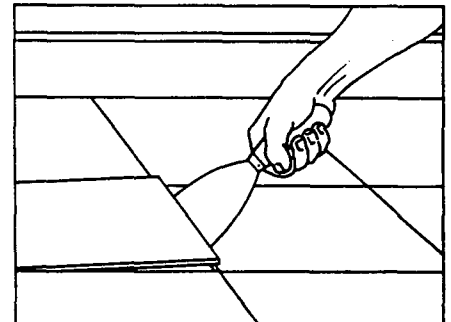


Illustration 15. Wedge the scraper in the seam of two adjoining tiles and gradually force tile upward.

2. Start the removal by carefully wedging the wall scraper in the seam of two adjoining tiles and gradually forcing the edge of one of the tiles up and away from the floor (see Illus. 15). Do not break off pieces of the tile but continue to force the balance of the tile up by working the scraper beneath the tile and exerting both a forward pressure and a twisting action on the blade to promote release of the tile from the adhesive and the floor.

3. When the first tile is removed, place it, without breaking it into smaller pieces, in the heavy duty impermeable trash bag or closed impermeable container which will be used for disposal.

4. With the removal of the first tile accessibility of other tiles is improved. Force the wall scraper under the exposed edge of another tile until the tile releases from the floor. Again, dispose of the tile, and succeeding tiles by placing in the heavy duty bag or closed container without additional breaking.

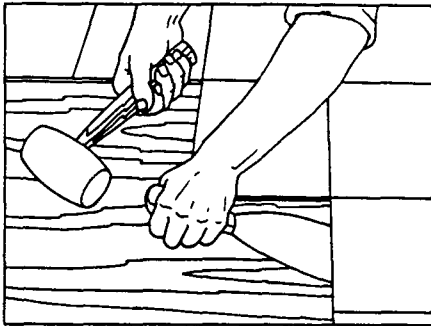


Illustration 16. Difficult tile removal can often be accomplished by striking the scraper handle with a hammer or mallet as shown.

5. Some tiles will release quite easily while others require varying degrees of force. Where the adhesive is spread heavily or is quite hard, it may prove easier to force the scraper through the tightly adhered areas by striking the scraper handle with a hammer using blows of moderate force while maintaining the scraper at a 25° to 30° angle to the floor (see Illus. 16).

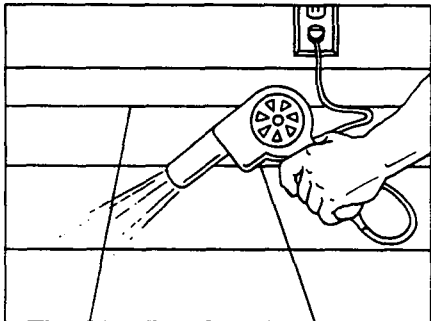


Illustration 17. In very difficult areas, using a hot air blower can simplify tile removal.

6. If some areas are encountered where even the technique detailed in the previous paragraph proves to be inadequate, the removal procedure can be simplified by thoroughly heating the tile(s) with a hot air blower until the heat penetrates through the tile and softens the adhesive. Note: Handle the hot air blower carefully to avoid personal burns (see Illus. 17 below).

7. As small areas of subfloor are cleared of tile the adhesive remaining on the floor must be scraped up with the 4" hand scraper until only a thin, smooth film remains. In those areas where deposits are heavy or difficult to scrape the removal can be expedited by heating with the hot air blower prior to scraping. Deposit scrapings in a heavy duty impermeable trash bag or closed impermeable container.

8. As indicated in previous paragraphs, tiles should be placed immediately in a heavy duty impermeable trash bag or closed impermeable container. Do not attempt to break the tiles after they are in the bag.

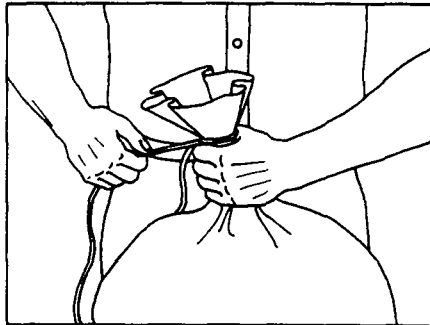


Illustration 18. Seal trash bags securely for disposal.

9. When all the tiles have been removed from the floor and placed in heavy duty bags or closed containers, seal the bags securely for disposal (see Sketch 8) and mark: "Caution — Contains Asbestos — Dispose in an approved land fill only."

Warning

Do Not Sand Existing Resilient Flooring Backing, or Lining Felt. These Products May Contain Asbestos Fibers That are Not Readily Identifiable. Sanding of Asbestos Containing Material Can Place Fine Particles of Asbestos in the Air. These Asbestos Particles if Inhaled May Cause Serious Bodily Harm.

Manufacturer Members

Amtico Flooring Division
American Biltrite, Inc.
Lawrenceville, NJ 08648

Azrock Floor Products Division
Uvalde Rock Asphalt Company
San Antonio, TX 78233

Congoieum Corporation
Resilient Flooring Division
Kearny, NJ 07032

Flintkote Company, The
Flooring Division
Dallas, TX 75221

Kentile Floors, Inc.
Brooklyn, NY 11215

Mannington Mills, Inc.
Salem, NJ 08079

National Floor Products Co., Inc.
Florence, AL 35630

Specific In-Plant Handling Description

Handling Description

(

Introduction

The Occupational Safety and Health Act in the United States and similar laws in Canada and other countries were enacted to ensure every worker, as far as possible, a safe and healthy work place. This legislation is far-reaching. It covers millions of employees and nearly every employer.

To assist in assuring compliance with these laws, the asbestos-cement industry is disseminating information regarding the hazards of exposure to airborne asbestos. One means of reducing hazards of exposure is to reduce the exposure through good work practices.

Good work practices is what this book is all about. The recommendations that appear on the following pages were developed through study and field testing. They are designed to achieve safer and more healthful job site conditions when working with asbestos-cement (A/C) sheet products. Since field conditions will vary, adherence to these work practices will not necessarily guarantee compliance with national, state or local regulations. Questions relating to compliance should be directed to appropriate regulatory agencies.

The Asbestos Information Association/ North America believes this booklet will help engineers, superintendents, contractors, foremen and crews to understand procedures for the safer handling and fabrication of A/C sheet products. This booklet supersedes AIA/NA recommended work practices for field fabrication of asbestos sheet products previously distributed in 1975.

