THE SOCIO-ECONOMIC IMPACT OF PHASING OUT ASBESTOS IN SOUTH AFRICA

Appendices to the Final Report

NOVEMBER 2002

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1 RESEARCH METHODOLOGY

The study to investigate the socio-economic impact of phasing out asbestos in South Africa has followed a 3-phased approach:

- o Phase 1: **Desk Research**
- o Phase 2: **Field Research** and **Economic Cost Benefit Analysis.**
- o Phase 3: preparation of the **Final Report**

1.1 DESK RESEARCH

This phase of the study focused on an examination of readily available published information relating to the historical background to the use of asbestos; international codes of practice and regulations regarding the safe use of asbestos; alternative fibres and substitute products that could be used to replace asbestos; and building a model of the South African asbestos mining and asbestos using industry sectors

1.2 FIELD RESEARCH AND ECONOMIC COST BENEFIT ANALYSIS

Interviews were conducted with representatives from a variety of organisations operating in the industries where asbestos is currently being used as a raw material input to manufacturing processes. These organisations included: regulatory authorities; research institutions; industry associations; manufacturing, distribution and end user/customer businesses; and labour unions

1.3 FINAL REPORT

This final phase involved the preparation of the **Final Report** document and the accompanying **Appendices to the Final Report** document.

1.4 ORGANISATIONS AND COMPANIES INTERVIEWED

Table 1 reflects a list of the organisations and companies that were interviewed as part of the Field Research. In most instances, these interviews involved face-to-face contact with senior executives/representatives.

TABLE 1: ORGANISATIONS AND COMPANIES INTERVIWED

INDUSTRY	SECTOR	COMPANY
AUTOMOTIVE	**Unions**	NUM
		NUMSA
	Customers/Users	McCarthy Nissan/Fiat
		Road Freight Association
		Super Group
		Unitrans
	Distributors	Autozone/Super Group
		Dunopie Distributors

INDUSTRY	SECTOR	COMPANY
		Duraline Distributors
		Midas
		Midas
		Sintech
AUTOMOTIVE	**Manufacturers**	ACA
		Alfa International
		Auto Friction
		Benoni Axle Manufacturers
		Brake Linings Natal
		Dynotherm
		Federal Mogul Ferodo
		Henred Freuhoff
		LUK Africa
		Metpro
		RBS
		Sachs SA
		Safeline
		Valeo/PHC
CONSTRUCTION		Tube Makers Association
	Architects	Gapp Architects
		National Home Builders Registration Council
		TC Design
	Contractors	Aveng/Grinaker
		Group 5
		Murray & Roberts
		Stocks Building Africa
		Stocks Housing Africa
	Distributors	Cashbuild
		Ferreiras
		Pennypinchers
	Engineers	Africon
	Manufacturers	AC Pipes
		Bambanani
		DPI Plastics
		Everite
		Gypsum Industries
		HH Robertson
		Lafarge Roofing
		Marley (UPVC Pipes)

INDUSTRY	SECTOR	COMPANY
		Marley Roof Tiles
	Property Owners	Old Mutual Properties
		Pareto (Eskom)
	Quantity Surveyors	Walters & Simpson
GOVERNMENT		Public Works Department
		SABS Automotive
		SABS Construction
		NCOH
MINING	**South Africa**	Hanova Mining
		Kaapsehoop
SPECIAL APPLICATIONS	**Customers/Users**	AECI
		AECI
		Afrox
		Gaskett Manufacturers
		Iscor
		Sans Fibres
		Sasol
	Distributors	BEP Bestobell
		Wright Seal & Plastics
	Manufacturers	Howden Pumps
		Interohm
		John Moffat Prolock
		Kapasit
		Klinger SA
TRANSPORT		SATS
WASTE DISPOSAL & REHABILITATION		Enviroserv
ZIMBABWE	**Distributors**	CJ Petrow
	Manufacturers	Turnall Fibre Cement
	Mining	AA Mining

1.5 QUESTIONNAIRES

This section contains an example of the questionnaires that were employed as part of the field research information gathering process.

Company:
People Present:
Date:

1 NATURE OF BUSINESS

PRODUCTS PRODUCED - ACM	PRODUCTS PRODUCED – NON ACM	TYPES OF CUSTOMERS	SHARE
KEY INPUT SUPPLIERS - LOCAL	KEY INPUT SUPPLIERS – INTERNATIONAL	COMPETITORS	SHARE

INDUSTRY SIZE/GROWTH	GENERAL COMMENTS

2 LOCAL RSA PURCHASES

2.1 Raw Asbestos Fibre

TYPE OF FIBRE	-2		-1		CURENT YEAR		+1		+2	
	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
1.										
2.										
3.										
4.										

2.1.1 To the extent that there is a significant increase/decrease, what is the cause

2.2 Finished Asbestos-Containing Products

TYPE OF PRODUCT		-2		-1		CURRENT YEAR		+1		+2	
		VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
5.	1.										
6.	2.										
7.	3.										
8.	4.										
9.	5.										
10.	6.										

2.2.1 To the extent that there is a significant increase/decrease, what is the cause

3 PURCHASED IMPORTS

3.1 Raw Asbestos Fibre

TYPE OF FIBRE		COUNTRY OF ORIGIN	-2		-1		CURRENT YEAR		+1		+2	
			VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
11.	1.											
12.	2.											
13.	3.											
14.	4.											

3.1.1 To the extent that there is a significant increase/decrease, what is the cause

3.2 FINISHED ASBESTOS-CONTAINING PRODUCTS

TYPE OF PRODUCT		COUNTRY OF ORIGIN	-2		-1		CURRENT YEAR		+1		+2	
			VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
15.	1.											
16.	2.											
17.	3.											
18.	4.											

3.2.1 To the extent that there is a significant increase/decrease, what is the cause

4 SALES VOLUMES

4.1 LOCAL SALES

4.1.1 Finished Asbestos-Containing Products

TYPE OF PRODUCT		-2		-1		CURRENT YEAR		+1		+2	
		VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
19.	1.										
20.	2.										
21.	3.										
22.	4.										

4.1.2 To the extent that there is a significant increase/decrease, what is the cause

4.2 EXPORTS

4.2.1 Finished Asbestos-Containing Products

TYPE OF PRODUCT		DESTINATION COUNTRY	-2		-1		CURRENT YEAR		+1		+2	
			VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
23.	1.											
24.	2.											
25.	3.											
26.	4.											
27.	5.											
28.	6.											

4.2.2 To the extent that there is a significant increase/decrease, what is the cause

5 EMPLOYMENT

	-2	-1	CURRENT YEAR	+1	+2
Management					
Professional (Acc/Leg/R&D/IT)					
Administration					
Technical/Artisans					
Workers					
TOTAL					

5.1.1 To the extent that there is a significant increase/decrease, what is the cause

5.2 CONDITIONS OF EMPLOYMENT (FULL-TIME, PART-TIME, CASUAL, OUT-SOURCING)

6 INVESTMENT

	-2	-1	CURRENT YEAR	+1	+2
Production					
Distribution					
Other					
TOTAL					

6.1.1 To the extent that there is a significant increase/decrease, what is the cause

7 ANTICIPATED IMPACT OF A PHASING OUT OF ASBESTOS

7.1 ALTERNATIVE FIBRES/SUBSTITUTE PRODUCTS THAT COULD BE USED

ASBESTOS-CONTAINING PRODUCTS	ALTERNATIVE FIBRES	SUBSTITUTE PRODUCTS
29. 1.		
30. 2.		
31. 3.		
32. 4.		
33. 5.		

7.1.1 Comments (sources – local, imports; reasons/drivers)

7.2 RELATIVE RAW MATERIAL COSTS

ASBESTOS-CONTAINING PRODUCTS		ALTERNATIVE FIBRES		SUBSTITUTE PRODUCTS	

7.2.1 Comments

7.3 RELATIVE TOTAL PRODUCTION COSTS

ASBESTOS-CONTAINING PRODUCTS		ALTERNATIVE FIBRES		SUBSTITUTE PRODUCTS	

7.3.1 Comments (labour, work processes, technology/equipment, materials)

7.4 RELATIVE SELLING PRICES TO CUSTOMERS

ASBESTOS-CONTAINING PRODUCTS		ALTERNATIVE FIBRES		SUBSTITUTE PRODUCTS	

7.4.1 Comments

7.5 EMPLOYMENT

7.5.1 Anticipated Job Loses (who, how many – direct and indirect)

CURRENT YEAR	+1	+2	+3	+4
Management				
Professional (Acc/Leg/R&D/IT)				
Administration				
Technical/Artisans				
Workers				
TOTAL				

7.5.2 Anticipated Job Creation (what types, how many, skills profile, conditions of employment)

CURRENT YEAR	+1	+2	+3	+4
Management				
Professional (Acc/Leg/R&D/IT)				
Administration				
Technical/Artisans				
Workers				
TOTAL				

7.5.3 Transfer/Retraining Opportunities (who, how many, skills profile, conditions of employment)

CURRENT YEAR	+1	+2	+3	+4
Management				
Professional (Acc/Leg/R&D/IT)				
Administration				
Technical/Artisans				
Workers				
TOTAL				

7.5.4 Conditions of Employment (full-time, part-time, casual, out-sourcing)

7.6 INVESTMENT

7.6.1 Dis-investment

	CURRENT YEAR	+1	+2	+3	+4
Production					
Distribution					
Other					
TOTAL					

7.6.2 New Investment

	CURRENT YEAR	+1	+2	+3	+4
Production					
Distribution					
Other					
TOTAL					

7.7 Disposal & Rehabilitation

7.7.1 Disposal of Stock-on-Hand and Waste Material

	CURRENT YEAR	+1	+2	+3
Raw Material				
Finished Products				
Waste Material				

7.7.2 Rehabilitation of Facilities

	CURRENT YEAR	+1	+2	+3
Warehouses/Storage				
Production Facilities				
Transport				
Other				

7.8 Viability of Business

8 TRANSITIONAL MEASURES/SUPPORT REQUIRED FROM GOVERNMENT

9 OCCUPATIONAL HEALTH AND SAFETY PRACTISES

9.1 People Exposed to ACM's

	-3	-2	-1	CURRENT YEAR	+1	+2
Warehouse/Storage						
Production						
Distribution						
Management						
Other						

9.2 Asbestos Related Disease Occurrence

ARD's	-4	-3	-2	-1	Current Year
Pleural Plaques					
Asbestosis					
Lung Cancer					
Mesothelioma					
GI Cancers					
Asbestos Warts					

9.3 ASBESTOS MANAGEMENT PROGRAMME

9.3.1 Do you have a formal AMP in place (Yes/NO)?

9.3.2 What are the main features of this programme?

A. *Have the appropriate authorities been informed that you are using and/or processing either asbestos in raw mineral form, or ACM's?*

B. *Is information and training provided to staff working with or who are exposed to asbestos?*

C. *Are staffs working with or who are exposed to asbestos provided with appropriate safety equipment and facilities?*

D. *Are areas where asbestos is being used appropriately zoned?*

E. *Is air monitoring for asbestos dust routinely carried out?*

F. *Are all workplaces maintained in a clean state and are they free of asbestos waste?*

G. *Is all asbestos that can release dust kept in enclosed receptacles?*

H. *Are articles sold which contain asbestos properly labelled?*

2 HISTORICAL BACKGROUND TO THE USE OF ASBESTOS

2.1 INTRODUCTION

Asbestos is a collective term for a group of naturally occurring fibrous silicates that are incombustible and separable into filaments: chrysotile (white asbestos), amosite (brown asbestos, cummingtonite, grunnerite), crocidolite (blue asbestos), anthophyllite, tremolite and actinolite[i]. Only the first three have widespread commercial use. In its natural state, asbestos occurs throughout much of the planet. It is found in two-thirds of the rocks in the earth's crust.

The ancient Greeks first used chrysotile asbestos over two thousand years ago as wicks for oil-lamps and it was they who gave us the word asbestos, meaning "everlasting" or "non-extinguishable"[ii]. There is evidence that it was used even earlier - some four thousand years ago - for strengthening clay pots in Finland. This non-flammable quality led ancient Greeks to manufacture asbestos lamp wicks.

The Romans mined asbestos and left us with both non-flammable cremation cloths and records of an illness among slaves who may have worked with asbestos[iii]. During the middle Ages, manuscripts in Europe mentioned diseases common to miners, but there was no mention of asbestos. A small asbestos textile industry developed in Russia during the time of Peter the Great (1675-1725) but asbestos use remained negligible until the time of the Industrial Revolution.

The commercial exploitation of asbestos fibre in modem times occurred in the latter part of the 19th century, when experiments were successfully carried out in producing asbestos thread, which was woven to form asbestos cloth – important for thermal insulation and protective clothing.

At the same time asbestos-cement building materials were being developed, thereby exploiting the reinforcement properties of the fibre in combination with cement. These developments led to the widespread introduction of manufacturing facilities for asbestos-cement corrugated and flat sheets, and high pressure pipes, together with a wide range of associated products. Subsequently other applications of asbestos fibre were developed to include friction materials, jointing and packing and electrical insulation. In total, there are over 3 000 recorded different uses for asbestos.

2.2 ASBESTOS MINERALS

Asbestos minerals may be broadly divided into two groups, namely: amphibole asbestos and serpentine asbestos.

2.2.1 Amphibole Asbestos

Amphibole asbestos, which has a chain-like crystalline structure, comprises of mainly crocidolite (or blue asbestos) as well as amosite, tremolite, anthophyllite and actinolite. Because of their chemical structure and straight, needle like fibres, amphiboles are very dusty, as well as highly biopersistent. In some countries, and for some special applications, the amphiboles continue to be used:

- **Crocidolite** is the strongest of the asbestos fibres. It has high tensile strength and acid resistance. Long-fibre crocidolite is woven into fabrics used for boiler lagging, acid-resistant packing and gaskets. Historically the principal use of the shorter crocidolite fibres was in the manufacture of asbestos-cement products, although this is no longer the case.

- **Amosite** is highly resistant to heat and quite flexible, but may be susceptible to strong acids and alkalis. It has less tensile strength than chrysotile or crocidolite and has only fair spinnability. Amosite asbestos has the longest fibre lengths. Its resistance to acids and seawater is greater than that of chrysotile, and it fuses at a much higher temperature than crocidolite. It is, however, somewhat more brittle. It is used in blanket form for felted insulation for high temperature applications. In compacted form it is applied as a covering for marine turbines, jet engines and similar applications.

2.2.2 Serpentine Asbestos

Serpentine asbestos has a leafy or layered structure and is represented by chrysotile (also known as white asbestos), the most common serpentine fibre. Silky in texture, with curly fibres, serpentine asbestos is unlikely to remain suspended in the air.

- **Chrysotile** currently accounts for more than 98% of world asbestos consumption[i]. Its fibres are characterised by high tensile strength, resistance to alkalis, high flexibility and good spinnability. Chrysotile's tensile strength and resistance to heat make it suitable for spinning and weaving and as counteraction to heat and fires. It is mainly used for asbestos textiles, friction linings and facings, asbestos cement and insulation products

2.3 Global Asbestos Deposits

Asbestos is a naturally occurring mineral fibre commercially available in most parts of the world. Supply is fairly diversified. Thus there is no strategic dependency on a single supply. Table 2 reflects worldwide reserves of asbestos[iv].

Table 2: worldwide asbestos reserves

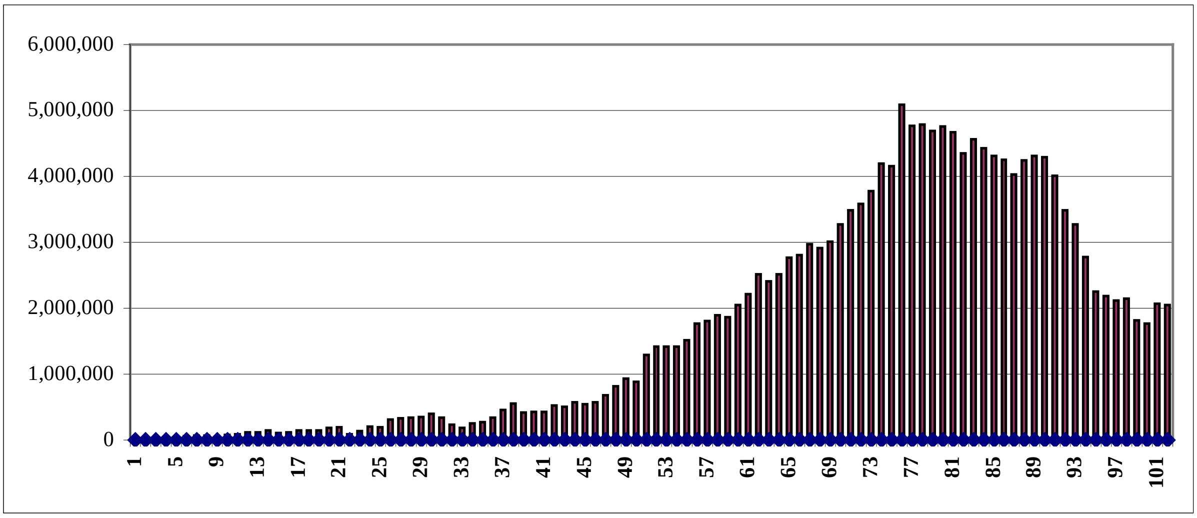
COUNTRY	TYPE OF ASBESTOS	RESERVE BASE
Canada	♦ Chrysotile	47-million tons
South Africa	♦ Chrysotile ♦ Amosite ♦ Crocidolite	8.2-million tons
USA	♦ Chrysotile	Large
China	♦ Chrysotile	Large
CIS	♦ Chrysotile	Large
Brazil	♦ Chrysotile	Moderate
Zimbabwe	♦ Chrysotile	Moderate
Others	♦ Chrysotile ♦ Amosite ♦ Anthophllite	Large

Unfortunately, this source does not provide a definition of “large” versus “moderate” deposits, therefore, it is difficult to assess into which category South Africa’s deposits fall. However, the fact that South Africa has deposits of all three major types of asbestos confirms that it has been an important international source of asbestos.

2.4 ASBESTOS PRODUCING COUNTRIES

Figure 1 reflects an estimate of world asbestos mining production for the twentieth century[v].

FIGURE 1: WORLD ASBESTOS MINING PRODUCTION – 1900 TO 2001



This figure indicates that asbestos mining production peaked at 5-million tons in 1975 and has steadily declined to the current levels of approximately 2-million tons in 2000 and 2001.

Table 3 reflects a schedule of asbestos producing countries[v], with their production levels for the 1996 to 2000 period.

TABLE 3: ASBESTOS PRODUCING COUNTRIES

	1996	1997	1998	1999	2000	
Argentina	446	400	380	350	350	0.02%
Brazil	170,000	170,000	170,000	170,000	170,000	8.75%
Bulgaria	400	300	300	350	350	0.02%
Canada	506,000	455,000	309,000	337,366	340,000	20.05%
China	293,000	288,000	314,000	247,000	260,000	14.44%
Egypt	1,836	2,000	2,000	2,000	2,000	0.10%
Greece	80,213	80,000	70,000	60,000	50,000	3.50%
India	23,215	25,051	18,751	20,000	21,000	1.11%
Iran	4,500	4,300	2,258	2,000	2,000	0.16%
Japan	18,000	18,000	18,000	18,000	18,000	0.93%
Kazakhstan	128,700	125,000	125,000	125,000	125,000	6.47%
Russia	615,000	710,000	600,000	675,000	750,000	34.50%
Serbia and Montenegro	509	360	633	361	550	0.02%
South Africa	57,120	49,986	27,195	18,700	18,909	1.77%
Swaziland	26,014	25,888	27,693	28,000	25,000	1.37%
Zimbabwe	165,494	144,959	123,295	115,000	110,000	6.78%

TOTAL	2,090,447	2,099,244	1,808,505	1,819,127	1,893,159	

These figures indicate that Russia, Canada, China, Brazil and Zimbabwe are the worlds largest asbestos mining countries and account for almost 85% of world supply.

2.5 ASBESTOS EXPORTING COUNTRIES

Table 4 reflects a schedule of asbestos exporting countries, ranked according to volume of 1998 exports[iv].

TABLE 4: ASBESTOS EXPORTING COUNTRIES

COUNTRY	1998	% OF PRODUCTION EXPORTED
Canada	295, 000	95%
Zimbabwe	117, 000	95%
USSR /Russia	99, 000	17%
Brazil	63, 000	35%
South Africa	25, 000	95%
China	14, 000	4.5%
Kazakhstan	5, 000	4%

As would be expected, the largest mining countries are also the largest exporting countries.

2.6 ASBESTOS CONSUMING COUNTRIES

Table 5 reflects a schedule of asbestos-consuming countries, ranked according to their 1994 consumption levels.

TABLE 5: WORLDWIDE ASBESTOS CONSUMPTION

	1994	
CIS	700,000	34.6%
China	220,000	10.9%
Japan	195,000	9.6%
Brazil	190,000	9.4%
Thailand	164,000	8.1%
India	123,000	6.1%
South Korea	85,000	4.2%
Iran	65,000	3.2%
France	44,000	2.2%
Indonesia	43,000	2.1%
Mexixo	38,000	1.9%
Colombia	30,000	1.5%
Spain	29,000	1.4%
USA	29,000	1.4%
Turkey	25,000	1.2%
Malasia	21,000	1.0%
South Africa	20,000	1.0%

TOTAL	**2,021,000**	

These statistics indicate that, even at this relatively recent stage, South Africa was already one of the smallest international consumers of asbestos.

2.7 PROPERTIES OF ASBESTOS

The most important properties exhibited by asbestos, and which account for its widespread use in a broad range of asbestos-containing products include[iii]:

- Tensile strength
- Resistance to high and low temperatures
- Fire, friction and acid resistance
- Chemical resistance - particularly to cement alkalinity
- Dielectrical resistance
- Resistance to bacteria, fungi, etc.
- Weather proofing, and
- Compatibility with cement as a binder

The mining and processing of asbestos and its use in manufactured products constitutes a billion dollar industry. Asbestos has been acclaimed for its heat, friction and acid-resistant properties. However, most asbestos is used as a cheap reinforcement agent: more than 70% of asbestos is used for reinforcing asbestos-cement in construction projects.

2.8 ASBESTOS CONTAINING MATERIALS (ACM'S)

Up until the 1970s, some 3,000 products were made with asbestos fibres of all types. These included toasters, dryers, ironing boards and low-density friable insulation products. Today, some sixty countries still use asbestos, but only the chrysotile variety and primarily in cement building materials such as roofing materials, cladding and pipe.

In a modern context, there are four common applications for asbestos[vi]:

1. Asbestos Cement

Chrysotile asbestos is used in asbestos cement as it has good reinforcing properties. Products are mainly in the form of profile sheets and slates. 90% of the world production of chrysotile is used in the manufacture of chrysotile-cement, in the form of pipes, sheets and slates. Asbestos-cement is valued principally for its excellent cost effectiveness and durability.

2. Friction Materials

Chrysotile asbestos has been used in friction materials because it is durable and resistant to heat and oil. Friction products represent about 7% of the chrysotile fibre used today.

3. Seals and Gaskets

The main uses are in:

- Packing and seals - braided and laminated packing, proofed asbestos cloths and tapes, and moulded gland packing used to seal openings in a variety of industrial applications

- o Gaskets - compressed asbestos fibre in a mixture of natural or synthetic rubber compounds that are used to seal joints in a variety of piping and pumps that transport liquids and gasses

4. Insulation Materials

The main chrysotile asbestos textiles are woven tapes, welting, cloths and yarns. Composites are generally asbestos fibre or cloth impregnated with resin and then formed into sheets, tubes, rods or shaped mouldings. These are used as insulation materials for temperature control purposes in a variety of industrial applications

2.9 CATEGORIES OF ASBESTOS-CONTAINING PRODUCTS

Table 6 categorises asbestos-containing products according to the density of their asbestos content.

TABLE 6: CATEGORIES OF ASBESTOS-CONTAINING PRODUCTS

	LOW-DENSITY PRODUCTS	HIGH DENSITY PRODUCTS
Density	> 20% asbestos content	< 20% asbestos content
Types of Asbestos	Amphibole (until ± 1980) Serpentine	Amphibole (until ± 1980) Serpentine
Friability	Friable (when dry can be crumbled, pulverised or reduced to powder by hand pressure)	Non friable
Applications	♦ Insulation ♦ Temperature control ♦ Fire protection ♦ Noise control ♦ Ornamental fittings	♦ Reinforcement ♦ Friction Resistance
Products	♦ Textiles ♦ Packings ♦ Braided Packings	♦ Asbestos-Cement Products: ♦ Profiled sheets ♦ Slates ♦ Pipes ♦ Moulded goods (containers etc.) ♦ Brake Pads ♦ Clutch Plates ♦ Gaskets ♦ Valve Stem Seals

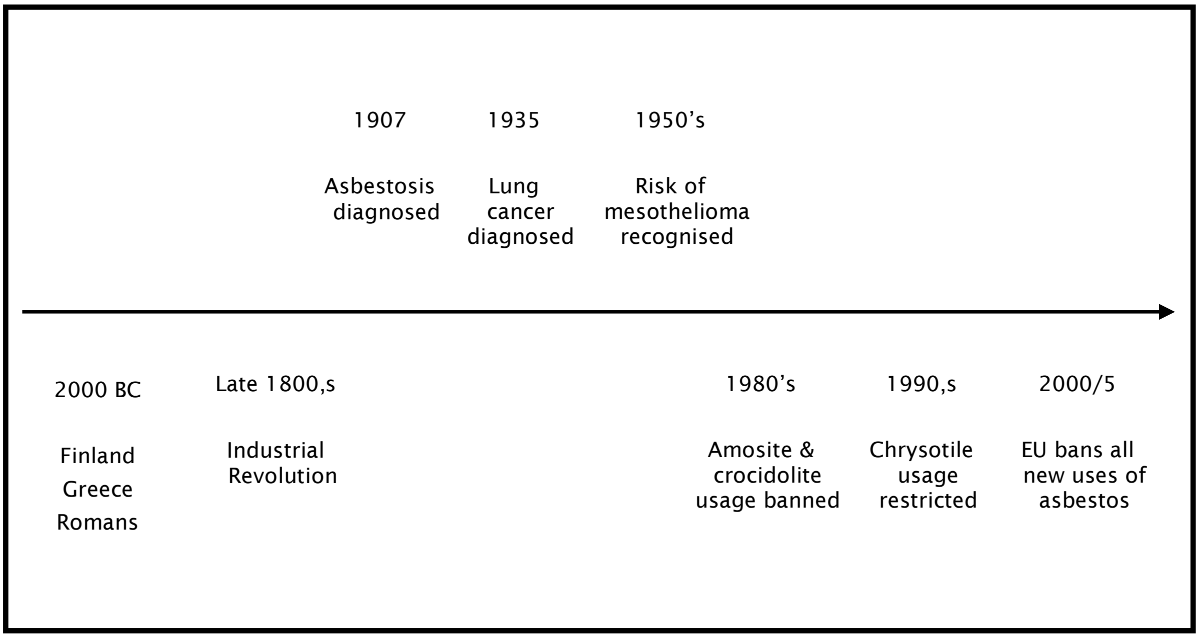
3 INTERNATIONAL TRENDS IN THE REGULATIONS AND CONTROL OF ASBESTOS

3.1 INTRODUCTION

Until the 1970s, some 3,000 products were made that contained varying quantities of asbestos fibres of all types. Today, some sixty countries still use asbestos, but only the chrysotile variety and primarily in cement building materials such as roofing materials, cladding and piping.

Figure 2 reflects a representative time line for the discovery and subsequent usage of asbestos on a global scale. This diagram also includes the timing of the international diagnosis of the major diseases associated with exposure to asbestos, and the timing of the subsequent introduction of regulations affecting the use of asbestos.

FIGURE 2: HISTORY OF THE USE OF ASBESTOS



This diagram clearly illustrates the introduction of increasingly more stringent controls on the use of asbestos as a consequence of the increasing awareness of the dangers associated with exposure to respirable asbestos fibres.

3.2 INTERNATIONAL ASBESTOS REGULATIONS AND CONTROLS

Currently, asbestos tends to be more commonly used in developing countries. For example, there are more than 30 manufacturers of asbestos-cement products in countries as diverse as Zimbabwe, Pakistan, Indonesia, Argentina, Lebanon, the Philippines, Mexico, India, Thailand, Chile, Turkey and Malaysia.

A number of countries worldwide have implemented bans and/or prohibitions on the use of asbestos. These countries are in various stages of developing and implementing these bans and prohibitions.

Based on the available information, it can be concluded that the strategic approach being adopted by most countries involves a three-phased transitional phasing out of asbestos from their economies and societies.

- **Phase 1: Ban all new uses of amphibole fibres (i.e. crocidolite and amosite), but allow the continued use of chrysotile asbestos**

  Many countries adopted this approach during the late 1970's and early 1980's.

- **Phase 2: Restrict the use of chrysotile asbestos**

  Many countries began pursuing this approach during the mid 1980's and early 1990's.

- **Phase 3: Ban all new uses of all types of asbestos fibres**

  A number of countries began pursuing this option from the mid 1990's onwards.

It is worth noting that no country appears to have banned all uses of asbestos as a first step. They all seem to have pursued a "phasing out" approach. A limited number of countries have now introduced a total ban on the new use of all asbestos-containing materials and products of any type.

So far, no country seems to be pursuing a strategy of proactively removing asbestos-containing materials and products from existing installations, except in some cases where the removal of friable asbestos products is practical. Rather, they seem to be adopting a policy of leaving installed asbestos in place, provided that it is in an acceptable state of repair; and only requiring that it be removed when it becomes a health hazard. Strict legislation controls the maintenance, removal and disposal of asbestos in these countries.

3.3 International Labour Organisation Codes of Practice

In accordance with the decisions taken by the Governing Body of the ILO at its 219th Session in February/March 1982, a meeting of experts was convened in Geneva in October 1983 to draw up a code of practice on safety in the use of asbestos. The meeting was composed of:

- Five experts appointed following consultations with governments
- Five experts appointed following consultations with the employers group, and
- Five experts appointed following consultation with the workers group of the governing body

The practical recommendations of the ILO code of practice are intended for the use of all those, both in the public and in the private sectors, who have responsibility for safety and health in the use of asbestos. The code is not intended to replace national laws or regulations or accepted standards. It was drawn up with the objective of providing guidance to those who may be engaged in the framing of provisions of this kind and, in particular, governmental or other public authorities, committees or management in related enterprises.

Local circumstances and technical possibilities determine how practicable it is to follow its provisions. Furthermore, these provisions should be read in the context of local conditions, the scale of operation involved and technical possibilities. In this regard, the needs of the developing countries have also been taken into consideration.

The governing body of the ILO approved the text of the code for publication at its 224th Session in November 1983.

The ILO code of practice for the safe use of asbestos incorporates recommendations regarding the following topics:

- The general duties of the competent authorities, employers, workers, manufacturers and vendors
- Exposure limits
- Monitoring in the workplace (i.e. Static monitoring, personal monitoring, measuring methods, monitoring strategies, record keeping, interpretation of data, and application of monitoring data)
- General preventive methods (alternative materials, methods of control, control programmes, designed and installation, local exhaust ventilation, and general ventilation)
- Personal protection (respiratory equipment and protective clothing)
- Cleaning of premises and plant (general, floors, walls, machinery and equipment, overhead structures, vacuum cleaning equipment)
- Taking, transport and storage (initial packing of fibre, packaging for transport, transport, damaged loads and backs, and warehousing)
- The disposal of asbestos waste (waste avoidance, waste collection, identification and isolation of waste, transport of waste, disposal of waste, personal protection and hygiene, and supervision)
- Supervision of the health of workers
- Information, labelling, education and training (labelling of products and risk areas, education and training)
- Control of asbestos exposure and specific activities:
- Mining and milling (opencast mining, underground mining, crushing and screening, chutes, conveyors, packing, and tailings)
- Asbestos cement (fibre preparation, handling finished products, finishing operations within the factory, work on site, and waste disposal)
- Textiles (carding, spinning, doubling and winding, weaving, breaking and plaiting, packaging, fabrication using asbestos cloth, mattress making, installation cladding, rope lagging, and waste disposal)
- Encapsulation or removal of friable thermal and acoustic installation (identification, indications for removal, enclosure of the work area, monitoring of doused and enclosure efficiency, hygiene, respiratory protection, supervision, work side preparation, encapsulation, dry stripping, wet stripping, stripping by high-pressure water jets, waste disposal, and decontamination procedures)
- Friction materials (fibre preparation and mixing, transfer of mixed compound to moulding and forming, preforming, forming, curing and moulding machines, finishing operations, reclamation of materials, processing friction materials infected conditions, use a friction materials and workshops, servicing of breaks and clutches in garages and workshops, and waste disposal)
- Handling of asbestos fibre in ports and container terminals (packaging, handling, spillages)
- Construction, demolition and alteration work (construction work, demolition and alteration work)

In addition to these recommendations, this code of practice also includes principles of the membrane filter method for the determination of airborne asbestos fibre concentrations by light microscopy, the principles of gravimetric methods of measuring airborne dust containing asbestos at the workplace, and recommendations concerning medical examinations.

3.4 ILO Convention 162

ILO Convention 162 Safety in the Use of Asbestos indicates clearly the responsibilities of employers when using asbestos or handling asbestos products[vii]. It establishes the baseline of any corporate or industry product stewardship or preventative and control programme, and includes the following principles:

- Participate, consult and co-operate with government and workers organisations to give effect to national regulations
- Comply with national regulations
- Establish a prevention programme with the participation of workers
- Implement engineering controls to prevent exposure
- Reduce exposure to as low a level as is reasonably practicable
- Establish procedures to deal with emergency situations
- Establish procedures for the training of workers
- Compete information about the health hazards related to work
- Measure airborne concentrations of fibres, and inform the workers and inspectors
- Arrange for medical examinations at no cost to the workers
- Provide full disclosure to the workers of the results of examinations
- Notifying government of certain types of work involving asbestos
- Adequately label containers and asbestos products
- Provide respiratory equipment and protective clothing
- Safely dispose of waste and prevent pollution
- Provide materials safety data sheets to all users of asbestos fibres and asbestos products

The emphasis of ILO Convention 162 is on the controlled use of asbestos-containing materials· The Convention called for two specific prohibitions:

- Crocidolite and all products containing crocidolite, and
- Sprayed-on applications of asbestos of any type.

3.5 Asbestos Bans

The Board of Officers of the International Commission on Occupational Health (ICOH), at its meeting in Paris on 30 to 31 August 2001, called for an international ban on the use of asbestos. They recommend that the ban be enforced in all countries, both developed and newly industrialised. They refered to asbestos as “an occupational and environmental hazard of catastrophic proportion”.

Many countries have in fact already banned the use of asbestos, or banned the use of the amphibole types of asbestos as early as the 1970s or 1980s. Table 7 on the following page provides a list of countries that have banned the use of asbestos[viii].