January 25, 1980

Asbestos and Health

Airborne asbestos fiber has been identified as a possible health hazard. Inhalation of these fibers in excessive quantities may cause pulmonary disease. But like the automobile, electricity and x-rays, there are non-harmful ways to use potentially harmful things.

Asbestos-cement (A/C) sheet products contain 15% to 40% asbestos. The asbestos fibers are not free, but "locked-in" the cement binder, like reinforcing rods in concrete. The distinction between "free" and "bound" asbestos is extremely important. First of all, it determines the probability of fiber release, which in turn, directly relates to the probability of risk. More importantly, it explains clearly and simply why A/C sheet is a proper use of asbestos.

The present state of scientific learning on asbestos shows that minimizing exposure to airborne asbestos dust reduces the hazards of asbestos-related disease. During the use and handling of A/C sheet, the only time that fibers may be released in significant quantities from a health standpoint, is during fabrication operations when sufficient mechanical energy is applied to the product to literally "tear" the fibers from the cement binder. One means of reducing airborne fiber generation is through good work practices.

Summary of OSHA Asbestos Standard

Under the current OSHA standard for occupational exposures to asbestos, it is the employer's responsibility to assure that exposure of employees to airborne concentrations of asbestos fibers does not exceed the following "permissible exposure levels":

- Eight-hour time-weighted average: Two fibers, longer than 5 micrometers, per cubic centimeter.
- Ceiling concentrations: Ten fibers, longer than 5 micrometers, per cubic centimeter.

In October, 1975, OSHA proposed a revision to the current standard which would reduce the eight-hour time-weighted average exposure to 0.5 fibers per cubic centimeter of air and ceiling concentrations to 5.0 fibers per cubic centimeter. OSHA specifically excluded the construction industry from coverage within that proposal. In their notice, OSHA stated that a separate standard would be proposed to cover workers who handle asbestos-containing products in the construction industry.

The Work Practices Recommended in This Booklet are Based on Data for "Peak Dust Concentrations" Representing Short Time Periods of Maximum Exposure. Field Fabricating Operations Involving the Cutting of A/C Sheet are Normally Infrequent and of Short Duration. Using These Recommended Work Practices, Which Will Maintain Fiber Levels Below OSHA Allowable Ceiling Concentrations, it is Improbable that Field Personnel Would be Exposed in a Typical Working Day to Levels Exceeding the Current OSHA Eight-Hour Time-Weighted Average Permissible Exposure Limit.

For full text of OSHA standard for occupational exposure to asbestos dust (29 CFR 1910.1001) refer to Appendix B.

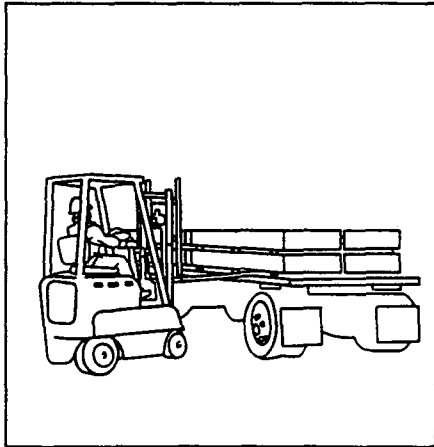
Products and Operations

The following work practices are applicable to flat and corrugated A/C sheet products:

Operations to which these work practices apply include:

- Shipping, Receiving and Handling
- Cutting
- Drilling
- Hole Cutting and Cutouts
- Housekeeping and Waste Disposal

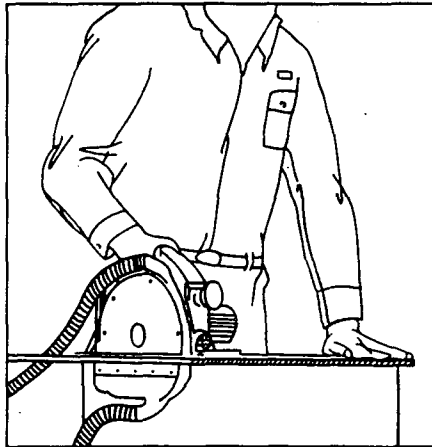
Equipment used with these work practices is available from the sources shown in the equipment list.



Shipping, Receiving and Handling

A/C sheet is shipped from the factory with clean surfaces, generally in pallet loads, using shipping methods acceptable to the producer and the customer.

All unloading operations should be carefully performed to avoid sheet damage. Pallet loads are normally unloaded by fork truck. Small shipments may require manual unloading.

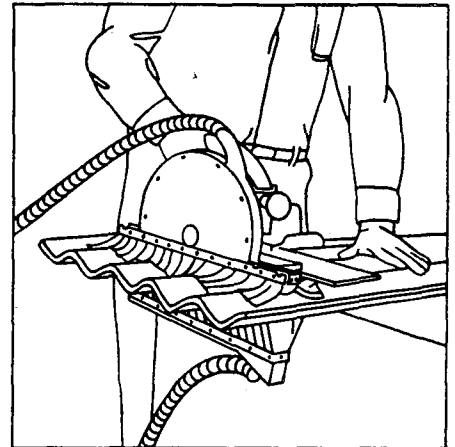


Cutting Flat Sheets with a Circular Saw

Circular saws for cutting flat sheets should be used *Only* when equipped with the specific dust collection hoods pictured above. Exhaust ventilation and dust collection is provided by a vacuum cleaner as described in the specifications.

A circular saw cuts by a "pulverizing" action which releases asbestos fibers and fine particulate. The combination of hood and vacuum source is highly effective in capturing and collecting these particles and fibers. Saw operating techniques are those normally employed. No special procedures are required except adjustment of the lower hood section to suit thickness of sheet being cut. Saw design requires the use of blades recommended by the tool supplier (abrasive disc or diamond).

For additional information on saw operation, refer to the supplier's instructions in Appendix A.



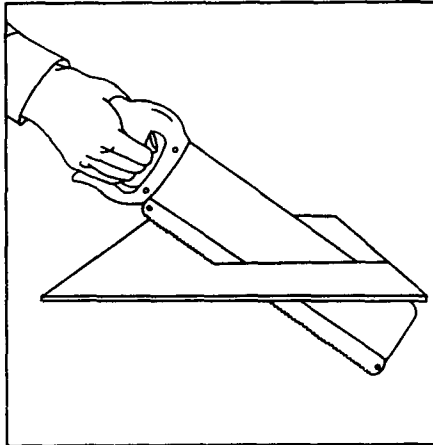
Cutting Corrugated Sheets with a Circular Saw

Circular saws for cutting corrugated sheets should be used *Only* when equipped with the specific dust collection hood pictured above. Exhaust ventilation and dust collection is provided by a vacuum cleaner as described in the specifications.

A circular saw cuts by a "pulverizing" action which releases asbestos fibers and fine particulate. The combination of hood and vacuum source is highly effective in capturing and collecting these particles and fibers. Saw operating techniques are those normally used. Saw design requires the use of blades recommended by the tool supplier (abrasive disc or diamond). This tool depends on pliable "fingers" to seal the cutting zone and is designed for use on sheets with 1½" (3-8 cm) deep corrugations.

For cutting sheets with deeper or irregular corrugations, consult the tool supplier.

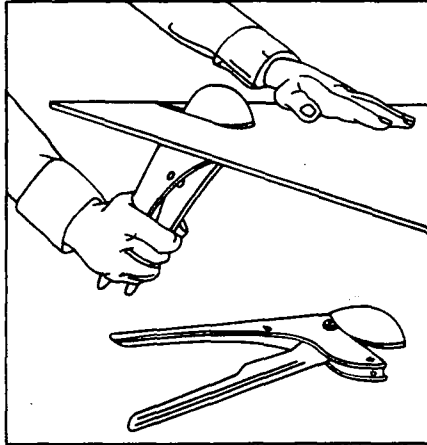
For additional information on saw operation, refer to the supplier's instructions in Appendix A.



Cutting with a Handsaw

This is a handsaw equipped with a carbide blade designed for cutting asbestos-cement sheet. Practical use of this saw is limited by its slow cutting speed. It is most useful in operations where cutting is infrequent and of short duration.

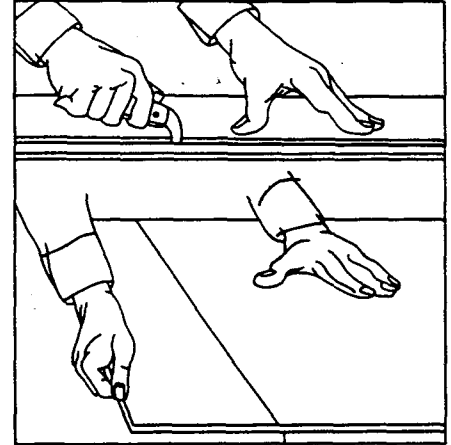
Because of the slow cutting speed, saw operation generates coarse particles of asbestos-cement with few airborne fibers. Its use does not require dust collection equipment for compliance with present exposure limits.



**Cutting Flat Sheets with Hand
Clippers**

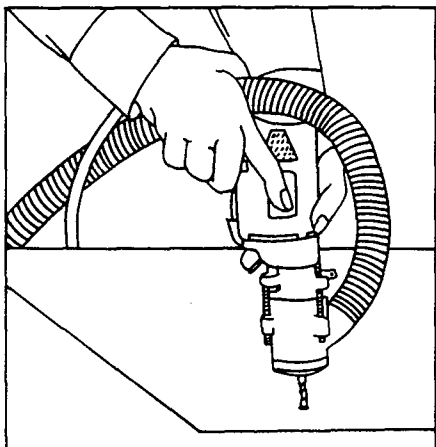
These hand clippers are designed for cutting sheet material up to 1/4" (.64 cm) in thickness. Practical use is limited by slow cutting speed. It is most useful in operations where cutting is infrequent and of short duration.

The clipper cutting action generates coarse particles of asbestos-cement with few airborne fibers. Its use does not require dust collection equipment for compliance with present exposure limits.



**Cutting Flat Sheets with a Score and
Snap Knife**

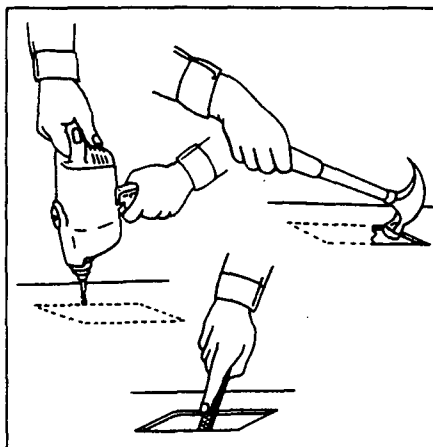
The scoring knife can be used with sheets up to 1/4" (.64 cm) in thickness. However, it performs best with sheets 1/8" and 3/16" (.32 cm and .48 cm) thick. The sheet is placed on a worktable or sawhorses. A suitable guide bar is placed or clamped along the cut line and the sheet scored repeatedly. After scoring, the sheet is hand snapped along the score line. This cutting procedure generates little dust and few airborne fibers. Its use does not require dust collection equipment for compliance with present exposure.



Drilling with a Power Drill

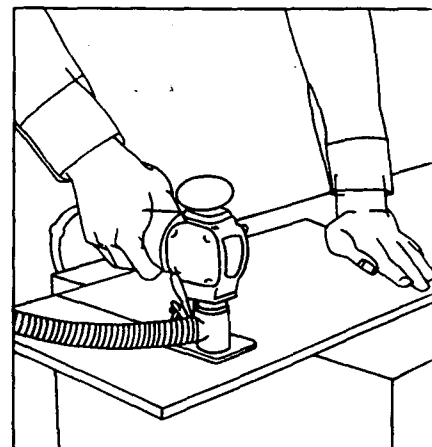
Drilling of small holes $\frac{1}{4}$ " (.64 cm) or less on vertical surfaces, or downward usually can be done without dust collection equipment and in compliance with present exposure limits.

Drilling of larger holes, and drilling overhead, requires dust collection equipment on the drill in order to achieve compliance. Equipment includes a hood (Cape Universal Building Products, Ltd.) and vacuum cleaner to provide exhaust ventilation and dust collection. Vacuum cleaner should be as described in specifications. Drilling techniques are those normally employed. No special procedures needed.



Hole Cutting and Cutouts for Flat Sheets with a Drill and Rasp

A simple method of making cutouts is to drill small holes around the edge of the opening to be cut and knocking out the material to be removed with a hammer. A rasp is used to dress or bevel edges of the cut. This procedure does not require dust collection equipment for compliance with the present exposure limits.



Hole Cutting and Cutouts for Flat Sheets with a Sabre Saw

Sabre saws should be used *Only* when equipped with the specific dust collection hood pictured above. Exhaust ventilation and dust collection is provided by a vacuum cleaner as described in the specifications.

Saw operating techniques are those normally employed. No special procedures are required.

For additional information on saw operation, refer to supplier's instruction: in Appendix A.