TABLE 7: NATIONAL ASBESTOS BANS

DATE	EVENT
1983	Iceland introduces ban on all types of asbestos (with exceptions). Updated in 1996
1984	Norway introduces ban on all types of asbestos (with exceptions). Revised in 1991
MID-1980S	El Salvador bans asbestos: first country in the Americas to do so
1986	Denmark introduces ban on chrysotile (with exceptions)
1986	Sweden introduces the first of a series of bans on various uses of chrysotile (with exceptions)
1988	Hungary bans amphiboles
1989	Switzerland bans crocidolite, amosite and chrysotile (with exceptions)
1990	Austria introduces ban on chrysotile (with exceptions)
1991	The Netherlands introduces the first of a series of bans on various uses of chrysotile (with exceptions)
1992	Finland introduces ban on chrysotile (with exceptions). Came into force in 1993
1992	Italy introduces ban on chrysotile (with some exceptions until 1994)
1993	Germany introduces ban on chrysotile (with minor exemptions), amosite and crocidolite having been banned previously. The sole derogation remaining is for chrysotile-containing diaphragms for chlorine-alkali electrolysis in already existing installations. These will be banned as of 2011
1993	Croatia bans crocidolite and amosite
1996	France introduces ban on chrysotile (with exceptions)
1997	Poland bans asbestos
1998	Belgium introduces ban on chrysotile (with exceptions)
DATE	EVENT
1998	Saudi Arabia bans asbestos
1998	Lithuania issues first law restricting asbestos use; ban expected by 2004
1999	UK bans chrysotile (with minor exemptions)
1999	European Union bans asbestos throughout all Member States to be phased out by 2005.
2000	Ireland bans chrysotile (with exceptions)
2000/2001	Brazil – the four most populous states ban asbestos as well as many towns and cities
2001	Latvia bans asbestos (exemption for asbestos products already installed. However, they must be labeled)
2001	Chile bans asbestos
2001	Argentina bans asbestos
2002	Spain and Luxembourg plan to ban chrysotile, crocidolite and amosite having been banned under earlier EU directives
2002	Slovak Republic expects to adopt EU asbestos restrictions banning all asbestos
2003	Australia: phase-out agreed by Workplace Relations Ministers Council and by all the States and the Federal Government with some, mainly defence, exemptions
2005	Croatia and Hungary expect to ban chrysotile

An important trend that can be noted from this table is that many countries banned the use of amphiboles before 1980 but allowed the continued use of chrysotile. However, the ban was later extended to include chrysotile, allowing for some “exceptions”. One may conclude that very few countries placed an immediate and outright ban on asbestos.

3.6 COUNTRY TRENDS

A number of countries worldwide have implemented asbestos restrictions and prohibitions on the use of asbestos. These countries are in various stages of developing and implementing these bans and prohibitions.

3.6.1 Argentina

Argentina banned amphibole asbestos by a resolution of the Ministry of Health in 2000[ix]. The final resolution, signed on 26 July 2001, became law on 31 July 2001 when it was published in Argentina's Official Bulletin.

Resolution 823/01 stipulates that the use of chrysotile in materials such as textiles, paper, rubber, plastic, paint, insulating materials, filters and gaskets will be effectively prohibited sixty days after the publication. It was further declared that the import, trade and uses of chrysotile would be strictly regulated until January 2003, when a total ban on the use of asbestos will be introduced.

3.6.2 Australia

On 17 October 2001, the National Health and Safety Commission declared a prohibition on the import and use of chrysotile asbestos in Australia with effect from no later than 31 December 2003[x].

This prohibition consolidated existing prohibitions on crocidolite and amosite asbestos into the instrument prohibiting the use of chrysotile asbestos, being the Amendments to Schedule 2 of the National Model regulations for the Control of Workplace Hazardous Substances (Prohibition of Asbestos) 2001.

The prohibition is being phased-in to allow producers, sellers and users of chrysotile products to make the necessary adjustments, which may include the development and marketing of new products and increasing supplies of non-asbestos products to meet greater demand.

It should be noted that the prohibition does not require the removal of chrysotile asbestos products in situ.

From December 2003, all uses of chrysotile asbestos will be prohibited, except for:

- Bona fide research or analysis,
- For removal or disposal, or
- Where it is encountered in non-asbestos mining.

The legislation allows for other exemptions that may be granted in limited circumstances where:

- Alternative products do not exist, or
- Where the use of alternative products would create greater risks than the corresponding chrysotile product.

The prohibitions on amosite and crocidolite include all uses of these substances, except for:

- Removal and disposal,
- Situations where they occur naturally

In conjunction with declaring the prohibitions, the NOHSC agreed to measures to support their implementation. These include the:

- Development of a consistent approach for the granting of exemptions,
- Implementation of corresponding bans on importation,
- Information and awareness raising activities targeted to industry and government agencies,
- Consideration of prohibition of the other three forms of asbestos (actinolite, antophyllite and tremolite).
- Review of the chrysotile exposure standard, given that the prohibition does not extend to removal of in situ chrysotile and natural occurrences that may give rise to exposure.

During the phase out period, the implementation of non-asbestos technology will proceed.

3.6.3 Canada

In Canada, the regulation of hazardous materials is based on the "life cycle" approach. That is, all activities from mining, transportation, manufacturing, installation and repair, to removal and disposal are addressed in order to protect not only public and worker health, but also the general environment.

Canada was one of the first countries to ratify ILO Convention 162. The process of ratification was completed in 1988.

On 28 May 1998, the government of Canada lodged a request with the World Trade Organisation for consultation with the European Communities "concerning certain measures taken by France for the prohibition of asbestos and products containing asbestos". Canada was supported by Brazil and Zimbabwe, two other asbestos producing countries. However, Brazil later withdrawn its support when it announced its intention in 2000 to phase out the use of asbestos by 2005. The appeal was rejected.

3.6.4 Brazil

Brazil does not have a national ban on asbestos[xi]. However, the Brazilian government intends to phase out asbestos by the year 2005.

Certain states (i.e. Rio de Janeiro, Matto Grasso and Sao Paulo) and cities (e.g. Osasco, Sao Ceatano du Sul, Mogi Mirim and Sao Paulo) have imposed bans on the use of asbestos.

Sao Paulo, the biggest city in Latin America, has banned the further use of asbestos and asbestos containing materials in the building and construction industry.

3.6.5 Chile

Chile banned the further use of asbestos in January 2001. The production, importation, distribution, sale and use of any material or product that contains crocidolite are banned[xii].

All other types of asbestos have also been banned, but with some exceptions. The health authorities may, in terms of legislation, authorise the use of asbestos in manufacturing where it is believed that there is no technically or economically feasible alternative. Under such circumstances strict health and safety measures apply.

Existing stock at the time of the ban must be reported to authorities on a six monthly basis, i.e. quantities moved and their destination.

3.6.6 European Union

A working procedure, the European Directive 1999/77, was adopted on 26 July 1999 that signals the end of asbestos use throughout all member states of the European Union[xiii]. This Directive prohibits the sale of asbestos-containing materials, such as asbestos-cement, friction products, seals and gaskets, effective from 1 January 2005. The Directive applies to chrysotile, whereas amosite and crocidolite have already been banned.

Under the principle of subsidiarity, member states of the European Union are free to implement asbestos restrictions before the year 2005. Unilateral bans are already in place in Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden and the United Kingdom.

An exception to the ban is the use of chrysotile asbestos in diaphragms for existing electrolysis installations until such time as they reach the end of their service life, or when asbestos-free substitutes becomes available. In addition, member states will not be required to remove in situ asbestos.

3.6.7 France

The French government announced on 3 July 1996 that asbestos products would be banned, effective from 1 January 1997. This decision stipulates that: "the production, import and sale of asbestos-containing products, notably asbestos-cement, are prohibited".

Exceptions will be granted in those product categories where less hazardous products do not exist, for example heavy truck brake linings and fireproof clothing.

3.6.8 India

Government committees involved in reviewing prominent asbestos issues from1985 to 1995 were in favour of the controlled use of asbestos. The Indian Government lowered import duties on asbestos by 68% between 1995 and 2000. This gave asbestos a decided advantage over the alternatives, and was one of the main reasons why a recent motion to replace asbestos in corrugated fibre cement roofing has failed.

There are signs, however, that the moves to ban asbestos are gaining momentum. Leading Indian academics, who were previously cautious about banning asbestos, have now expressed support for a ban on asbestos. A recent medical conference organised by the Indian Association for Occupational Health supported the banning of asbestos. They urged the Indian government to close tremolite mines, and to ratify the ILO Convention 162 on asbestos.

According to a report in the Times of India (9 November 2001), officials in the City of Delhi are "seriously considering" a ban on asbestos in the city. The Board responsible for water and sewage in Delhi has decided to use cement or ductile iron pipes in place of asbestos-containing water pipes.

The Indian Government's Central Building Research Institute is conducting research into the use of alternative vegetable fibres in order to replace asbestos in fibre-cement building products. The research has led to the development of roofing tiles and building blocks. Further research is being conducted to develop other fibre cement building materials that incorporate by-products of oilseeds and maize

3.6.9 Japan

Japan banned all uses of crocidolite and amosite in 1995. In June 2002, the Japanese Minister of Health, Labour and Welfare announced that the government is considering plans to implement a unilateral ban of chrysotile asbestos. The Ban Asbestos Network of

Japan (BANJAN) has been calling for a ban on all types of asbestos for the past fifteen years.

Japan is one of the world's largest consumers of asbestos. In 1999, Japan imported over 100-thousand tons of asbestos from countries such as Canada, South Africa, Zimbabwe, Brazil, USA and the former Soviet Union, more than 95% of which was used in the production of asbestos-cement building products. A total ban on all types of asbestos would have significant implications for the international asbestos mining and producing countries.

3.6.10 Latin America

Government, health and labour representatives from Brazil, Costa Rica, Cuba, Chile, Ecuador, Nicaragua, Paraguay, Peru, Uruguay and Venezuela at the Latin American Asbestos Meeting in 2002 resolved to establish a Permanent Asbestos Forum.

The purpose this Forum is to forward recommendations to governments in the region to "accept their responsibility and commit themselves to moving towards the ban on asbestos that was initiated in the Southern Cone".

3.6.11 The Netherlands

The government of the Netherlands began introducing a progressive series of restrictions on the use of asbestos from as early as the 1970's that culminated in a final ban in 1993:

- 1978: a ban of spray applications of asbestos and the use of crocidolite
- 1983: trade in asbestos is limited exclusively to tightly bonded asbestos products
- 1988: the Labour Inspectorate introduces stricter measures relating to working with asbestos
- 1993: a total ban on the use of new asbestos

Despite the control measures that were in place 1970's and 1980"s, Government concluded that it was still not possible to control the risks of asbestos exposure adequately and, therefore, a total ban on the use of new asbestos was introduced in July 1993: The Asbestos Decree (Working Conditions Act), (Ministry of Social Affairs and Employment), which bans the professional use of asbestos.

Consumers in the Netherlands were prohibited from purchasing products containing asbestos.Retailers and wholesalers were not permitted to stock asbestos-containing products after July 1993.

In addition, various other asbestos-related decrees have been implemented, covering aspects such as:

- Labelling of asbestos-products
- Removal and disposal of asbestos from buildings and industrial activities,
- Atmospheric emissions, under the Environmental Management Act
- Prohibition on the use asbestos-containing friction materials in private cars, with a few exceptions, and
- Waste removal (chemical waste designation and disposal at landfills).

The unavoidable use of asbestos is permitted with the issuing of an exemption permit. Municipalities are responsible for issuing permits for the removal of asbestos as part of their responsibility for administering municipal building regulations.

3.6.12 United Kingdom

Only Chrysotile asbestos was permitted in the United Kingdom when amosite and crocidolite were banned in 1985. More recently, the UK banned all forms of asbestos with the introduction of the Asbestos (Prohibitions) (Amendment) Regulations 1999, which came into effect in November 1999, five years ahead of the European deadline of 2005. In drafting the legislation for this asbestos ban, the Health and Safety Executive (HSE) worked closely with their counterparts from the European Commission. It was resolved that the UK ban would be pursued under the mantel of European mobilization.

The Asbestos (Prohibition) (Amendment) Regulations of 1999 forbids the import of crude fibre, flake, powder or waste chrysotile and the new use of asbestos cement, boards, panels, tiles and other products. The regulations forbid the second-hand sale of asbestos cement products and building materials covered with asbestos-containing coatings.

Chrysotile-containing products installed before 24 November 1999 can remain in place until they reach the end of their service life. The Regulations contains two pages of time-limited derogations that apply to specialised equipment[xiv].

The residual problem of brake linings was addressed with legislation that implemented European Commission Directive 98/12/EC. The Road Vehicles (Brake Linings Safety) Regulations of 1999 prohibit the supply or fitting to a motor vehicle or trailer of brake linings containing asbestos as of October 1999.

3.6.13 United Nations

The United Nations Environmental Programme (UNEP), an agency of the United Nations, is calling for global trade restrictions on all forms of asbestos.

UNEP announced in February 2002 that all forms of asbestos should be added to an international list of chemicals subject to trade controls. This decision by UNEP follows a review that was triggered by the unilateral ban imposed by the European Union.

3.6.14 United States of America

Asbestos is still legal in the United States. However, there is substantial pressure to ban asbestos. U.S Senator Patty Murray introduced broad, comprehensive legislation for the ban of asbestos in the United States in the form of the Ban Asbestos in America Act of 2002. This Act would order the Environmental Protection Agency (EPA) to issue regulations by January 2005 that prohibit the “manufacturing, processing, importation and distribution of asbestos-containing products”.

The EPA had previously issued a phase-out schedule for asbestos in 1989 under the Toxic Substances Control Act. Following legal action from the asbestos industry, the Fifth Circuit US Court of Appeal's overturned the Environmental Protection Agency's 1989 ruling on 18 October 1991 that would have banned nearly all uses of asbestos in the US by 1996.

The Court did not find fault with the science and medical opinion, but with deficiencies in how the EPA conducted a cost-benefit analysis. The court found the Environmental Protection Agency’s support for a ban under the Toxic Substances Control Act (TSCA) deficient in several major ways:

- The EPA failed open "to explore in more than a cursory way, the less burdensome alternatives to a total ban". More specifically, it virtually ignored the feasibility of a controlled-use approach
- The Court chastised the EPA for not evaluating "the harm that will result from the increased use of substitute products"

- The EPA refused to consider the "cost side of the TSCA equation" to meet the statutory requirement to "balance the costs of its regulations against the benefits"

.
Though the Court's 1991 decision overturned the EPA rule in its entirety, it did say that the EPA could ban asbestos products listed in the rule, provided they were not being manufactured, imported or processed in the United States when the rule was published in July 1989. On November 5, 1993, the EPA published a notice in the Federal Register confirming that asbestos-cement sheets (corrugated and flat), asbestos-cement shingles, asbestos clothing, roofing felt, mill board, pipeline wrap and vinyl asbestos tiles were not subject to the 1989 ban rule.

The Ban Asbestos In America Act of 2002 intends to banish the six regulated forms of asbestos. The Act further requires the EPA to determine whether people are exposed to asbestos, and how. The EPA would conduct a public education programme and an EPA panel would look into creating uniform standards and protocols across federal agencies.

The Act would require the National Institutes of Health to conduct research on diseases caused by asbestos and to create a registry and treatment centres for mesothelioma.

The Occupational Safety and Health Administration (OSHA) issued revised regulations in 1986 and 1988, covering asbestos exposure in general industry and construction in particular[xv]. OSHA has promulgated two standards for protecting workers from asbestos:

- 20 CFR section 1910.1001, which applies to workers in general industry, and
- 29 CFR section 1915.1001, which applies to workers in the construction industry

Both standards set maximum exposure limits and include provisions for engineering controls and respirators, protective clothing, exposure monitoring, hygiene facilities and practises, warning signs, labelling, record keeping, and medical exams. Tremolite, anthophyllite and actinolite were excluded from coverage under the asbestos standard in May 1992.

In both general industry and construction, workplace exposure must be limited to 0.1 fibres per cubic centimetre of air, averaged over an eight-our age work shift. In construction, there are special regulated-area requirements for asbestos removal, renovation, and diminishing operations. These provisions include a negative pressure area, decontamination procedures for workers, and a "competent person" with the authority to identify and control asbestos hazards.

4 ASBESTOS HEALTH HAZARDS

4.1 Introduction

The dangers associated with the inhalation of asbestos fibres have been known, although not necessarily very widely, for more than a hundred years[xvi]. The disease-causing capabilities of asbestos were unknown until the first case of asbestosis was recorded in England around 1900 and described by Dr Murray in 1907.[xvii] Since then, literally thousands of reports have been published. Figure 3 illustrates the pattern of disease awareness as it developed over a century and a half.