Housekeeping and Waste Disposal

Housekeeping is an essential part of any safe construction operation. It is even more essential when airborne dust created by the *Lack* of good housekeeping has the potential for harm to employees and others.

Equipment: All external surfaces of equipment should be maintained free of dust accumulations that might, if dispersed, create asbestos fibre concentrations above permissible exposure limits.

Waste Disposal: Asbestos-cement dust chips and cuttings from the field operations described in this booklet must be collected in a manner that will not contribute airborne asbestos dust to the atmosphere. *Loose Material Should Never Be Dry Swept.* When vacuum equipment is available, it should be used. Water or other dust suppressants should be applied in those circumstances where sweeping is unavoidable. *Do Not Blow Waste Material with Compressed Air.*

No visible emissions to the atmosphere are permitted from the collection, processing, packaging, transporting or deposition of any asbestos-containing material. Wastes must be collected and disposed in accordance with the requirements of the U.S. Environmental Protection Agency. For full text of EPA waste disposal requirements (40 CFR, Chapter 1, Part 61) refer to Appendix C.

Vacuum Cleaner Specifications

(Values shown below are minimum recommended)

Circular Saw — Flat and Corrugated Sheet Cutting

Vacuum (lift)	59" (149.9 cm) W. G. (water gauge)
Airflow	175 SCFM (standard cubic feet per minute) (5.0 m ³ /min.)
Filtration System	Multi-stage, designed for use with asbestos-containing dusts.
Dust Collection	Unit must be provided with, or capable of using a disposable plastic or paper bag for collecting and removing dust.

Sabre Saw Drill

Vacuum (lift)	59" (149.9 cm) W. G.
Airflow	65 SCFM (1.8 m ³ /min.)
Filtration System	Multi-stage, designed for use with asbestos-containing dusts.
Dust Collection	Unit must be provided with, or capable of using a disposable plastic or paper bag for collecting and removing dust.

Equipment Suppliers

Tools shown in this pamphlet are available from:

Wheeler-Pilot International

P.O. Box 3128
20433 Earl Street
Torrance, CA 90510
(213) 371-1238

Nilfisk of America, Inc.

224 Great Valley Parkway
Malvern, PA 19335
215-647-6420

Suppliers claiming to have vacuum cleaning units suitable for use with asbestos-containing dusts are:

American Cleaning Equipment Corp.

111 South Route 53
Addison, IL 60101

Beamco, Inc.

707 Stierlin Road
Mountain View, CA 94040

Breauer Electric Manufacturing Co.

5100 No. Ravenswood Ave.
Chicago, IL 60640

Hild Floor Machine Co., Inc.

5339 West Lake St.
Chicago, IL 60644

Karl-Vac Inc.

4360 W. 127th St.
Alsip, IL 60658

Nilfisk of America, Inc.

224 Great Valley Parkway
Malvern, PA 19355

Pullman/Holt Products

10702 46th Street
Tampa, FL 33617

Vac-U-Max

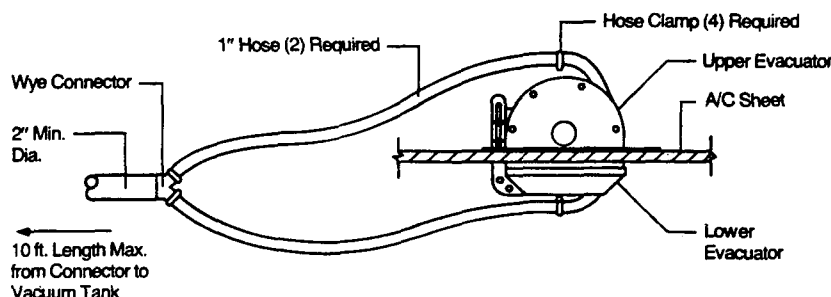
227 Main St.
Belleville, NJ 07109

Wheeler-Pilot International

20433 Earl Street
Torrance, CA 90510

Note:

It is recognized that equipment suppliers other than those listed above may be available. Mention of any company is not to be considered an endorsement by AIA/NA.



Wheeler-Pilot Flat Sheet Circular Saw — Model 888

Operating Instructions

1. The WPI Model 888 uses the Black & Decker Model 3037 Circular Saw. Black & Decker operating instructions for Model 3037 must be read and understood prior to operation.

2. Only vacuum cleaners certified by the manufacturer for use with asbestos dust and having the capability of 175 CFM (5.0 m³/min.) minimum are to be used with this tool. A vacuum hose of not less than 2 inches (5.1 cm) in diameter and not more than 10 feet (3.0 m) long is to be used between the Wye Connector and vacuum tank. The vacuum manufacturer's operating instructions must be read and understood before operation.

3. Inspect all system elements for cracks, punctures or openings, i.e. hood, vacuum hose and connectors. Repair or replace any faulty item or part.

4. Connect the vacuum hoses as shown, insuring all connections and clamps are tight.

5. Turn on vacuum and check for any stoppages or air leaks in the vacuum line or hood and insure adequate air flow in the open area of the saw.

6. If any leaks or stoppages are located, change or repair faulty item.

7. Adjust lower evacuator so that the rubber skirt contacts the underside of the sheet to be cut.

8. Connect circular saw to electrical outlet and feed into work. There should be virtually no visible dust or debris. If excess dust is visible, (a) check vacuum cleaner bag for overload per manufacturer's instructions, (b) check lines for air leaks and (c) check proper adjustment of lower evacuator.

9. Avoid using excessive force feeding saw into work. If great force is required stop and check tool for proper operation.

Blade Replacement

(In addition to Black & Decker operating instructions)

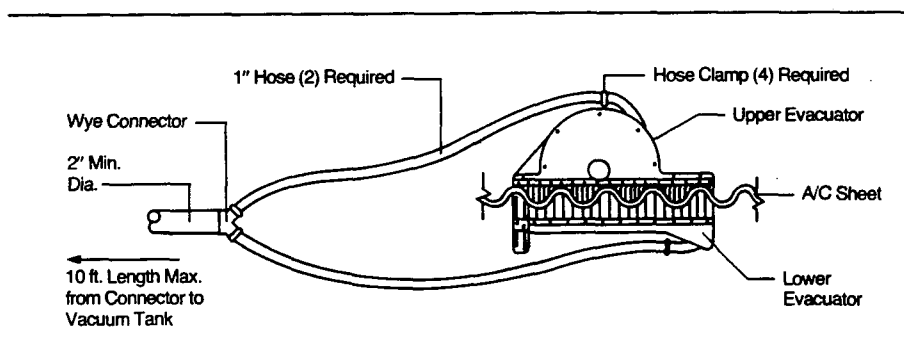
1. Disconnect unit from electrical outlet

2. Lower or remove lower evacuating hood.

3. Remove (4) screws and cover to expose blade.

4. Grasp the exposed lower portion of the blade and remove hub screw with wrench.

5. Blade can be removed or replaced (caution: silicon carbide blades must be mounted with appropriate side out, the blades are marked accordingly.)