Figure 3: The relationship between asbestos production and asbestos-related diseases

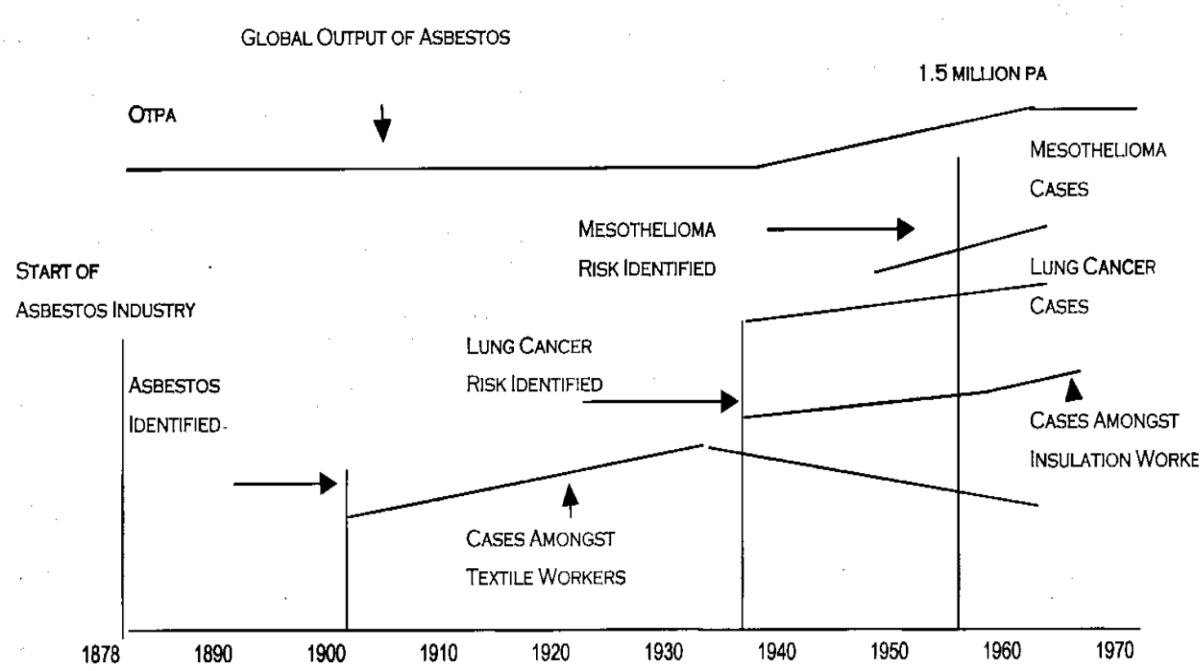


Figure 3: The relationship between asbestos production and asbestos-related diseases.
(see reference in text below)

The relationship between asbestos exposure and disease was firmly established by 1930. In 1935, the link between asbestos exposure and lung cancer had been demonstrated and by 1955, it had been linked to several other types of cancers as well[xviii]. Asbestos has been declared a proven human carcinogen by the United States Environmental Protection Agency (EPA) and by the International Agency for Research on Cancer of the World Health Organization.

Clinical studies have established incontrovertibly that asbestos causes cancer of the lung, malignant mesothelioma of the pleura and peritoneum, cancer of the larynx, certain gastrointestinal cancers, as well as asbestosis, a progressive fibrotic disease of the lungs. The risk of contracting these diseases increases with increased exposure[xix xx].

An important feature of most asbestos-related diseases is the latency period: it may take 20 to 40 years for the first symptoms to manifest. As such, many of those affected today were exposed to large quantities of fibres (sometimes more than 100 f/ml) up until the 1970s.

These levels, mostly a result of workers installing extremely dusty, sprayed-on (friable) asbestos insulation materials, were 100 to 200 times higher than current statutory exposure limits in most countries. In addition, more hazardous amphibole varieties of asbestos were frequently used at the time. Workers in the shipbuilding and construction industries who installed friable asbestos insulation materials have been the most severely affected[xxi].

Despite standards and regulations that have been in existence since the 1970s, the number of asbestos-related deaths is still rising in some countries. This may suggest that the control measures introduced were ineffective.

4.2 Possibilities of Exposure

Before discussing the health risks of exposure to asbestos, one should first distinguish between the various possibilities of exposure. As stated in the introduction, most asbestos related diseases have a long latency period, often more than 30 years. Persons that were not occupationally exposed in the years immediately before diagnosis may too easily be classified under "neighbourhood exposure", although occupational exposure may have taken place 20 to 40 years previously.

It is also necessary to stress that it is not the presence of asbestos containing materials as such but the presence of asbestos fibres that are fine enough to be inhaled or ingested that constitutes a risk.

The following categories of exposure may be distinguished[xxii].

4.2.1 Direct Occupational Exposure

Examples include work in asbestos mines, asbestos textile weaving, manufacture of asbestos cement and asbestos insulation work. In addition to these classical exposures, there are a number of jobs in which asbestos containing materials have to be handled, i.e. workers in the building industry, cutters and layers of water pipes and blowing out of vehicle brake linings. Of the occupations exposed to asbestos, those most at risk are workers who are unknowingly exposed to high concentrations of respirable asbestos in buildings: plumbers, gas fitters, carpenters and electricians, whose job has involved drilling and sawing asbestos.

4.2.2 Indirect Occupational Exposure

In these situations, workers do not handle asbestos themselves, but are exposed as a result of the activities of others at nearby workplaces.

4.2.3 Para-Occupational Exposure

This category includes leisure time activities, sometimes serving as a second job. "Handyman", or Do-it-Yourself projects may involve cutting and working with asbestos containing products. During Do-it-Yourself projects, control measures such as those enforced in industry are more than often neglected, leading to potentially high exposures for the operator and others.

4.2.4 Para-Occupational Domestic Exposure

Women married to asbestos workers, or other members of the household may be exposed as a result of handling asbestos contaminated clothing. There is insufficient data to accurately estimate the population at risk, but there is some evidence of an increased prevalence of asbestos related disease in relatives of asbestos workers.

Today, most industries enforce strict personal hygiene measures, including workplace showers and laundries.

4.2.5 Neighbourhood Exposure

This category includes people living in the vicinity of asbestos mines, asbestos processing factories and asbestos dumps.

4.2.6 True Environmental Exposure

True public health exposure includes the presence of asbestos in ambient air, food, beverages, water, as well as the wear and tear of asbestos products (i.e. building products, friction materials, etc.) In recent years, public concern has shifted from the workplace to exposure in the general environment. The environmental risks of asbestos have been studied by a number of major scientific bodies. For example, the WHO Conference on Mineral Fibres in the Non-Occupational Environment in September 1987 concluded that, for the general population, the risks of mesothelioma and lung cancer attributable to asbestos are probably undetectable low, and the risk of asbestosis is virtually zero.

A meeting on the Environmental Reduction of Asbestos convened by the WHO in 1988 calculated that high-density products (such as asbestos cement building products and friction materials) do not present an unacceptable risk to the general population, although care is needed to contain airborne dust during installation and repair. The meeting also recommended that the use of friable asbestos insulation materials should be discouraged. Diseases have developed where exposure has been only very brief, or where the quantity of airborne asbestos was very small.

4.3 Asbestos Related Conditions and Diseases

In order to cause harm, asbestos fibres must be breathed into the lungs. Respirable asbestos fibres are defined as being less than 3 microns in diameter and more than 5 microns in length, with an aspect ratio of 3:1. Such a fibre would require 500 times magnification to be seen with the human eye.

Researchers have identified a number of conditions and diseases that are associated with the inhalation of the various types of asbestos fibre. A review of the literature is provided below.

4.3.1 Asbestos bodies in the Sputum and Lung

Asbestos bodies are elongated structures between 20 μm and 200 μm[xxiii] and usually have bulbous ends. An asbestos body consists of an iron-mucoprotein complex surrounding, or coating the asbestos fibres after inhalation and retention in the lung. However, it has been demonstrated that any inorganic fibre of the appropriate size[xxiv] may form the core.

It seems as if the formation of asbestos bodies is a defence mechanism of the lungs and the mere presence thereof in the sputum or lung is not indicative of disease. Coated fibres are at the most indicative of exposure to asbestos.

4.3.2 Pleural Plaques and Diffuse Pleural Fibrosis

Pleural plaques are circumscribed areas composed of very firm, white hyaline material that may be focally calcified. These plaques may be extensive, are leaf shaped, often bilateral and have an irregular shape[xxiv].

In some cases there is generalised pleural fibrosis, leaving the lungs completely sheathed in a thick layer of fibrous tissue. Unlike plaques, generalised pleural thickening can restrict the expansion of the lungs, causing breathlessness[xxiv].

Pleural plaques are frequently found in asbestosis cases and in persons casually exposed to asbestos dust. Low exposures from work-related, domestic and natural sources may induce pleural plaques. The duration since first exposure is an important determinant in the chance of getting the disease. For diffuse pleural thickening, high exposure levels may be required[xxv].

Pleural plaques are generally not found in less than10 years, and seldom in less than 20 years after first exposure to asbestos. Pleural calcification rarely occurs less than 20 years after first exposure to asbestos. Most cases of pleural effusion occur later in persons with prolonged exposure, but in a small number it has been seen after an interval of less than 10 years[xxv].

4.3.3 Asbestosis

Asbestosis is a form of pneumoconiosis, specially associated with exposure to asbestos dust. The disease is characterised by a massive interstitial fibrosis starting at the base of the lungs and progressing slowly upwards[xxiii xxiv xxvi]. During the development of the disease, the lung tissue is gradually changed into a diffuse collagenous fibrotic mass. The active lung tissue is thereby replaced by inactive scar tissue, resulting in dyspnoea[xxiii].

Asbestosis is usually associated with the presence of large numbers of asbestos bodies and fibres in the tissue. Pleural plaques may be present[xxv]. A dose-effect relationship has been establishment for asbestosis. The degree of the disease will therefore depend on the dose, i.e.

$$\text{Dose} = \text{Concentration} \times \text{Duration of exposure.}$$

Asbestosis is generally associated with relatively high exposure levels and there is no evidence that casual exposure, such as occurs in the general population, causes asbestosis. According to Rees[5], asbestosis presents after a minimum of 10 to 20 years of exposure, with a latent period between first exposure and disease discovery a minimum of 15 years, and often considerably longer.

As a general guideline, asbestosis will not progress to clinical manifestation at or below a lifetime occupational exposure of 25 fibre/ml years, i.e. concentrations of 5 fibres/ml for 5 years, or 1 fibre/ml for 25 years, etc[xxv]. In this respect, it is important to refer to the section of this report dealing with South African regulations, as the Asbestos Regulations introduced in 1987 in RSA specified an Occupational Exposure Limit of 1 fibre/ml (assuming 24-hour exposure during a working lifetime of 25 years) and was primarily aimed at preventing asbestosis.

Asbestosis does not occur as a result of the occasional cutting of asbestos but rather in workmen regularly exposed to the dust. The disease, however, has been demonstrated in wives that came into continuous contact with the clothes of workmen and in persons living in the vicinity of asbestos mines, factories and dumps[xxv].

Asbestosis may be well established before it is diagnosed by radiological or physiological examination and cigarette smoking often obscures the symptoms[xxv]. Sufficient exposure may cause the disease to progress after the worker has left the industry.

4.3.4 Cancer of the Lung

In 1955 Doll concluded that asbestos workers faced a lung cancer risk ten times as great as that in the general population. It must be added that the group of affected workers had had 20 years or more exposure before the implementation of the Asbestos

Regulations in England in 1931.

A more recent study indicated that the risk of developing lung cancer varied between 1,5 to 5,6 times or higher than the normal risk[xviii]. Most studies suggest a dose-response relationship with lung cancers more common in those groups most heavily exposed.

The Helsinki Criteria offers practical guidelines as to whether a lung cancer should be attributed to asbestos exposure. According to these criteria, a minimum lag time of 10 years from first exposure to asbestos is required to attribute lung cancer to asbestos.

The risk of contracting a lung cancer seems to run parallel with the asbestosis risk, i.e. asbestosis sometimes leads tocancer of the lung[xviii xxiii xxiv].

There is a definite relationship between cancer of the lung and cigarette smoking in asbestos workers. The risk of a cigarette-smoking worker heavily exposed to asbestos developing lung cancer is 25 to 50 times greater than an age-matched non-smoker who has never worked with asbestos[xxiv]. The reason for this increased risk associated with smoking seems to be that the two carcinogenic factors act in a multiplicative fashion rather than an additive fashion.

4.3.5 Mesothelioma

Mesothelioma is a rare diffuse cancer that spreads over the surface of the lung (pleura) and the abdominal organs (peritoneum). Wagner et al first suggested an association between this disease and asbestos exposure in 1960, when he found an abundance of cases in the vicinity of asbestos mines in the Northern Cape Province[xxvii]. Today this association is clear, although discussions continue on whether some types of asbestos fibre and level of exposure have greater potential in causing the disease than others.

Patients with mesothelioma often have a history of only transient exposure to asbestos, amounting to a few weeks only, many years before diagnosis[xxiii]. Mesothelioma may be present in the absence of any radiological or pathological evidence of fibrosis. Some cases show amounts of asbestos bodies in the lung that are the same as that observed in city dwellers[xxiii]. This raises the question of whether minor degrees of asbestos pollution are capable of giving rise to mesothelioma.

According to Rees, city dwellers are not at risk from the general background pollution produced by widespread asbestos use[xxv].

Lag periods of between 25 years and 50 years with an average of 33 years between first exposure and the onset of symptoms have been recorded[xxiii]. Rees gives a latency period of 30 to 40 years as the norm.

4.3.6 Cancer of the Gastro-Intestinal Tract

Several studies have reported a significant increase in cancer of the gastro-intestinal (GI) tract as a result of asbestos exposure[xxiii xxiv]. A GI cancer risk of 1 in 10 workers exposed to asbestos is mentioned.

Many everyday commodities, such as water, beer and other drinks, may present a health hazard as a result of asbestos contamination[xxiii].

4.3.7 Asbestos Warts

These wart-like formations in the skin develop around asbestos fibres that have penetrated into the skin. They are found in exposed parts of the skin of asbestos workers. These warts are harmless[xxiii].

4.4 The Incidence of Asbestos Related Diseases

Studies regarding the incidence of asbestos related diseases (ARD's) in South Africa and elsewhere in the world have been conducted since the mid 1920's. The studies have proven the causal effect of asbestos in causing certain diseases such as asbestosis, cancer of the lung and mesothelioma.

The earliest South African reference to asbestos related disease was a report of the histological findings in the lung of a chrysotile miner who died in 1926[xxviii].

A systematic epidemiological study of South African chrysotile miners by Slade between 1926 and 1930 revealed that: "with continued exposure to high concentration of asbestos dust, workers may show symptoms and physical signs of pulmonary fibrosis within a year"[xxix].

Autopsy findings of 64 Pietersburg asbestos field miners, who died in active service between July 1959 and June 1964, revealed the presence of asbestosis in 51 out of 64 autopsies (80%)[xxx].

Mesothelioma is considered to be a rare tumour. An association between this disease and asbestos exposure was suggested by Wagner et al in 1960, who found an abundance of cases in the vicinity of asbestos mines in the Cape Province (now referred to as Northern Cape)[xxxi].

Mesothelioma's incidence has been reported as between 1 and 2,2 per-million-per-year in Canada and the USA respectively[xxxii]. Research conducted by McDonald & McDonald revealed that mortality rates for mesothelioma seemed to be the highest in insulation workers[xxxiii]:

- Ranging from 5,2% to 8,8% in insulation workers
- 0,8 to 6% in asbestos factory workers
- 0% to 0,19% in anthophyllite or chrysotile miners and millers; and
- 0,03% to 0,06% in the general population

These figures are, however, representative of the situation in countries such as Canada and the USA and are, therefore, not entirely applicable to South Africa.

The South African incidence of mesothelioma has been found to be more than 3 times higher than in the USA. The explanation given is that asbestos is not mined or milled in any quantity in the USA, whereas these activities are central to the South African asbestos industry[xxxiv]. The Canadian incidence rate was also found to be much lower than in South Africa, presumably because only chrysotile is mined and milled in Canada. South Africa mined crocidolite and amosite which are considered to be more carcinogenic in man than chrysotile[xxxv].

Solomons stated that the reporting of mesothelioma cases in South Africa is unreliable[xxxiv]. Considering the dose-response relationship, it was further stated that it is reasonable to assume that employees with shorter durations of exposure have a lower relative risk of contracting mesothelioma, compared to those with longer exposures[xxxvi]. Most South African asbestos miners have been exposed for relatively longer periods and would therefore have a significantly higher risk (an exposure of greater than 2-3 fibre-years/ml) for the development of asbestos disease. Solomons stated that, in spite of the relatively large numbers of miners who have mesothelioma, significant numbers of cases are not recognised or diagnosed. From the mean figure of 96,3 new cases of mesothelioma per year at the time of the study, Solomons derived a mesothelioma incidence rate of 7,2 per million of population (Age-adjusted to US population (1980) for annual best-available South African mesothelioma incidence rate).

A further study conducted by Solomons reviewed the clinical and epidemiological features of 80 cases of malignant mesothelioma (as proven by examination of biopsy specimens) referred to the clinic at the NCOH between January 1977 and June 1983. This study revealed that there was a positive history of asbestos exposure in 71 out of the 80 subjects (89%). Similar studies in the past have found between 18% and 97% positive asbestos related exposure histories[xxxv]. Exposures included Cape crocidolite and amosite asbestos, predominantly in mixed combinations. In 17 out of the 80 subjects (21%), the exposure was solely to Cape crocidolite asbestos. A mean exposure period of 13,6 years, and a mean lag period of time from first exposure to diagnosis of 34,4 years, was reported[xxxiv].

Felix, in a study of the Mafefe community, drew attention to the potential numbers of previously undetected cases of occupational lung disease among the men and women living around old asbestos mines[xxxvii]. The study also drew specific attention to the exposure of women to asbestos. In a random sample of adults living in Mafefe in 1998, Felix found that 126/247 (51%) men and 137/432 (32%) women had worked in mines. 60% of the men and 44% of the women were found to have radiological evidence of asbestos related pleural disease.

The above-mentioned findings led to the first survey of occupational lung disease in women. A study by Davies et al of a sample of 770 women, who had worked in asbestos mines in the Northern Province between 1929 and 1992, determined the prevalence of asbestos related disease[xxxviii]. A clinical diagnosis of pleural and/or parenchymal asbestosis was made in 741/770 (96,2%) of the women. The reasons for the high prevalence of asbestosis may be attributed to the high levels of amphibole dust exposure and the long residence time of the dust in the lungs. This study therefore confirmed that there is a significant unrecognised burden of asbestos related diseases among woman in South Africa who have worked on asbestos mines.

A broad study was conducted by Rees et al covering the major centres in South Africa, to describe the exposure experiences of South African mesothelioma cases, with emphasis on the contribution made to the caseload by different fibres during exposure[xxxix]. A sample of 123 subjects, diagnosed with mesothelioma, was interviewed in various centres in South Africa.

The results revealed a convincing history of asbestos exposure in 118/123 (96%) of the subjects:

- Strong evidence of exposure to crocidolite asbestos was reported in 68/123 (55,3%) of the mesothelioma cases
- None of the 123 mesothelioma subjects had previously worked on chrysotile asbestos mines
- Environmental exposure accounted for 22/123 (18%) of the mesothelioma cases, of which 20/22 (91%) had contact with Cape crocidolite asbestos.
- There was a relative scarcity of cases linked to amosite and no convincing chrysotile asbestos case.

From the results of this study, and taking note of the high percentage of asbestos exposure histories in the mesothelioma subjects, it can be deducted that non-asbestos cases of mesothelioma occur rarely in South Africa. The study further establishes that there is fibre gradient of mesotheliomagenic potential for South African asbestos: crocidolite > amosite > chrysotile.

Sluis-Cremer et al suggested that, according to South African data, amosite is less dangerous than Cape Crocidolite, at least as far as mesothelioma is concerned[xl]. These researchers found the incidence of mesothelioma for crocidolite exposed workers to be 446 per million person-years, and for amosite exposed workers to be 78 per million person-years. A significant difference can be detected for the mesothelioma incidence between workers exposed to crocidolite and amosite fibres respectively

A birth cohort mortality study was carried out by Kielkowsky et al to establish the risk of developing mesothelioma in a group born between 1916 and 1936, in Prieska, Northern Province. Kieslowsky referred to several studies that have shown an increased risk of developing mesothelioma or respiratory cancer after occupational or environmental exposure to crocidolite asbestos.

Botha et al reported an annual death rate due to asbestosis or mesothelioma for white people of 542 per million for a high exposure crocidolite area (which included Prieska), 87 for a low exposure crocidolite area, and 24 in a control area[xli]. By comparison the rates for coloured people were 573 per million for high exposure areas and 215 per million for low exposure areas, respectively. Sluis-Cremer et al showed a mesothelioma rate of 446 per million person-years for white men employed in crocidolite mining[xxx]. By comparison, a recently published study conducted in Australia estimated the incidence of mesothelioma due to environmental asbestos exposure in Witenoom as 270 per million person-years[xlii]. From the above it may be deducted that there are consistently observed, increased rates of asbestos related diseases, such as mesothelioma, especially in areas where crocidolite asbestos was mined.

The study conducted by Kielkowsky et al in the Prieska area revealed high figures for mesothelioma mortality, and for lung cancer mortality[xliii]. The mortality rates for men and women were 366 and 172 per million person-years respectively. The mortality for lung cancer was 287 per million person-years. The study found that all cancer mortality ratios were increased. The reasons given for the higher mortality rates in men, was that men were more likely to be exposed to both occupational and environmental exposure. The mortality rate for woman was still considered to be high and may be attributed to the high level of environmental exposure in the Prieska area. Kielkowsky further stated that the cause-specific mortality rates could be expected to increase over time due to the long latency periods from the first exposure to diagnosis of the neoplasms.

4.5 OCCUPATIONAL HEALTH RISKS

There are no valid, reliable incidence statistics of asbestos related diseases (ARD's) for South African mining and industrial environments. There are a number of sources from which it is possible to obtain individual case information. However, no one has as yet attempted to produce statistics that would indicate the percentage of people that are exposed to asbestos and who then subsequently develop an ARD.

This makes projecting the occupational health benefits of phasing out of asbestos in South Africa extremely difficult. Unlike the economic costs and benefits (i.e. disinvestments/investment, employment, cost/price changes, etc.), it is impossible to project with any degree of reliability the likely reduction in diseases and deaths, nor the medical and compensation cost savings that would be made from a complete phasing out of asbestos in South Africa.

4.6 ARD COMPENSATION STATISTICS

One of the few organisations that does have data on ARD's is the Workers Compensation Fund. This organization processes claims for compensation from South African workers who have develop occupational diseases. As such, the Fund has case information for workers that have submitted claims for ARD's.

Table 8 reflects a breakdown of the 277 ARD cases processed by the Workers Compensation Fund for the 1994 to 1997 period. The table reflects the numbers of claims submitted and paid out by industry sector, ranked by number of claims submitted.

TABLE 8: WORKERS COMPENSATION FUND ARD CASES

	NUMBER OF CASES		NUMBER OF PAYOUTS	TOTAL PAY OUT	AVERAGE PAY OUT
Underground Mining	92	33.2%	84	R 13,946,323	R 166,027.65
Transnet Operations	34	12.3%	29	R 4,054,316	R 139,804.00
Asbestos Product Manufacturing	27	9.7%	26	R 3,082,740	R 118,566.92
Metal Tube Manufacturing	17	6.1%	15	R 2,483,750	R 165,583.33
Electrical Power Generation	11	4.0%	11	R 2,071,200	R 188,290.91
Foundry Manufacturing	10	3.6%	10	R 776,494	R 77,649.40
Cement/Coal Merchanting	9	3.2%	9	R 1,393,685	R 154,853.89
Chemical Manufacturing	8	2.9%	8	R 1,370,600	R 171,325.00
Building & Construction - General	7	2.5%	7	R 502,823	R 71,831.86
Professional Services	5	1.8%	5	R 828,480	R 165,696.00
Textile Manufacturing	5	1.8%	5	R 341,552	R 68,310.40
Auto Maintenance	4	1.4%	4	R 267,609	R 66,902.25
Brick Manufacturing	4	1.4%	4	R 1,448,193	R 362,048.25
Concrete Manufacturing	4	1.4%	4	R 834,573	R 208,643.25
Iron and Steel Manufacturing	4	1.4%	4	R 181,483	R 45,370.75
Glass Manufacturing	3	1.1%	3	R 380,967	R 126,989.00
Oil Distribution	3	1.1%	3	R 81,896	R 27,298.67
Steel Erection	3	1.1%	3	R 277,428	R 92,476.00
Banking, Finance and Insurance	2	0.7%	2	R 223,015	R 111,507.50
Bonded Warehousing	2	0.7%	2	R 29,788	R 14,894.00
Farming	2	0.7%	2	R 301,656	R 150,828.00
Food Retailing	2	0.7%	2	R 421,636	R 210,818.00
Building & Construction - Installation	1	0.4%	1	R 20,783	R 20,783.00
Building Merchanting	1	0.4%	1	R 15,032	R 15,032.00
Candle Manufacturing	1	0.4%	1	R 17,637	R 17,637.00
Cement Manufacturing	1	0.4%	1	R 105,542	R 105,542.00
City Council Administration	1	0.4%	1	R 17,345	R 17,345.00
Educational Services	1	0.4%	1	R 349,398	R 349,398.00
Electronics Manufacturing	1	0.4%	1	R 11,776	R 11,776.00
Fruit Canning	1	0.4%	1	R 19,015	R 19,015.00
Gas Manufacturing	1	0.4%	0	R 0	#DIV/0!
Grain Milling	1	0.4%	1	R 242,485	R 242,485.00
Granite Manufacturing	1	0.4%	1	R 54,864	R 54,864.00
Hospitals	1	0.4%	1	R 67,379	R 67,379.00
Hotels	1	0.4%	1	R 28,181	R 28,181.00
Panel Beating	1	0.4%	1	R 498,916	R 498,916.00
Printing	1	0.4%	1	R 25,700	R 25,700.00
Shipping	1	0.4%	1	R 31,707	R 31,707.00
Tobacco Manufacturing	1	0.4%	1	R 465,052	R 465,052.00

	Number of Cases		Number of Payouts	Total Pay Out	Average Pay Out
Transport	1	0.4%	1	R 18,030	R 18,030.00
Vulcanising	1	0.4%	1	R 906	R 906.00
TOTALS	**277**		**260**	**R 37,289,955**	**R 143,422.90**

Although these statistics do not reflect the incidence of ARD's in these sectors, a comparison of the absolute number of claims submitted and paid per sector may give some indication of the relative prevalence of ARD's across industries.

Mining, with 33%, has the highest number of claims. Relative to mining all of the other industries have srelatively small numbers of claims. This seems to suggest that the incidence of ARD's in these industries may be quite low. However, without proper epidemiology and incidence statistics, this may in fact be an invalid assumption.

4.7 Summary and Conclusion

The relationship between asbestos exposure and diseases such as asbestosis, cancer and mesothelioma has been demonstrated in numerous studies conducted over the greater part of the last century. There are a number of possibilities where workers or members of the general public may be exposed to asbestos, ranging from occupational to environmental exposure.

With regard to the ability of the various forms of asbestos fibres to cause disease, it was proven that a fibre gradient could be observed. Rees et al concluded that there is a fibre gradient of mesotheliomagenic potential for South African asbestos. This fibre gradient can be summarised as follows: crocidolite > amosite > chrysotile. Studies by Sluis-Cremer et al support this view.
Various researchers have expressed the opinion that current estimates of asbestosis and mesothelioma, and other asbestos related lung diseases, are an underestimate of the true situation. It was stated by Rees that comprehensive information on occupational lung disease is not available for South Africa and, what is available underestimates disease burdens markedly[xliv].

Despite the fact that there are no valid reliable epidemiological studies of the incidence of asbestos related diseases in South Africa, there is a significant body of case related evidence that suggests that ARD's are a significant public health issue.

More research, surveillance and case-finding activities are needed and the data that is gathered by state agencies needs to be put to better use. Compensation and enforcement agencies need to appreciate the value of the data they create, and thus publish it more quickly and comprehensively, and make data sets available to researchers as a matter of course[xliv].

Useful data is contained in compensation statistics (i.e. Workmens Compensation Commission, the Medical Bureau for Occupational Disease – MBOD), surveillance programmes (i.e. Surveillance of Work-Related and Occupational Respiratory Diseases in South Africa – SORDSA, the Pathology Division Report) and national registers (i.e. the National Cancer Register). However, because of differences in recording, great care should be exercised when making comparisons and extrapolations from the available information[xliv].

5 ALTERNATIVE FIBRES AND SUBSTITUTE PRODUCTS FOR ASBESTOS

5.1 ALTERNATIVE FIBRES

There is a wide range of alternative fibres that can readily be used to replace asbestos in the manufacturing of materials and products that currently contain asbestos[xlv]. The range of alternative fibres include:

- Natural organic fibres:
- Cellulose
- Cotton
- Jute
- Synthetic organic fibres:
- Aramid
- Polyvinyl alcohol (PVA)
- Polyamides and polyacrylonitrile
- Natural minerals:
- Aluminium oxide
- Carbon/graphite fibres
- Fibrous clays
- Steel wool
- Wollastonite
- Man-made mineral fibres (MMMF):
- Ceramic fibres (ceramic textile fibres and refractory ceramic fibres)
- Glass fibre (i.e. glass wool or fibreglass, continuous glass filaments and special purpose glass fibres)
- Kevlar
- Mineral wool (rock wool and slag wool)
- Silicon carbide fibres and whiskers

For all new or replacement uses of chrysotile asbestos, consideration should be given to using an alternative fibre or substitute product[xlvi]. In doing so, the following steps should be taken:

- Identify the alternative/substitute product
- Compare the risks of using chrysotile asbestos against available non-asbestos alternatives/substitutes
- In comparing, consider:
- The direct effect on human health of exposure to chrysotile asbestos compared with the non-asbestos material
- The balance of risks, i.e. If the technical performance of the alternative/substitute is inferior to chrysotile asbestos, compared failure may result, leading to accidents and danger to human health, safety or the environment

Each case should be considered on its merits. Where, in exceptional circumstances, it is still not practicable to replace asbestos, a continuous review of new alternative fibres and substitute products should be maintained.

5.1.1 Performance Characteristics

In most instances, alternative fibres provide acceptable performance levels as compared to asbestos. However, in the case of certain very high temperature and high-pressure applications, alternative-fibre formulations may not provide acceptable sealing and/or insulation performance. In these exceptional cases, it may not yet be possible to replace the existing asbestos-containing gaskets, seals or insulation materials with non-asbestos alternatives/substitutes.

Metal, carbon and refractory ceramic fibres have a narrow range of specialist applications. Initially, the use of such alternative fibres may have led to a reduction in technical performance. However, many of these technical deficiencies have now been overcome and these alternative fibres now provide acceptable performance levels as compared to asbestos.

There are other speciality fibres, such as silicon carbide whiskers, which may be used for special, high-tech applications, for example in aircraft engines. These special-use applications have specific requirements for particular fibre characteristics and the fibres used are thus not strictly a replacement for asbestos.

5.1.2 Cost Differences

In general, alternative fibres are more expensive that asbestos. The direct cost-per-kilogram premiums vary from 50% to 1,000%. However, in many instances, material/product formulations can be varied so that the comparative cost differences at the end-user/customer level can be restricted to 10% to 50% price premiums.

5.2 THE HEALTH EFFECTS OF ALTERNATIVE FIBRES

The potential for adverse health effects related to the production and use of substitute fibres, and in particular man-made mineral fibres (MMMF), is still being studied. Based on the available information, there is evidence of biological activity, and that the effects will vary according to the different types of substitute fibres.

Because of the similarity of the chemical composition and morphology of, especially MMMF materials to those of asbestos, questions have been raised about their health implications, and in particular if these substitutes pose a carcinogenic risk.

Before considering the health effects of substitute fibres, the main determinants of toxicity should be clarified. The primary factors related to potential for toxicity due to exposure to fibres are:

- Fibre dimension
- Fibre durability and
- Dose.

According to the "Stanton hypothesis" (as determined by animal implantation studies), the carcinogenic potential of fibres is related to their dimension and durability (1). Fibres that are long and thin (but of a respirable size) are considered to have the greatest potential for causing adverse health effects, if delivered to the lungs in sufficient concentration.

5.2.1 Fibre Dimension

The dimension of fibres dictates what is inhaled, what is deposited and which fibres will reach the target tissue. Fibres of a respirable size are those that are less than 3.0 to 3.5 µm in diameter and less than 200µm in length – according to the ILO, "a respirable fibre is a particle with a diameter of less than 3µm and with an aspect ratio of 3:1 or greater". The greatest risk for developing adverse health effects is associated with fibres less than 0.25µm in diameter and greater than 8µm in length.

The dimensions of natural occurring fibres, such as asbestos, differ from MMMF's. Natural occurring fibres exist in a polycrystalline structure with the tendency to cleave along longitudinal planes, creating thinner fibres with higher length-to-diameter ratios that have a greater potential for toxicity (2). MMMF's, on the other hand, are non-crystalline or amorphous and will fracture perpendicularly to their longitudinal plane into shorter fibres. This is an important difference between asbestos and man-made fibres.

The dimensions of MMMF's can be manipulated and are manufactured according to specific nominal diameters varying according to fibre type and use. Table 9 indicates that MMMF's in general have larger diameters compared to asbestos fibre (3).

TABLE 9: NOMINAL DIAMETERS OF SOME MAN-MADE MINERAL FIBRES

FIBRE TYPE	NOMINAL DIAMETER (MM)
Refractory Ceramic Fibres	1.2 - 6.0
Glass Wool	0.05 – 15.0
Mineral Wool	6.0 – 9.0

It is believed that the comparatively larger fibre diameters of MMMF's may explain the observed differences in the carcinogenic potential between man-made mineral fibres and asbestos fibres in both animal inhalation and human studies (4). The larger (in diameter) man-made mineral fibres may be deposited in the respiratory tract and may not reach the lung tissue in the same quantities as the finer asbestos particles.

It may be concluded that the fibre dimension is an important factor in determining whether the inhaled fibres will reach the target organ/s. MMMF's may be considered as intrinsically safer than naturally occurring fibres such as asbestos, due to the fact that the fibre dimensions can be manipulated and controlled during the manufacturing process.

5.2.2 Fibre Durability

There is a collective opinion among researchers that fibres, once inhaled, must be durable and persist for a certain time in order to induce a tumour. There is, however, no precise agreement about the length of time that fibres must persist to alter cells of the bronchial walls or the pleural or peritoneal tissues.

Durability can be defined as the relative resistance of the fibre to dissolution through attack by the body's biological fluids. The durability of fibres deposited in the lung is dependant upon the lung's ability to clear the fibres, as well as the fibres' physical and chemical properties.

Processes such as dissolution, disintegration, elimination or migration through the body may affect the persistence of a fibre in the body.

Research conducted on the ability of different fibre types to dissolve, have shown that there is a direct link between how long it takes for a fibre to dissolve and the likelihood of developing health effects (5). In general, it can be stated that fibres capable of dissolving in the human body are rendered harmless. On the other hand, fibres that don't dissolve are almost certain to cause adverse health effects, particularly if they are respirable fibres.

The durability of MMMF's (as in the case of the fibre dimension) can be manipulated in the production process according to specific end-use requirements through the addition of certain stabilisers.
It has been stated that the durability of a fibre is dependant on chemical composition. Therefore, the known chemical composition of a fibre can predict the potential with which a fibre may cause disease.

"K-Dis" is a term used to express the relative solubility of a fibre, and is expressed as a number given to a fibre according to its chemical composition (6). A high K-Dis means that the fibre dissolves easily, and therefore the potential to cause disease is low. A low K-Dis, on the other hand, means that the fibre persists in the lung, with a subsequent high potential for causing disease.

The "ideal' K-Dis rating that can be awarded to a fibre is 100 or more. Fibres that are given a high K-Dis rating can be regarded as "healthy" or safe, as opposed to fibres with a low K-Dis rating, which would be regarded as dangerous.

To provide an example, asbestos has a low K-Dis rating and is therefore harmful if the fibres would be inhaled into the lungs.

In a study conducted by a manufacturer of fibreglass (Owens Corning), it was revealed that fibreglass produced by the company had a K-Dis rating of close to 100, according to its chemical composition. In the event that these fibres would be inhaled, the rapid dissolution will render the fibres harmless.

In general, it has been stated that durability studies indicate that glass and mineral wool fibres are less durable than ceramic fibres, which in turn, are less durable than asbestos fibres.