**Wheeler-Pilot Corrugated Sheet
Circular Saw — Model 898**

Operating Instructions

1. The WPI Model 898 uses the Black & Decker Model 3037 Circular Saw. Black & Decker operating instructions for Model 3037 must be read and understood prior to operation.

2. Only vacuum cleaners certified by the manufacturer for use with asbestos dust and having the capability of 175 CFM (5.0 m³/min.) minimum are to be used with this tool. A vacuum hose of not less than 2 inches (5.1 cm) in diameter and not more than 10 feet (3.0 m) long is to be used between the Wye Connector and vacuum tank. The vacuum manufacturer's operating instructions must be read and understood before operation.

3. Inspect all system elements for cracks, punctures or openings, i.e., hood, vacuum hose and connectors. Repair or replace any faulty item.

4. Connect the vacuum hoses as shown, insuring all connections and clamps are tight.

5. Turn on vacuum and check for any stoppages or air leaks in the vacuum line or hood and insure adequate air flow in the open area of the saw.

6. If any leaks or stoppages are located, change or repair faulty item.

7. Adjust lower evacuator so that the runners on the inside of the skirt fingers are approximately 1/4 inch (.64 cm) from the bottom of the sheet.

8. Connect circular saw to electrical outlet and feed into work. There should be virtually no visible dust or debris. If excess dust is visible, (a) check vacuum cleaner bag for overload per manufacturer's instructions, (b) check lines for air leaks and (c) check proper adjustment of lower evacuator.

9. Avoid using excessive force feeding saw into work. If great force is required, stop and check tool for proper operation.

Blade Replacement

(In addition to Black & Decker operating instructions)

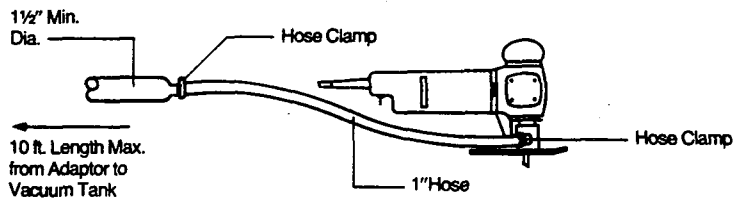
1. Disconnect unit from electrical outlet.

2. Lower or remove lower evacuating hood.

3. Remove (8) screws and cover to expose blade.

4. Grasp the exposed lower portion of the blade and remove hub screw with wrench.

5. Blade can be removed or replaced (caution: silicon carbide blades must be mounted with appropriate side out, the blades are marked accordingly).



Wheeler-Pilot Sabre Saw — Model 878

Operating Instructions

1. The WPI Model 878 uses the Black & Decker Model 3155 Saber (JIG) Saw. Black & Decker operating instructions for Model 3155 must be read and understood prior to operating this unit.

2. Only vacuum cleaners certified by the manufacturers for use with asbestos dust and having a capability of 65 CFM (1.8 m³/min.) minimum are to be used with this tool. A vacuum hose of not less than 1½ inches (3.8 cm) in diameter and not more than 10 feet (3.0 m) long is to be used. The vacuum manufacturer's operating instructions must be read and understood before operation.

3. Inspect all system elements for cracks, punctures or openings, i.e., hood, vacuum hose and connectors. Repair or replace any faulty item.

4. Assemble vacuum hose as shown above, insuring all connections and clamps are tight.

5. Turn on vacuum and check for any stoppages or air leaks in the vacuum line or hood and insure adequate air flow in the open area of the saw.

6. If any leaks or stoppages are located, change or repair faulty item.

7. Connect saber saw to electrical outlet and feed into work. There should be no visible dust or debris. If excess dust is visible, (a) check vacuum cleaner bag for over-load per manufacturer's instructions, (b) check lines for air leaks.

To Install or Remove Blade (In addition to Black & Decker operating instructions)

1. Disconnect unit from electrical outlet.
2. Remove the two screws which retain the shield.
3. Pull shield straight down (shield fits firmly in position. A soft tap may be necessary.)
4. Remove blade (see Black & Decker operating instructions).
5. Reassemble.

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Appendix B

OSHA Standard for Occupational Exposure to Asbestos

Note: *Federal Register*, Vol. 40 No. 103, May 28, 1975, announced that the OSHA standard for exposure to asbestos dust was recodified from 1910.1001. This change simplifies the reference system for toxic substance standards in subpart Z, Part 1910, Occupational Safety and Health Standards.

1910.93a Asbestos.

(a) Definitions. For the purpose of this section, (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite and actinolite.

(2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.

(b) Permissible exposure to airborne concentrations of asbestos fibers—
(1) Standard effective July 7, 1972. The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(2) Standard effective July 1, 1976. The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

(3) Ceiling concentration. No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers, per cubic centimeter of air as determined by the method described in paragraph (e) of this section.

(c) Methods of compliance - (1) Engineering methods. (i) engineering controls. Engineering controls, such as, but not limited to, isolation, enclosure, exhaust ventilation, and dust collection, shall be used to meet the exposure limits prescribed in paragraph (b) of this section.

(ii) Local exhaust ventilation. (a) Local exhaust ventilation and dust collection systems, shall be designed, constructed, installed, and maintained in accordance with the American National Standard Fundamental Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971, which is incorporated by reference herein.

(b) See 1910.6 concerning the availability of ANSI Z9.2-1971, and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in 1910.100.

(iii) Particular tools. All hand-operated and power-operated tools which may produce or release asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section such as, but not limited to, saws, scorers, abrasive wheels, and drills, shall be provided with local exhaust ventilation systems in accordance with subdivision (ii) of this subparagraph.

(2) Work practices — Wet methods. Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers in excess of the exposure limits prescribed in paragraph (b) of this section, unless the usefulness of the product would be diminished thereby.

(ii) Particular products and operations. No asbestos, cement, mortar, coating, grout, plaster, or similar material containing asbestos shall be removed from bags, cartons, or other containers in which they are shipped, without being either wetted, or enclosed, or ventilated, so as to effectively prevent the release of airborne asbestos fibers in the excess of the limits prescribed in paragraph (b) of this section.