An in vitro durability ranking study conducted by Scholze and Conrad revealed further evidence regarding the durability of different fibres. The study expressed the fibre durability in terms of fibre life years. Excerpts from the results of the study are presented in Table 10.

TABLE 10: COMPARATIVE FIBRE DURABILITY RANKINGS

RANK	MATERIAL	MEDIAN DIAMETER (μM)	DISSOLUTION VELOCITY (NM/DAY)	FIBRE LIFE (YEARS)
1	**Glass wool, TEL**	3.5	3.45	0.4
2	**Glass wool, Superfine**	0.38	1.4	1.0
3	**Slag wool**	4.8	0.69	2.0
4	**Refractory, Fibrefrax**	1.85	0.27	5.0
5	**Asbestos, Chrysotile**	0.074	0.005	Approx. 100
6	**Asbestos, Crocidolite**	0.17	0.011	Approx. 110

The results of this durability study revealed the differences between man-made and natural fibres. From the above it may be estimated that man-made mineral fibres will dissolve in less than 10 years, compared to natural fibres, such as chrysotile and crocidolite, which may require approximately 100 years or longer to dissolve.

Asbestos fibres have substantially higher residence times in the lungs and, therefore, display a higher potential for causing disease, when compared with man-made fibres.

Because of the differing chemical composition and fibre dimensions of man-made fibre, the potential toxicity is expected to vary, and has to be evaluated on a fibre-type-by-fibre-type basis.

5.2.3 Dose

The extent of physiological response is related to the dose. According to Singh and Coffman, dose is perhaps the most important factor in explaining the observed differences in the carcinogenic potency of asbestos and MMMF's (8).

It was further stated that exposures of workers in man-made mineral fibre industries to airborne fibres are generally lower than exposures in similar processes where asbestos is involved. This may be ascribed to the larger fibre diameters of man-made mineral fibres compared to asbestos.

Unlike asbestos fibres, man-made mineral fibres do not split longitudinally into fibres of small diameter, but tend to break transversely into shorter and thicker segments than asbestos fibres. The result is that the inhaled coarser man-made mineral fibres may not always reach the target tissue to cause comparable damage.

In summary, when considering the primary factors related to potential for toxicity, man-made mineral fibres are thought to have less potential than natural occurring fibrous silicates (i.e. asbestos) for producing adverse health effects, due to the following reasons:

- The non-crystalline state of man-made mineral fibres and the tendency to fracture into shorter fibres and
- Man-made mineral fibres, once inhaled, are generally less durable to attack from the body's biological fluids.

5.3 SUBSTITUTE PRODUCTS

There are many long-established alternatives to chrysotile asbestos that do not rely on fibre technology. For example, corrugated polyvinyl chloride (PVC) and steel sheeting can be used instead of asbestos cement sheets.

5.3.1 Non-Asbestos Fibre-Cement

Since 1985, considerable success has been achieved with the use of organic cellulose (or wood) fibres as the reinforcing in a calcium silicate hydrate matrix. Initially the product range was limited to flat sheets such as ceiling boards, partitions and roofing slates. Efforts to develop non-asbestos profiled roofing sheets were not, however, successful until 1998. The breakthrough followed a decision to concentrate on improving the strength and the permeability of the total matrix. The addition of small amounts of condensed silica fume, together with the optimisation of the raw material mix and improvements in the manufacturing process, boosted the inherent strength of the product.

A recent innovation is the introduction of a small quantity of synthetic fibre (polyvinyl alcohol - PVA) into the product mix to allow shaping of the wet product into moulded products and more sharply defined roofing sheet profiles.

Cellulose fibre-cement products manufactured in South Africa comply with SABS ISO 9933.

5.3.2 Corrugated Metal Roofs

Studies have shown that, depending on the type of corrosion protection used; the useful life of corrugated iron roofing is significantly shorter (by one-quarter to one-third) than that of chrysotile-cement roofing. Not only is the maintenance of corrugated iron costly over time, it clearly has inferior acoustic and thermal insulation characteristics.

The production of corrugated galvanized iron sheets consumes 2 to 2.5 times more energy than chrysotile-cement. The figure rises even more when the energy content of coatings applied for aesthetic reasons and to prolong the durability of the products is factored in. When the longer service life of chrysotile-cement is factored in, coated galvanized iron sheet is estimated to consume about 5 times more energy than chrysotile-cement sheet production.

5.3.3 PVC (Polyvinyl Chloride)

The principal competing products for chrysotile-cement pressure pipes are PVC and ductile iron. PVC in particular has made great inroads in these markets. There is, however, growing attention from the medical and scientific communities on the potential health and safety risks of these materials. For example, vinyl chloride monomer (VCM) used in PVC is a well-known human carcinogen that affects the brain and liver. VCM is also known to leach out of the pipe into drinking water. Furthermore, in developing countries, PVC pipe may contain lead as a stabilising agent. Concerns have also been raised regarding the quantity of dioxins released into the environment during the production of PVC. In addition, several of the bonding agents used in the installation of PVC pipe are potential toxins.

Overall, the predicted durability of PVC is about 50 years. Chrysotile-cement pipe has an expected life of approximately 70 years. And for the same price, four times as much chrysotile-cement pipe can be installed. Moreover, it is known that PVC pipes do not stand up well to the climactic conditions of certain regions: a rise in water temperature or exposure to ultraviolet rays during storage and installation may damage them.

5.3.4 Ductile Iron Pipes

Like chrysotile-cement pipe, cast iron pipe with a protective coating has a useful life of about 70 years. The useful life of cast iron may be shorter in more aggressive soils or water, often because of the presence of corrosive agents.

Ductile iron pipe is also not without risks. In its landmark ruling overturning the US Environmental Protection Agency's asbestos ban, the US Court of Appeals concluded that there is evidence that ductile iron is associated with cancer deaths. The EPA's own studies found that the population cancer risk for the production of ductile iron pipe may be comparable to the population cancer risk for the production of asbestos-cement pipe.

5.3.5 Reliability and Performance of Substitute Fibres in Brakes

In addition to the health problems linked to their handling, some non-asbestos friction materials may have inferior physical and technical characteristics. Despite higher manufacturing costs than for chrysotile-containing products, and despite years of technological research and development, substitute fibre-based products still pose performance problems for certain types of vehicles.

In the United States, every year exploding heavy truck brake drums cause numerous highway fatalities. Diagnoses of truck brake drums in the past few years show that the rupture is often linked to a defective non-asbestos brake shoe.

A study by the EPA and the American Society for Mechanical Engineers shows that it is dangerous to install non-asbestos brake linings on cars initially designed with linings containing asbestos.

To alleviate the problems of unbalanced non-asbestos brakes, manufacturers have developed anti-locking systems. It is still too soon to evaluate the advantages and risks of these products, but one thing is clear, the price of cars has been increased without necessarily adding to the safety of consumers.

5.3.6 Replacement of Chrysotile in Gaskets

It takes 50 to 60 different substances to replace the various grades of chrysotile fibre used in the gasket industry. Development of these substances and their industrial applications involves very costly research for the industry, and hence, increased costs to consumers.

Gaskets that previously contained 80% chrysotile now contain 20% to 25% substitutes, the difference being made up by filler. It has been argued that such a composition may result in sudden rupture and shattering of the gasket, particularly in high temperature, high-pressure applications. In addition, it requires more frequent inspections than those usually foreseen for chrysotile-based gaskets which were much more resistant.

5.4 SUMMARY AND CONCLUSIONS

The available information suggests that there are many alternative fibres that could be used as replacements for asbestos fibres in most existing asbestos-containing materials. In addition, there are also substitute products that could be used instead of asbestos-containing products for a number of applications where these products are currently being used.

However, it would also appear as if there are still some asbestos-containing materials and products where replacement may not be possible (or wise), based on the inability of alternatives and substitutes to meet the functional performance requirements and safety standards stipulated by either customers or regulations. Also, it would appear as if there might be significant cost differences between asbestos and the replacement fibres and products.With regard to occupational health and safety requirements, there appear to be differing views with regard to the safety of some of the alternative fibres (and even some of the substitute products). In considering these alternative fibres and substitute products, the following questions need to be addressed:

- What is the application for which an asbestos-containing product is being used – what is the core functional need that is being satisfied (i.e. insulation, friction-control, sealing, reinforcement, etc.)?
- Is it technologically feasible to replace asbestos with an alternative fibre, or a substitute product – does an alternative fibre and/or substitute product exist? And will the alternative/substitute provide an acceptable level of functional performance that satisfactorily addresses the core need?
- Is it economically viable to replace asbestos with an alternative fibre or substitute product – is the cost of the alternative/substitute acceptable? Can an adequate profit be made? Will the customer be willing to pay the price?
- Is the alternative fibre or substitute product safe – what are the occupational health implications for workers handling these substances/products? And what is the impact on the broader environment and, therefore, other community stakeholders?

The answers to these questions will have a direct bearing on any decision to replace asbestos with an alternative fibre or a substitute product.

6 HISTORY OF ASBESTOS IN SOUTH AFRICA

6.1 HISTORICAL DEVELOPMENT

In the early years of the 20th century, asbestos deposits were found in South Africa and what is now Zimbabwe. Asbestos mining in South Africa began in earnest in the 1930s. In the following decades, it attracted a multitude of big and small companies, and even individuals. In the early days, mining and production methods were crude, with the fibre being separated from the ore by hand. In some cases the "mines" were spade-and-wheelbarrow operations run by farmers who had found deposits on their land.

Two international mining groups, the Swiss Eternit Group, and the British-owned Cape Asbestos SA, and the South African-owned Griqualand Exploration and Finance Company (Gefco) were the major mining companies that were active in South African asbestos mining from the early 1940s to the late 1990s.

Asbestos mining peaked in the late 1970s when Gefco had four active mines, Eternit four and Cape two. In 1979, Eternit sold its asbestos mines to Rand Consolidated Properties who in turn sold out to Gefco in 1981. At this stage, after a long series of mergers and acquisitions, the number of major producers had been reduced to two companies: Gefco and Msauli Asbestos. Gefco produced the amphiboles crocidolite and amosite - commonly known as blue and brown asbestos - in the North-Western Cape and in the North-Eastern Transvaal; while Msauli produced chrysotile, or white asbestos, in the former KaNgwane homeland near Barberton. Ultimately, Gefco purchased Msauli, leaving only one active asbestos mining company in South Africa.

In 1988, Gefco disinvested from asbestos mining and sold its remaining mines, including Msauli, to management, who formed a company called Hanova Mining Holdings.

As a result of declining international demand, South African asbestos mines began closing towards the end of the 1970s. The first mines to close were the brown and blue asbestos mines in the early 1990s. The last white asbestos mines, Kaapsehoop (December 2001) and Msauli (September 2001), ceased mining operations in 2001.

6.2 NATURAL OCCURRENCE OF ASBESTOS IN SOUTH AFRICA

Asbestos deposits are found mainly in four regions of South Africa: the Northern Cape, the North-West Province, the Northern Province/Limpopo and Mpumalanga[xlvii]. Table 11 identifies the types of asbestos found in each of these regions.

TABLE 11: SOUTH AFRICAN ASBESTOS DEPOSITS

REGION	TYPE OF ASBESTOS DEPOSITS
Northern Cape ♦ Griqualand West ♦ Prieska ♦ Kuruman	Crocidolite
North-West Province	Crocidolite
Northern Province ♦ Chuniespoort Group ♦ Pietersburg District ♦ Letaba District ♦ Steelpoort River ♦ Penge	Amosite Anthophyllite Crocidolite Tremolite
Mpumalanga ♦ Barberton Area	Chrysotile

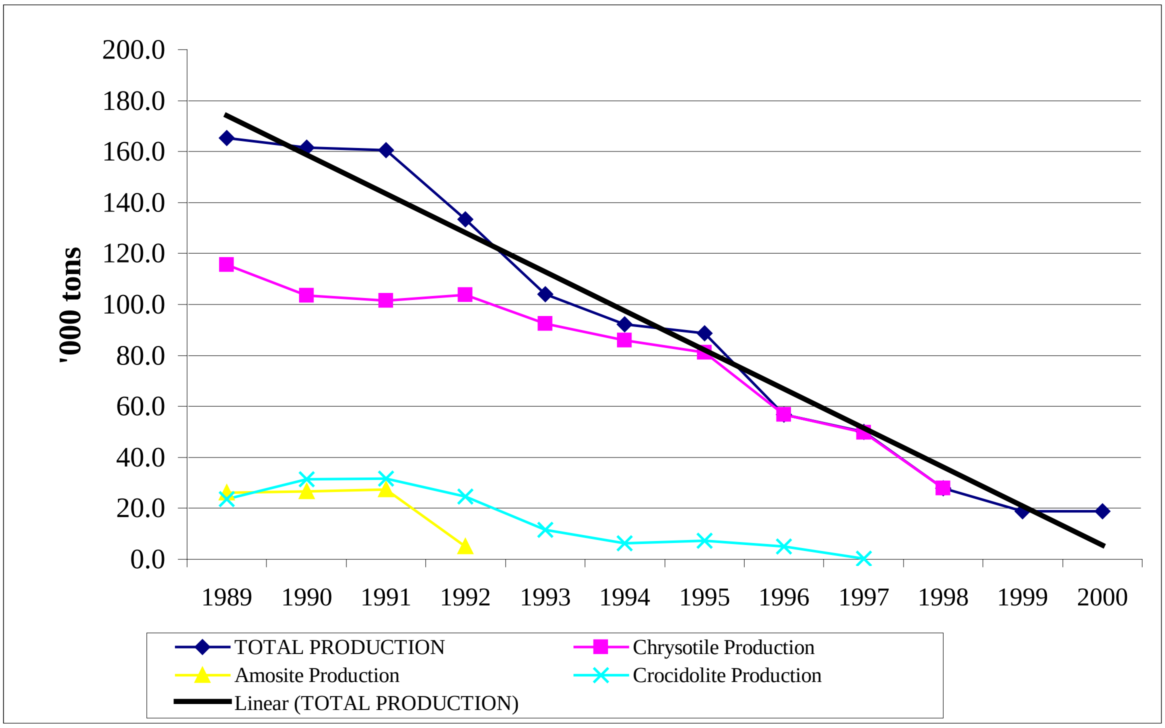
6.3 SOUTH AFRICAN ASBESTOS MINING

Table 2 on the following page reflects South African asbestos mining output from 1989 to 2001. The figures have been obtained from official statistics provided by the Department of Minerals and Energy[xlvii]. The Local Sales, Imports and Local Usage figures form 2001 and 2002 have been obtained directly from the local and Zimbabwean mining operations.

6.3.1 South African Asbestos Mining Production

Figure 4 depicts South Africa's asbestos mining production volumes of all types of asbestos for the twelve-year period from 1989 to 2000 period.

FIGURE 4: SOUTH AFRICAN ASBESTOS MINING PRODUCTION



This diagram indicates that there has been a dramatic decline in asbestos mine production in the past decade, down from 165-thousand tons in 1989 to 18.8-thousand tons in 2000. During this period, mining production of amosite and crocidolite stopped altogether, leaving only the mining of chrysotile asbestos.

Table 12 on the following page presents a detailed schedule of asbestos mining production, local sales, exports and imports for the 1989 to 2002 period.

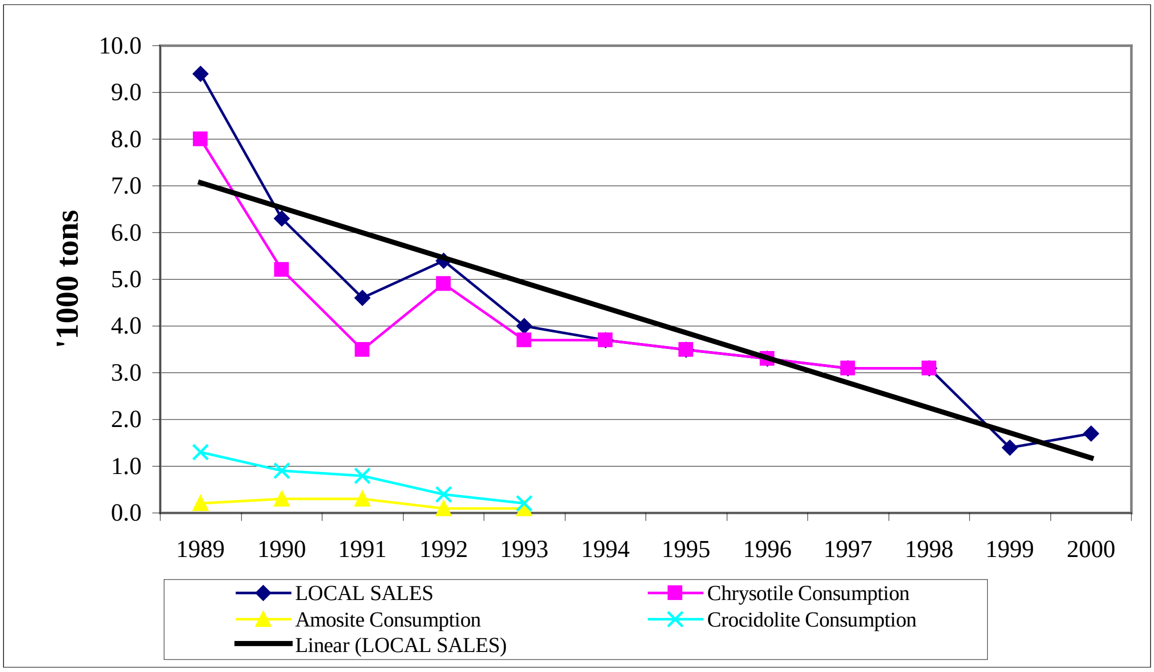
TABLE 12: SOUTH AFRICA ASBESTOS MINING OUTPUT ('000 TONS)

YEAR	PRODUCTION				LOCAL RSA SALES				EXPORTS				TOTAL IMPORTS	TOTAL LOCAL USAGE
	CHRYSOTILE	AMOSITE	CROCIDOLITE	TOTAL	CHRYSOTILE	AMOSITE	CROCIDOLITE	TOTAL	CHRYSOTILE	AMOSITE	CROCIDOLITE	TOTAL		
1989	115.5	26.1	23.7	165.3	8.0	0.2	1.3	9.4	110.6	26.1	35.2	171.9		
1990	103.4	26.6	31.5	161.5	5.2	0.3	0.9	6.3	107.9	34.1	36.8	178.8		
1991	101.6	27.4	31.6	160.5	3.5	0.3	0.8	4.6	99.7	21.9	25.9	147.5		
1992	103.7	5.1	24.5	133.3	4.9	0.1	0.4	5.4	98.4	15.2	17.5	131.1		
1993	92.4		11.6	104.0	3.7	0.1	0.2	4.0	92.9	4.5	12.7	110.1		
1994	85.9		6.3	92.1	3.7			3.7	80.2		15.4	95.5		
1995	81.2		7.4	88.6	3.5			3.5	82.3		9.8	92.1		
1996	56.7		5.1	56.9	3.3			3.3	52.3		8.5	60.8		
1997	49.8		0.2	50.0	3.1			3.1	34.3		5.8	38.2	9.6	12.7
1998	27.8			27.8	3.1			3.1	23.9		1.0	24.9	7	10.1
1999				18.8				1.4				20.2	10.3	11.7
2000				18.8				1.7				16.6	9.3	11.0
2001								1.1				11.1	5.6	6.7
2002								0.8				5.1	5.44	6.2

6.3.2 Local South African Sales of Asbestos Fibre

Figure 5 reflects local South African sales of asbestos for the twelve-year period from 1989 to 2000[xlvii].

FIGURE 5: LOCAL SOUTH AFRICAN ASBESTOS SALES

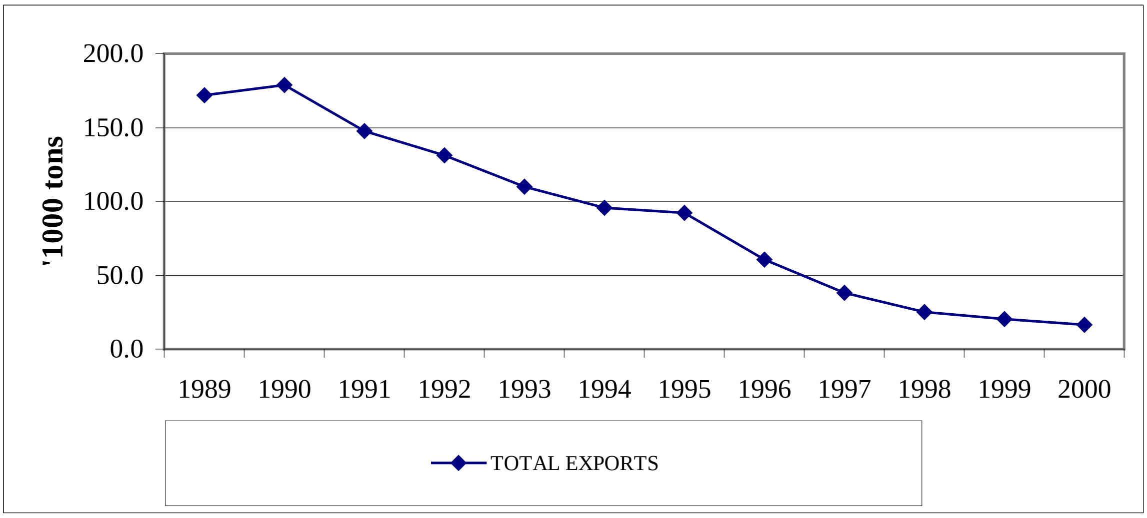


During this period, local sales of raw asbestos fibres declined from 9.4-thousand tons to 1.7-thousand tons in 2000. Amosite and crocidolite disappeared from the local market in 1993.

6.3.3 South African Asbestos Fibre Exports

Figure 6 reflects South Africa's asbestos export volumes for the period from 1989 to 2000[xlvii].

FIGURE 6: SOUTH AFRICAN ASBESTOS FIBRE EXPORTS

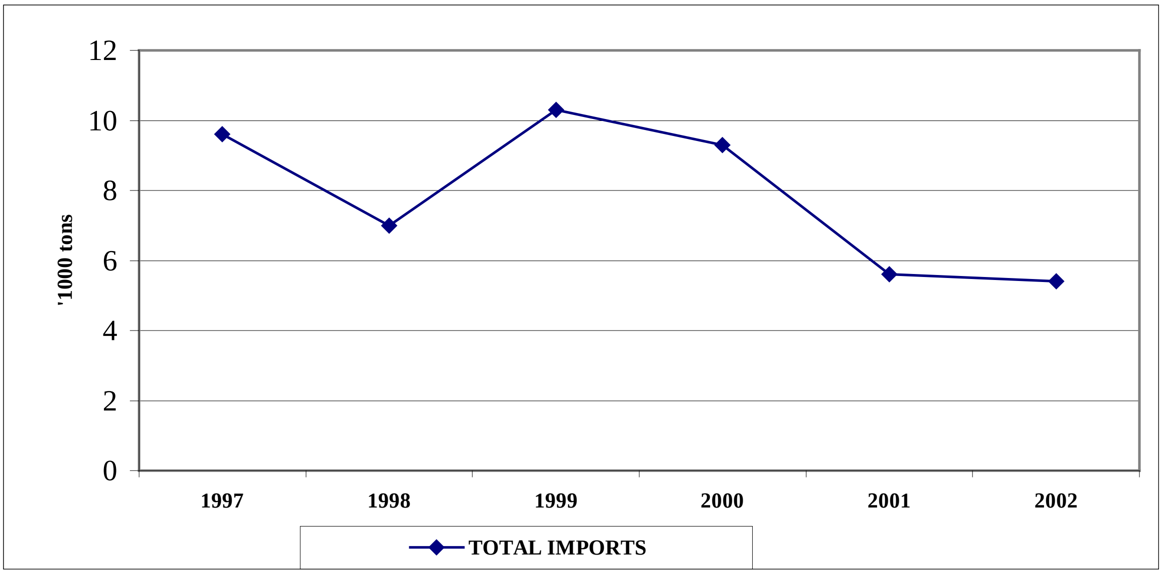


South African asbestos exports have also declined significantly, in line with the decline in mining production.

6.3.4 South African Asbestos Fibre Imports

All of South Africa's raw asbestos fibre is imported from Zimbabwe – SA imports approximately 4% of Zimbabwe's asbestos exports. South Africa's imports of raw asbestos fibres have declined from just over 10, 000 tons in 1999 to just over 5, 000 tons in 2002. Figure 7 reflects this trend.

FIGURE 7: SOUTH AFRICAN ASBESTOS FIBRE IMPORTS



6.4 THE CURRENT STATUS OF SOUTH AFRICAN ASBESTOS MINING

Before the closure of Penge in 1992, South Africa's asbestos industry was unique in that it mined all three principal varieties of asbestos: amosite, chrysotile and crocidolite[xlviii]. Crocidolite was first mined in South Africa in 1893. Chrysotile mining/production followed about a decade later, and amosite started in the early 1930s.

Amosite mining/production stoppedin 1992, while crocidolite mining stopped in 1989. Chrysotile mining endedwith the closure of the Msauli Mine on the Swaziland border in 2001. Two smaller operations are still recovering asbestos particles from mine dumps in

Mpumalanga.

Table 13 reflects the current status of asbestos mining in South Africa.

TABLE 13: THE CURRENT STATUS OF ASBESTOS MINING IN SOUTH AFRICAN

TYPE OF ASBESTOS DEPOSITS	MINING/PRODUCTION STATUS
Crocidolite	Stopped in 1989
Crocidolite	Stopped in 1989
Amosite	Stopped in 1992
Anthophyllite	Stopped in 1989
Crocidolite	Stopped in 1989
Chrysotile	Stopped in 2001

6.4.1 Current Operations

Currently, there is a stockpile of chrysotile asbestos fibre at the Msauli mine near Barberton. Table 14 reflects sales figures for the January to August 2000 to period from this source.

TABLE 14: MSAULI 2002 SALES

	EXPORTS		LOCAL RSA SALES	
	VOLUME (TONS)	VALUE (US$)	VOLUME (TONS)	VALUE (SAR)
January	178	45,435	160	213,628
February	380	82,405	144	244,288
March	417.5	84,186	118.3	203,294
April	260	54,445	90.7	179,204
May	870	155,591	40	85,000
June	710	118,686	63.5	132,518
July	545	97,019	52.3	113,528
August	355	77,093	26.1	56,836

Table 15 reflects the remaining stockpile tonnage at this location as at the end of August 2002, along with an estimate of the number of months that it will take to sell off these remaining stocks, calculated at the average monthly sales for the first eight months of 2002.

TABLE 15: CHRYSOTILE ASBESTOS STOCKPILES

LOCATION	STOCKPILES (TONS)	SELLING PERIOD
Msauli	6,768	12.28 months

This calculation implies that Msauli will continue to sell asbestos until September 2003.

6.4.2 Employment

Currently, there are three partners (all of whom are retired) and four staff members employed at Hanova's head office.

The Msauli mine in Barberton employs 20 people who are working on closing down and rehabilitating the mine. At this stage, it is anticipated that these people will remain in Hanova's employ until the end of June 2003.

6.4.3 Investment

Hanova's assets include R40-million cash, and approximately R15-million in mining equipment at Msauli. These assets are frozen, pending the outcome lawsuits brought against the company.

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7 CURRENT SOUTH AFRICAN REGULATIONS GOVERNING THE SAFE USE OF ASBESTOS

7.1 INTRODUCTION

Occupational Health and Safety in South African is not driven by morality, humanitarian considerations or ethics, but rather by legislation. Although our mining and industrial sectors date back more than a century, it is obvious that every single milestone with regard to the control of asbestos coincides with the promulgation of new acts or regulations.

The health and safety of employees or the public at large is not governed by one single statute, but rather by a number of acts, regulations, ordinances and by-laws. From an Occupational Health and Safety point of view, the main acts are the Mine Health and Safety Act (MHSA) and the Occupational Health and Safety Act (OSHAct). Legislation regarding disability and compensation also needs to be mentioned. There are also various other statutes that deal with Air Pollution, Waste Disposal, Packaging, Transport and Labelling of asbestos and asbestos products.

The following discussion provides an overview of the legislation that governs the safe use of asbestos in South Africa.

7.2 ASBESTOS MINING

The Mine Health and Safety Act (MHSA) came into effect on 15 January 1997, replacing the Minerals Act 50 of 1991 as the legal basis for regulating occupational health and safety in South African mines, including asbestos mines[xlix].

The MHSA also replaced those sections of the Occupational Diseases and Mines and Works Act 78 of 1973 (ODMWA), which regulated the control of occupational health hazards in the mines thereby consolidating the provisions dealing with the control of occupational health into a single statute.

The MHSA was enacted after an extensive policy review undertaken by the Commission of Enquiry into Health and Safety in the Mines ("the Leon Commission") which published its report and recommendations in 1995. The Act, as well as the subsequent Mine Health and Safety Amendment Act of 1997, was developed through a tri-partite consultation process involving representatives of government, employers and trade unions. As a result of the high level of participation in it's drafting, the Act enjoys substantial legitimacy among employers and workers in the industry.

The Leon Commission concluded that the mining industry had taken inadequate steps to protect mineworkers from work-related health conditions. There was no evidence indicating a decline in the prevalence or severity of the major occupational diseases in the mining industry during the past 20 years. Legislation had been inadequately enforced and the State's enforcement agencies had not been able to control occupational health problems[l]. This led the Commission to recommend a major legislative restructuring coupled with the devotion of greater resources to enforcing of mine health and safety standards.

The MHSA draws upon and modernises the approach in the Occupational Health and Safety Act 85 of 1993, which regulates health and safety in other sectors of the South African economy. The International Labour Organisation's Mine Health and Safety Convention 177 of 1995, adopted during the process of developing the new Act, also significantly influenced the legislation[4].

The Act is also influenced by the Labour Regulations Act 66 of 1995, particularly in its approach to worker participation on health and safety and the resolution of disputes over the disclosure of information[li].

The principal features of the MHSA are –

- o The primary responsibility for ensuring a healthy and safe working environment in mines is placed on the mine owner (employer). The act sets out in detail the steps that employers must take to identify, assess, record and control health and safety hazards in the mine
- o The act entrenches basic worker rights, most notably, the right of workers to participate in health and safety, the right to receive health and safety information, the right to training and the right to withdraw from the workplace in the face of danger
- o The act establishes representative tri-partite institutions to promote a culture of health and safety and develop policy, legislation and regulations
- o The responsibility for enforcing the OHSAct lies with the mine health and safety inspectorate. The inspectorate's powers are recast and include the power to impose administrative fines upon employees who contravene the OHSAct. The act also contains innovative approaches to the investigation of accidents, diseases and other occurrences that threaten health and safety

The Act provides for the use of a range of legal and policy instruments in regulating health and safety:

- o Mine Health and Safety Act
- o Regulations (including regulations previously in force under the Minerals Act). The Minister may make regulations after consulting the Mine Health and Safety Council
- o Codes of Practices – Mines must prepare codes of practice as required by the Chief Inspector. Codes of practice must be comply with any guidelines issued by the Chief Inspector
- o The legal permissible exposure limit for asbestos in the South African mining industry was 5 f/ml, prior to 1975. According to available medical information, employees exposed to a level of 5 f/ml will run a risk of developing asbestosis after 5 years, with the disease presenting itself 10 to 20 years later, i.e. those exposed would have become ill between 1985 and 1995.
- o The exposure limit was reduced in 1975 to 2, 0 f/ml and again reduced to 1,0 f/ml in 2002.

7.3 Asbestos in the Industrial Sector

The health and safety of employees working with asbestos in the industrial sector is governed by the Occupational Health and Safety Act (No 85 of 1993)[lii], which replaced the Machinery and Occupational Safety Act (No 6 of 1983).

The OHSAct applies to all employers and employees in the RSA. It also applies to self-employed persons, as well as private households. The following are exceptions:

- o Any premises where the Mine Health and Safety Act applies, and
- o An explosives factory and an explosives magazine within the meaning of the Explosives Act (27 of 1956)[liii]

It includes those in such diverse spheres as the public sector, agriculture, commerce and

local government.
Apart from the State and the South African Transport Services, more than 220 000 employers and approximately 6,5 million employees\ are covered by this legislation. The purpose of the OHSAct is to provide for the Health and Safety of employees at work as well as members of the public where the activities of other persons may affect them.

The OHSAct empowers the Minister of Labour to make regulations in the interest of Occupational Health and Safety. The Asbestos Regulations were the first occupational hygiene regulations and were published on 10 April 1987. The asbestos regulations were amended and the new Asbestos Regulations came into effect March 2002[lii].

The new Asbestos Regulations are comprehensive, and make provision for:

- Informing and training employees that may be exposed regarding, amongst others, the health risks of asbestos and how to work safely with this material.
- Assessment of potential exposure
- Air Monitoring
- Medical Surveillance
- Zoning of asbestos work areas
- Implementation of control measures, and
- Housekeeping

The regulations also make specific provision for the control of asbestos in the following applications:

- Asbestos that forms part of the structure of a workplace, building, plant or premises
- Asbestos cement sheeting and related products, and
- Demolition (of buildings and structures that contains asbestos in its raw mineral form, including the gleaning of any spilt asbestos)

The new Asbestos Regulations make provision for an Occupational Exposure Limit of 0,2 regulated asbestos fibres per millilitre of air averaged over any continuous period of 4 hours, and a short term exposure limit of 0,6 regulated asbestos fibres per millilitre of air averaged over any 10 minutes.

7.4 COMPENSATION

The compensation of asbestos related diseases are dealt with in two independent systems.

The Occupational Diseases in Mines and Works Act, No 78 of 1973 (as amended by Act 208 of 1993) (ODMWA) covers occupational lung diseases in miners[liv]. The following asbestos related diseases are compensateable under ODMWA.

- Asbestosis in asbestos miners
- Malignant mesothelioma in asbestos miners
- Pleural Plaques in asbestos miners
- Asbestos-related lung cancer in asbestos miners

The Compensation for Occupational Injuries and Diseases Act, 130 of 1993 (COIDA), covers compensation of employees for asbestos related diseases sustained in the industrial sector[lv].

The following asbestos related diseases are compensatable under COIDA.

- Pneumoconiosis (asbestosis)
- Pleural thickening causing significant impairment of function
- Mesothelioma of the pleura or peritoneum, or other lung malignancy

7.5 Environmental Dust Pollution

The Atmospheric Pollution Prevention Act (45 of 1965) is administered by the Department of Health and provides for the control of, amongst others, dust pollution[lvi].

Part IV of the act provides for the abatement of dust at two main sources, namely dust arising from waste mine dumps and dust emanating from industrial processes. The abatement of dust pollution centres on control at the source.

7.6 Transport

Chapter VIII of the National Road Traffic Act, 93 of 1996 and the SABS Codes of Practice incorporated in the act governs the transport of asbestos by road[lvii]. Quantities less than 20 kg is exempted from the requirements of this legislation. SABS 0228, Identification and Classification of Dangerous Substances and Goods, as well as SABS 0229, Packaging of Dangerous Goods for Road and Rail Transportation in South Africa are worthy of special mention.

The legislation, in addition to the identification and classification of goods also lists packaging requirements (SABS 0229), statutory vehicle inspection (SABS 0230), rules and procedures during the transportation of dangerous goods (SABS 0231), signage requirements and emergency response guides (SABS 0232/1 and SABS 0232/3).