(iii) Spraying, demolition, or removal. Employees engaged in the spraying of asbestos, the removal, or demolition of pipes, structures, or equipment covered or insulated with asbestos, and in the removal or demolition of asbestos insulation or coverings shall be provided with respiratory equipment in accordance with paragraph (d) (2) (iii) of this section and with special clothing in accordance with paragraph (d) (3) of this section.

(d) Personal protective equipment —

(1) Compliance with the exposure limits prescribed by paragraph (b) of this section may not be achieved by the use of respirators or shift rotation of employees, except:

(i) During the time period necessary to install the engineering controls and to institute the work practices required by paragraph (b) of this section;

(ii) In work situations in which the methods prescribed in paragraph (c) of this section are either technically not feasible or feasible to an extent insufficient to reduce the airborne concentrations of asbestos fibers below the limits prescribed by paragraph (b) of this section; or

(iii) In emergencies.

(iv) Where both respirators and personnel rotation are allowed by subdivisions (i), (ii), or (iii) of this subparagraph, and both are practicable, personnel rotation shall be preferred and used.

(2) Where a respirator is permitted by subparagraph (1) of this paragraph, it shall be selected from among those approved by the Bureau of Mines, Department of the Interior, or the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare, under the provisions of 30 CFR Part 11 (37 F.R. 6244, Mar. 25, 1972), and shall be used in accordance with subdivisions (i), (ii), (iii) and (iv) of this subparagraph.

(i) Air purifying respirators. A reusable or single use air purifying respirator, or a respirator described in subdivision (ii) or (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average airborne concentrations of asbestos fibers are reasonably expected to exceed no more than 10 times those limits.

(ii) Powered air purifying respirators. A full facepiece powered air purifying respirator, or a powered air purifying respirator, or a respirator described in subdivision (iii) of this subparagraph, shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 10 times, but not 100 times, those limits.

(iii) Type "C" supplied-air respirators, continuous flow or pressure-demand class. A type "C" continuous flow or pressure-demand, supplied-air respirator shall be used to reduce the concentrations of airborne asbestos fibers in the respirator below the exposure limits prescribed in paragraph (b) of this section, when the ceiling or the 8-hour time-weighted average concentrations of asbestos fibers are reasonably expected to exceed 100 times those limits.

(iv) Establishment of a respirator program. (a) The employer shall establish a respirator program in accordance with the requirements of the American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969, which is incorporated by reference herein.

(b) See 1910.6 concerning the availability of ANSI Z88.2-1969 and the maintenance of an historic file in connection therewith. The address of the American National Standards Institute is given in 1910.100.

(c) No employee shall be assigned to tasks requiring the use of respirators if, based upon his most recent examination, an examining physician determines that the employee will be unable to function normally wearing a respirator, or that the safety or health of the employee or other employees will be impaired by his use of the respirator. Such employee shall be rotated to another job or given the opportunity to transfer to another position whose duties he is able to perform with the same employer, in the same geographical area and with the same seniority, status, and rate of pay he had just prior to such transfer, if such a different position is available.

(3) Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos fibers, which exceed the ceiling level prescribed in paragraph (b) of this section.

(4) Change rooms: (i) At any fixed place of employment exposed to airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this

section, the employer shall provide change rooms for employees working regularly at the place.

(ii) Clothes lockers: The employer shall provide two separate lockers or containers for each employee, so separated or isolated as to prevent contamination of the employee's street clothes from his work clothes.

(iii) Laundering: (a) Laundering of asbestos contaminated clothing shall be done so as to prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(b) Any employer who gives asbestos-contaminated clothing to another person for laundering shall inform such person of the requirement in (a) of this subdivision to effectively prevent the release of airborne asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section.

(c) Contaminated clothing shall be transported in sealed impermeable bags, or other closed, impermeable containers, and labeled in accordance with paragraph (g) of this section.

(e) Method of measurement. All determinations of airborne concentrations of asbestos fibers shall be made by the membrane filter method at 400-450 X (magnification) (4 millimeter objective) with phase contrast illumination.

(f) Monitoring — (1) Initial determinations. Within 6 months of the publication of this section, every employer shall cause every place of employment where asbestos fibers are released to be monitored in such a way as to determine whether every employee's exposure to asbestos fibers is below the limits prescribed in paragraph (b) of this section. If the limits are exceeded, the employer shall immediately undertake a compliance program in accordance with paragraph (c) of this section.

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(2) Personal monitoring — (i) Samples shall be collected from within the breathing zone of the employees, on membrane filters of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of employees. In no case shall the sampling be done at intervals greater than 6 months for employees whose exposure to asbestos may reasonably be foreseen to exceed the limits prescribed by paragraph (b) of this section.

(3) Environmental monitoring — (i) Samples shall be collected from areas of a work environment which are representative of the airborne concentrations of asbestos fibers which might reach the breathing zone of employees. Samples shall be collected on a membrane filter of 0.8 micrometer porosity mounted in an open-face filter holder. Samples shall be taken for the determination of the 8-hour time-weighted average airborne concentrations and of the ceiling concentrations of asbestos fibers.

(ii) Sampling frequency and patterns. After the initial determinations required by subparagraph (1) of this paragraph, samples shall be of such frequency and pattern as to represent with reasonable accuracy the levels of exposure of the employees. In no case shall sampling be at intervals greater than 6 months for employees whose exposures to asbestos may reasonably be foreseen to exceed the exposure limits prescribed in paragraph (b) of this section.

(4) Employee observation of monitoring. Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this paragraph and shall have access to the records thereof.

(g) Caution signs and labels. (1) Caution signs (i) Posting. Caution signs shall be provided and displayed at each location where airborne concentrations of asbestos fibers may be in excess of the exposure limits prescribed in paragraph (b) of this section. Signs shall be posted at such a distance from such a location so that an employee can read the signs and take necessary protective steps before entering the area marked by the signs. Signs shall be posted at all approaches to areas containing excessive concentrations of airborne asbestos fibers.

(ii) Sign specifications. The warning signs required by subdivision (i) of this subparagraph shall conform to the requirements of 20" X 14" (50.8 cm X 35.6 cm) vertical format signs specified in 1910:145 (d) (4), and to this subdivision. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to that specified in this section.

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Legend	Notation
Asbestos	1" (2.5 cm) Sans Serif, Gothic or Block.
Dust Hazard	¾" (1.9 cm) Sans Serif, Gothic or Block.
Avoid Breathing Dust	¼" (.64 cm) Gothic.
Wear assigned Protective Equipment	¼" (.64 cm) Gothic.
Do Not Remain In Area Unless Your Work Requires It	¼" (.64 cm) Gothic.
Breathing Asbestos Dust May be Hazardous To Your Health.	14 Point Gothic

Spacing between lines shall be at least equal to the height of the upper of any two lines.

(2) Caution labels — (i) Labeling. Caution labels shall be affixed to all materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.

(ii) Label specifications. The caution labels required by subdivision (i) of this subparagraph shall be printed in letters of sufficient size and contrast as to be readily visible and legible. The label shall state:

CAUTION
Contains Asbestos Fibers
Avoid Creating Dust
Breathing Asbestos Dust May
Cause Serious Bodily Harm

(h) Housekeeping — (1) Cleaning. All external surfaces in any place of employment shall be maintained free of accumulations of asbestos fibers if, with their dispersion, there would be an excessive concentration.

(2) Waste disposal. Asbestos waste, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing, consigned for disposal, which may produce in any reasonably foreseeable use, handling, storage, processing, disposal, or transportation airborne concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section shall be collected and disposed of in sealed impermeable bags, or other, closed impermeable containers.

(i) Recordkeeping — (1) Exposure records. Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least three years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives for either.

(2) Employee Access. Every employee and former employee shall have reasonable access to any record required to be maintained by subparagraph (1) of this paragraph, which indicates the employee's own exposure to asbestos fibers.

(3) Employee notification. Any employee found to be exposed at any time to airborne concentrations of asbestos fibers in excess of the limits prescribed in paragraph (b) of this section shall be notified in writing of the exposure as soon as practicable but not later than 5 days of the finding. The employee shall also be timely notified of the corrective action being taken.

(j) Medical examinations. (1) General. The employer shall provide or make available at his cost, medical examinations relative to exposure to asbestos required by this paragraph.

(2) Preplacement. The employer shall provide or make available to each of his employees, within 30 calendar days following his first employment in an occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination, which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches, 35.6 x 43.2 cm), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

3. Annual examinations. On or before January 31, 1973, and at least annually thereafter, every employer shall provide, or make available, comprehensive medical examinations to each of his employees engaged in occupations exposed to airborne concentrations of asbestos fibers. Such annual examinations shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches, 35.6 x 43.2 cm), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

4. Termination of employment. The employer shall provide, or make available, within 30 calendar days before or after the termination of employment of any employee engaged in any occupation exposed to airborne concentrations of asbestos fibers, a comprehensive medical examination which shall include, as a minimum, a chest roentgenogram (posterior-anterior 14 x 17 inches, 35.6 x 43.2 cm), a history to elicit symptomatology of respiratory disease, and pulmonary function tests to include forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV 1.0).

5. Recent examinations. No medical examination is required of any employee, if adequate records show that the employee has been examined in accordance with this paragraph within the past 1 year period.

6. Medical records. (i) Maintenance. Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained by employers for at least 20 years.

(ii) Access. The contents of the records of the medical examinations required by this paragraph shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of NIOSH, to authorized physicians and medical consultants of either of them, and upon the request of an employee or former employee, to his physician. Any physician who conducts a medical examination required by this paragraph shall furnish to the employer of the examined employee all the information specifically required by this paragraph, and any other medical information related to occupational exposure to asbestos fibers.

7. The first sentence in 61.23 is revised as follows: 61.23 Air-Cleaning

If air-cleaning is elected, as permitted by 61.22(f) and 61.22(d) (4) (iv), the requirements of this section must be met.

8. The first sentence in 61.24 is revised and redesignated as paragraph (e) and new paragraphs (c) and (d) are added as follows: 61.24 Reporting.

(c) For sources subject to 61.22(j) and 61.22(k):

(1) A brief description of each process that generates asbestos-containing waste material.

(2) The average weight of asbestos-containing waste material disposed of, measured in kg/day.

(3) The emission control methods used in all stages of waste disposal.

(4) The type of disposal site or incineration site used for ultimate disposal, the name of the site operator, and the name and location of the disposal site.

(d) For sources subject to 61.22(1):

(1) A brief description of the site.

(2) The method or methods used to comply with the standard, or alternative procedures to be used.

(e) Such information shall accompany the information required by 61.10. The information described in this section shall be reported using the format of Appendix A of this part.

9. A new section 61.25 is added to subpart B as follows: 61.25 Waste disposal sites.

In order to be an acceptable site for disposal of asbestos-containing waste material under 61.22(j) and (k), an active waste disposal site shall meet the requirements of this section.

(a) There shall be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited, except as provided in paragraph (e) of this section.

(b) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeters of the sections of the site where asbestos-containing waste material is deposited, at intervals of 100 m (ca. 330 feet) or less except as specified in paragraph (d) of this section. Signs shall be posted in such a manner and location that a person may easily read the legend. The warning signs required by this paragraph shall conform to the requirements of 29 CFR 1910.145 (d) (4) and this paragraph. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend

**Asbestos Waste Disposal Site
Do Not Create Dust
Breathing Asbestos is Hazardous
to Your Health**

Notation

1" Sans Serif, Gothic or Block
¾" Sans Serif, Gothic or Block
14 point Gothic

Spacing between lines shall be at least equal to the height of the upper of the two lines.

(c) The perimeter of the disposal site shall be fenced in order to adequately deter access to the general public except as specified in paragraph (d) of this section.

(d) Warning signs and fencing are not required where the requirements of paragraph (e) (1) of this section are met, or where a natural barrier

adequately deters access to the general public. Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access to the general public.

(e) Rather than meet the requirement of paragraph (a) of this section, an owner or operator may elect to meet the requirements of paragraph (e) (1) or (e) (2) of this section or may use the alternative control method for emissions from active waste disposal sites which has received prior approval by the Administrator.

(1) At the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material.

(2) At the end of each operating day, or at least every 24-hour period while the disposal site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion. Such agent shall be used as recommended for the particular dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon prior approval by the Administrator. For the purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

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Tuesday, October 14, 1975.

Asbestos Information Association
1745 Jefferson Davis Highway
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23505

1910.19 Asbestos dust.

Section 1910.93a shall apply to the exposure of every employee to asbestos dust in every employment and place of employment covered by 1910.12, 1910.13, 1910.14, 1910.15 or 1910.6, in lieu of any different standard on exposure to asbestos dust which would otherwise be applicable by virtue of any of those sections.

Note: Following defines additional occupational areas affected by section 1910.19 above:

1910.12 Construction Work
(construction, alteration, and/or repair, including painting and decorating)

1910.13 Ship repairing

1910.14 Shipbuilding

1910.15 Shipbreaking

1910.16 Longshoring

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Thursday, June 27, 1974

Appendix C

**U.S. Environmental
Protection Agency
Regulations for Disposal of Asbestos-
Containing Wastes**

(j) Waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations: The owner or operator of any source covered under the provisions of paragraphs (c), (d), (e), or (h) of this section shall meet the following standards:

(1) There shall be no visible emissions to the outside air, except as provided in paragraph (j) (3) of this section, during the collection; processing, including incineration; packaging; transporting; or deposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing material shall be deposited at waste disposal sites which are operated in accordance with the provisions of 61.25.

(3) Rather than meet the requirement of paragraph (j) (1) of this section, an owner or operator may elect to use either of the disposal methods specified under (j) (3) (i) and (ii) of this section, or an alternative disposal method which has received prior approval by the Administrator:

(i) Treatment of asbestos-containing waste material with water:

(A) Control device asbestos waste shall be thoroughly mixed with water into a slurry and other asbestos-containing material shall be adequately wetted. There shall be no visible emissions to the outside air from the collection, mixing and wetting operations, except as provided in paragraph (f) of this section.

(B) After wetting, all asbestos-containing waste materials shall be sealed into leak-tight containers while wet, and such containers shall be

deposited at waste disposal sites which are operated in accordance with the provisions of 61.25.

(C) The containers specified under paragraph (j) (3) (i) (B) of this section shall be labeled with a warning label that states:

Caution
Contains Asbestos
Avoid Opening or Breaking Containers
Breathing Asbestos is Hazardous
to Your Health

Alternatively, warning labels specified by Occupational Safety and Health Standards of the Department of Labor Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.93a (g) (2) (ii) may be used.

(ii) Processing of asbestos-containing waste materials into non-friable forms.

(A) All asbestos-containing waste material shall be formed into non-friable pellets or other shapes and deposited at waste disposal sites which are operated in accordance with the provisions of 61.25.

(B) There shall be no visible emission to the outside air from the collection and processing of asbestos-containing waste material, except as specified in paragraph (f) of this section.

(4) For the purposes of this paragraph (j), the term of all asbestos-containing waste material as applied to demolition and renovation operations covered by paragraph (d) of this section includes only friable asbestos waste and control device asbestos waste.

(k) Waste disposal for asbestos mills: The owner or operator of any source covered by the provisions of paragraph (a) of this section shall meet the following standard:

(1) There shall be no visible emissions to the outside air except as provided in paragraph (k) (3) of this section, during the collection, processing, packaging, transporting or disposition of any asbestos-containing waste material which is generated by such source.

(2) All asbestos-containing waste material shall be deposited at waste disposal sites which are operated in accordance with the provisions of 61.25.

(3) Rather than meet the requirement of paragraph (k) (1) of this section, an owner or operator may elect to meet the following requirements in paragraphs (k) (3) (i) and (ii), or use an alternative disposal method which has received prior approval by the Administrator:

(i) There shall be no visible emissions to the outside air from the transfer of control device asbestos waste to the tailings conveyor, except as provided in paragraph (f) of this section. Such waste shall be subsequently processed either as specified in paragraph (k) (3) (ii) of this section or as specified in paragraph (j) (3) of this section.

(ii) All asbestos-containing waste material shall be adequately mixed, with a wetting agent recommended by the manufacturer of the agent to effectively wet dust and tailings, prior to deposition at a waste disposal site. Such agent shall be used as recommended for the particular dust by the manufacturer of the agent. There shall be no discharge of visible emissions to the outside air from the wetting operation except as specified in paragraph (f) of this section. Wetting may be suspended when the ambient temperature at the waste disposal site is less than -9.5°C (ca. 15°F). The ambient air temperature shall be determined by an appropriate measurement method with an accuracy of $\pm 1^\circ\text{C}$ ($\pm 2^\circ\text{F}$) and recorded at least at hourly intervals during the period that the operation of the wetting system is suspended. Records of such temperature measurements shall be retained at the source for a minimum of two years and made available for inspection by the Administrator.

(1) The owner of any inactive waste disposal site, which was operated by sources covered under 61.22 (a), (c) or (h) and where asbestos-containing waste material produced by such sources was deposited, shall meet the following standards:

(1) There shall be no visible emissions to the outside air from an inactive waste disposal site subject to this paragraph, except as provided in paragraph (1) (5) of this section.

(2) Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material was deposited, at intervals of 100 m (ca. 330 ft) or less, except as specified in paragraph (1) (4) of this section. Signs shall be posted in such a manner and location that a person may easily read the legend. The warning signs required by this paragraph shall conform to the requirements of 20" x 14" upright format signs specified in 29 CFR 1910.145 (d) (4) and this paragraph. The signs shall display the following legend in the lower panel, with letter sizes and styles of a visibility at least equal to those specified in this paragraph.

Legend

**Asbestos Waste Disposal Site
Do Not Create Dust
Breathing Asbestos is Hazardous
to Your Health**

Notation

1" Sans Serif, Gothic or Block
3/4" Sans Serif, Gothic or Block
14 point Gothic

Spacing between lines shall be at least equal to the height of the upper of the two lines.

(3) The perimeter of the site shall be fenced in a manner adequate to deter access by the general public, except as specified in paragraph (1) (4) of this section.

(4) Warning signs and fencing are not required where the requirements of paragraphs (1) (5) (i) or (ii) of this section are met, or where a natural barrier adequately deters access by the general public. Upon request and supply of appropriate information, the Administrator will determine whether a fence or a natural barrier adequately deters access to the general public.

(5) Rather than meet the requirement of paragraph (1) (1) of this section, an owner may elect to meet the requirements of this paragraph or may use an alternative control method for emissions from inactive waste disposal sites which has received prior approval by the Administrator.

(i) The asbestos-containing waste material shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos-containing material, and a cover of vegetation shall be grown and maintained on the area adequate to prevent exposure of the asbestos-containing waste material; or

(ii) The asbestos-containing waste material shall be covered with at least 60 centimeters (ca. 2 feet) of compacted non-asbestos-containing material and maintained to prevent exposure of the asbestos-containing waste; or

(iii) For inactive waste disposal sites for asbestos tailings, a resinous or petroleum-based dust suppression agent which effectively binds dust and controls wind erosion shall be applied. Such agent shall be used as recommended for the particular asbestos tailings by the dust suppression agent manufacturer. Other equally effective dust suppression agents may be used upon approval by the Administrator. For purposes of this paragraph, waste crankcase oil is not considered a dust suppression agent.

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