Documentation to be carried by the driver is stipulated in Regulation 281. This includes, inter alia, a Dangerous Goods declaration issued by the consigner, reflecting confirmation that the load is correctly identified, packed, labelled and basically in all respects compliant with legislation.

Asbestos transported by air is packed in accordance with the current edition of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air, or the IATA Dangerous Goods Regulations.

Asbestos transported by sea are packed in accordance with the current edition of the IMDG Code and are acceptable for inland transportation by road or by rail.

7.7 Waste Disposal

Asbestos waste must be disposed of at sites specifically designated for this purpose in terms of the Environment Conservation Act (73 of 1989) and the National Environmental Management Act (107 of 1998)[lviii lix].

7.8 Summary and Conclusions

South Africa has some of the best legislation in place to protect employees against asbestos health risks. The legislation is based on similar statutes and regulations as those found in most developed countries, and often exceeds their standards.

However, in a report presented to the Parliamentary Portfolio Committee, researchers suggested poor compliance with legislation in South Africa and stated that self-regulation is not enough to protect workers[lx]. There are too few inspectors to police regulations and they are poorly trained.

8 ASBESTOS-CEMENT BUILDING AND CONSTRUCTION MATERIALS

8.1 INTRODUCTION

Asbestos cement products have traditionally been valued for their ease and relative low cost of manufacture; their strength and durability; their resistance to corrosion (particularly at coastal locations); and their waterproof and insulating properties. As such, they have been used extensively in the building of affordable housing, commercial and industrial buildings, and water and sewage reticulation systems.

The major use of asbestos fibre in South Africa is for manufacturing building materials and pipes in which approximately 10% asbestos is bound in a cement matrix. As in many countries of the world, asbestos cement roofing sheets and external cladding have been used for generations to provide cost-effective, safe and sturdy shelters. Asbestos cement pipes are the single most popular solution for distributing drinking water throughout the world and there are few sewage disposal plants that do not use this durable product.

In the past, asbestos was used in many building materials. These included: insulation boards used for sound protection or temperature insulation and vinyl-asbestos floor tiles. Asbestos lagging was also used as insulation for boilers, hot water geysers and pipes. Although this is no longer allowed, the asbestos used in the past is often still in place in the buildings where it was installed.

8.2 PROPERTY OWNERSHIP IN SOUTH AFRICA

There are no reliable statistics regarding the number of buildings that contain asbestos materials and products in South Africa. However, anecdotal evidence indicates that asbestos cement products were almost routinely used in the building of low cost, mass housing up until the mid 1980's, particularly in coastal developments. In addition, it is estimated that "as many as 80% of State buildings contain asbestos materials and products – including insulation materials used for insulating hot water piping".

Broadly speaking, property can be categorised as:

- Civil Constructions (i.e. bridges, dams, roads, ports, etc.)
- Non-Residential Buildings:
- Commercial/Office Buildings
- Industrial/Warehouse Buildings
- Retail Buildings
- Other Buildings (hotels, casinos, schools, hospitals, etc)
- Residential Buildings
- Suburban housing
- Apartments/flats
- Cluster/Town houses
- Affordable houses
- Low Cost "RDP" housing

Construction and building properties in South Africa are either owned by the state (i.e. central, provincial or local government) or are privately owned.

8.2.1 Government Owned Properties

Government (i.e. the Public Works Department) is in the process of building an Asset Register database that contains the number and value of buildings and civil constructions owned by central and provincial governments. Table 16 on the following page reflects the various types of government-owned buildings that can be found in this database.

TABLE 16: NATIONAL REGISTER OF STATE-OWNED FIXED ASSETS

Offices	Store
Open Parking	House: Office
Under Cover Parking	Fencing
Parking Garage	Police Station
Open Car Park	House
Under Cover Car Park	Flat
Shop	Single Quarters
Ablution	Duplex
Hall	Simplex: Town House
Museum, Library	Semi-Detached House
Private Siding	Free Offices
Miscellaneous Farm Buildings	Free Parking
Dog Kennel	Land
Civil Works	Office/Miscellaneous Buildings
Court Buildings	Interstate Boundary Fences
Restaurant	Living Quarters
Mess	Industrial Buildings
Hanger	Hospital/Clinic
Computer Bureau	Classrooms
Miscellaneous Structures	Schools
Cell	
Mortuary	

8.2.2 Privately Owned Non-Residential Property in South Africa

Privately owned non-residential property is concentrated in the hands of large financial institutions (i.e. Sanlam, Old Mutual, Investec, Liberty, Metropolitan, RMB, etc.), who own this property as part of their overall asset investment portfolios; and listed and non-listed companies that own their own buildings and facilities.

8.2.3 Privately Owned Residential (and Non-Residential) Properties

Statistics South Africa publishes various statistics related to the private sector building and construction industry, including the number of buildings completed each year. Unfortunately, this institution does not keep a cumulative record of its data. Therefore, it does not have a readily available set of data that would reflect the entire "installed base" of privately owned buildings is South Africa.

As an indication of the type of data available from this source, Table 17 reflects "Buildings Completed" data for the 1997 to 2000 period[lxi].

TABLE 17: BUILDINGS COMPLETED

THOUSANDS	1997	1998	1999	2000
Residential Buildings				
♦ Houses	52, 885	50, 022	58, 313	48, 594
♦ Flats/Townhouses	15, 060	11, 907	8, 402	7, 527
♦ Other Residential	127	103	194	255
♦ Additions and Alterations	27, 626	24, 170	28, 397	26, 611
Non-Residential Buildings				
♦ Industrial and Warehouse	831	815	780	704
♦ Office and Banking	336	357	241	274
♦ Shopping	377	360	262	232
♦ Other (Schools, Crèches, Hospitals, Churches, Sport, Recreation)	751	593	564	494
♦ Additions and Alterations	2, 735	2, 244	2, 381	2, 152

8.2.4 The Low Cost Housing Sector

A study for the Department of Housing in 2001 to investigate "the use of asbestos in the low cost housing sector" states that "asbestos materials are still widely used in affordable housing, particularly in the coastal areas of KwaZulu Natal and the Eastern and Western Capes"[lxii]. This study estimates that "up to 1-million state-funded lower income housing units with asbestos based products, predominantly roof sheeting, exist".

In addition, rural communities have used asbestos fibre as a material for building, where asbestos tailings – obtained from mine dumps – are mixed with mud to plaster the walls of traditional houses[lxiii]

The Housing Monitor database contains details of 1, 323 subsidised housing projects that have been constructed since 1994, involving 874,757 housing units[Error! Bookmark not defined.]. Information regarding the construction materials used is available for 341 projects, involving 240, 833 units. Of these, 24% (i.e. 57,800 units) were constructed with asbestos-cement roof sheeting.

The National Department of Housing provided the information reflected in Table 18 on the following page[lxiv].

TABLE 18: HOUSES COMPLETED OR UNDERCONSTRUCTION

PROVINCE	1994/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	TOTAL
Eastern Cape	6,511	42,223	29,659	21,345	44,021	11,816	155,575
Free State	16,042	21,001	20,391	8,177	26,088	9,005	100,704
Gauteng	65,660	83,416	28,726	144,575	25,911	20,233	368,521
Kwazulu-Natal	17,553	78,468	53,105	28,997	28,547	14,379	221,049
Mpumalanga	19,884	10,873	16,838	4,808	16,457	14,584	83,444
Northern Cape	8,666	6,768	3,387	3,600	7,148	3,588	33,157
Northern Province	11,108	15,743	22,899	12,401	20,996	16,667	99,814
North West	21,287	20,977	18,367	12,944	17,609	17,385	108,569
Western Cape	25,321	43,834	34,575	26,916	17,730	16,634	165,010
TOTAL	192,032	323,303	227,947	263,763	204,507	124,291	1,335,843

Applying the 24% statistic from the Housing Monitor database to the above figures, suggests that approximately 320, 600 of these houses may include asbestos-containing materials.

Unsupervised and inappropriate construction techniques in both the construction of new houses as well as the maintenance of existing houses, specifically roofing, may result in occupational exposure to asbestos. This is exacerbated in the low income housing environment where:

- The use of unskilled and ill-equipped local labour is extensive
- Limited financial resources often result in inadequate or no provision of protective clothing and masks for workers

Prevailing winds and the generation of dust by cutting and drilling the asbestos products on the construction site are common occurrences, enhancing the chances of inhalation of asbestos. A further hazard to health will arise from unskilled attempts to clean asbestos cement products prior to coating application and from physical injury during such operations, e.g. falling off or through a roof.

Although there is no legislation prohibiting the use of asbestos-containing building materials, some Local Authorities in the Free State, Mpumalanga, Northern Province, and Western Cape have specified that asbestos-containing materials may not be used, i.e. City of Cape Town Specification for the Construction of 791 Houses at KTC 2B1, KTV 2B2 and Millerscamp in Nyanga, Cape Town (Q02/18) states in clause 3 that "Roofing to be 6,0mm thick "Bigsix" or other equal and approved pattern fibre-reinforced cement sheets, <u>free of asbestos fibre</u>, …".

There appears to be a developing trend towards the use of corrugated metal roofing in low cost "RDP" housing (i.e. very basic 30 sqm houses). The reason for this is that this roofing material requires a minimum of support (virtually no wooden trusses) and, therefore, can cost as little as one-third of the cost of using fibre cement sheeting and concrete tiles – both of which require substantial support structures. The only exception to this trend occurs in coastal housing projects. Here, metal roofing is subject to relatively rapid corrosion by salt-containing sea air.

Fibre cement sheeting generally represents the roofing material of choice as it the cheapest alternative – particularly asbestos cement roof sheets imported from Zimbabwe.

8.3 ASBESTOS CEMENT PRODUCT MANUFACTURING

The sole South African manufacturer of asbestos cement building products has been undertaking a “conversion program” for the past twenty years. This program involves the identification and development of alternative fibres to replace asbestos in its range of fibre-cement products.

Traditionally, this company has manufactured and sold a range of asbestos cement products that include:

- **Roofing Products** (i.e. roof tiles, roof sheeting, fascia boards, barge boards, soffit boards, and window sills), equal to 20% of sales
- **Flat Sheet Products** (i.e. ceiling boards, partitioning boards, etc.), equal to 70% of sales
- **Moulded Products** (i.e. gutters, down pipes, containers), equal to 10% of sales
- **Water and Sewage Reticulation Piping** (sold through the AC Pipes division)

This conversion program began in the early 1980’s and is almost complete. The first products to be converted in 1985 were the flat products (i.e. facia boards, window sills, external cladding and internal partioning). The remaining products (i.e. profiled roof sheets, barge boards, moulded containers, etc.) will be replaced by the end of 2002. Products that cannot be converted to non-asbestos fibre formulations have/will be discontinued (i.e. certain roofing profiles, rain water goods, water tanks, water and sewage piping). During this time, this business has progressively discontinued the production and sale of most of its asbestos cement products. Currently, 90% of this business's fibre-based products (by volume) are manufactured using cellulose fibres.

This business anticipates that the remaining asbestos containing products will have been converted to cellulose fibres by the end of 2002. The asbestos cement water pipe division stopped manufacturing asbestos cement water and sewage products early in 2002 and is currently selling off stock-on-hand – it is anticipated that this sell-off will have been completed by the end of March 2003

8.3.1 Technical Challenges of Cellulose Cement

According to the company its non-asbestos fibre cement is manufactured using a calcium silicate hydrate binder reinforced with organic cellulose (or softwood) fibres.

The introduction of cellulose cement flat sheets products in 1985 was successful but difficulties were experienced with load bearing roof sheets. An investment of R40 million in research and development and assistance from fibre-cement manufacturer, James Hardie of the United States, saw a breakthrough in 1998. This breakthrough resulted in the development of traditional Big Six profiled roofing sheets spanning 1,4 metres. Non-asbestos “Nutec” Big Six sheets comply with SABS ISO 9933.

Full conversion of the Big Six range to non-asbestos fibre-cement was completed by September 2002. The company will, however, no longer manufacture roofing sheets such as Span, Canalit and Profile B because of their longer spanning requirements and the manufacturing complexities involved.

The further addition of PVA to the product mix allowed the full conversion of moulded goods (plant containers and roof fittings) by the end of October 2002.

The company reports that quality problems were experienced in 2001 after it closed and relocated both its Durban and Cape Town factories into one plant near Johannesburg. During this time senior management were changed a number of times and it was only in early 2002 that the new company structure became entirely settled. Plant and process stability are now reported to be exceptional with reject rates reduced to world-class benchmarks.

Product quality is now at a standard where volumes are being exported to a number of countries where asbestos has been banned. The company reports that manufacturing capacity is well in excess of local market requirements.

The company is satisfied that the raw materials used in the manufacture of cellulose cement products are generally considered safe:

- Portland cement (tri & di-calcium silicate) is a fine powder that can cause skin or eye irritation with prolonged exposure. Prolonged inhalation of more than 10 milligrams/ cubic metre may cause coughing. It is non-toxic in the environment in small quantities but large quantities can adversely affect the pH of water.
- Cellulose fibre is unbleached softwood pulp. These fibres are identical to those used in the paper and cardboard manufacturing industries and are sourced from renewable commercial forests.

In the mid 1980s, Swiss toxicologist, Professor Ulrich Gruber, conducted an extensive literature search on the possible health effects of cellulose fibres. He concluded that, although cellulose can also release respirable fibres, it does not present a health threat in the human lung. The American Conference of Government and Industrial Hygienists (ACGIH) considers softwood pulp to be inert and of low risk below 10 milligrams/cubic metre. Nevertheless, dust control measures are necessary during production and fabrication, as would apply to any other potentially dusty material.

- Condensed silica fume is an amorphous non-crystalline silica of sub-micron particle size. It is a fly ash resulting from cement kiln production. Silica fume is considered to be of low toxicity, although prolonged exposure to high concentrations of dust should be avoided as it can cause irritation to the eyes, nose and throat.
- Aluminium trihydroxide is a non-fibrous powder that can cause mild irritation to eyes, skin and upper respiratory tract for people with asthma, chronic lung disease and skin rashes.
- Bentonite is non-toxic clay. Inhaling large quantities will cause temporary discomfort and coughing.
- Polyvinyl alcohol (PVA) is a synthetic fibre that does not present a health threat through inhalation and will not emit toxic gas when burned.

Cellulose cement is now a technology in use worldwide for both exterior and interior applications.

8.3.2 Asbestos Fibre Purchases

Table 19 reflects this business's purchases of chrysotile asbestos fibres for the past four years. All of this asbestos fibre is purchased from AA Mines in Zimbabwe.

TABLE 19: ASBESTOS FIBRE PURCHASES

	1999	2000	2001	2002	2003

Volume (tons)	8, 000	4, 000	3, 000	2, 000	0.000

8.3.3 Sales Volumes

Table 20 reflects sales of fibre cement products to the local market. (Both asbestos and cellulose cement.)

TABLE 20: LOCAL SALES

TYPE OF PRODUCT	1999		2000		2001		2002	
	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
34. 1. Profiled Roof Sheeting (sq. m / millions)	3.2	R53.6	3.1	R54.9	2.3	R46.4	2.8	R64.99
35. 2. Flat Sheet (sq. m / millions)	4.4	R66.8	4.7	R75.9	4.9	R87.2	5.3	R113.1
36. 3. Moulded Products	0.85	R39.1	0.79	R39.6	0.78	R41.7	0.83	R50.3

80% of this business's local sales are made to Building Merchants. The remaining 20% is sold directly to developers, building contractors, municipalities and plant nurseries. Table 21 reflects export sales

TABLE 21: EXPORTS (BOTH ASBESTOS AND CELLULOSE CEMENT.)

TYPE OF PRODUCT	7/99 – 6/00		7/00 – 6/01		7/01 – 6/02		7/02 – 6/03	
	VOL	VAL	VOL	VAL	VOL	VAL	VOL	VAL
37. 1. Profiled Roof Sheeting (sq. m millions)	0.16	R2.2	0.11	R1.6	0.13	R1.9	0.27	R4.9
38. 2. Flat Sheets (sq. m millions)	1.3	R15.1	0.67	R9.3	0.69	R13.8	1.2	R24.9
39. 3. Moulded Products	0.009	R0.34	0.010	R0.5	0.006	R0.28	0.034	R1.6

Destination countries include: Australia, Far East, Middle East, South America, and the United Kingdom.

8.3.4 Employment

Table 22 reflects the number of people employed in the manufacturing business

TABLE 22: EMPLOYMENT

	2000	2001	2002	2003
Management	19	9	9	8
Professional (Acc/Leg/R&D/IT)				

Administration				
Technical/Artisans	12	12	12	10
Workers	1,479	848	803	762
TOTAL	1,510	869	824	780

The major reasons for the decline in employment include:

- Declining demand from the building and construction markets
- A loss of market share to imports of asbestos cement building products from Zimbabwe
- A loss of market share to substitute products (i.e. metal roof sheeting, concrete roof tiles; gypsum flat products; PVC, GRP and HDPE water piping)

These factors have caused this business to undertake a major restructuring and rationalisation programme which has involved the closure of a number of manufacturing plants and the retrenchment of significant numbers of management and staff.

Management is of the opinion that most of the job losses have resulted from the restructuring and "right sizing" exercise and not because of the challenges associated with the conversion from asbestos cement to cellulose fibre-based products. Anticipated job losses in 2003 will come about as a result of the closure of the water pipe division.

8.3.5 Investment

Table 23 reflects investment that has been made in the manufacturing business during the past few years.

TABLE 23: NEW INVESTMENT

	2000	2001	2002
Production	65	35	27
Distribution			
Other			
TOTAL (R-million)	65	35	27

Despite the restructuring process, this business is still investing in new production equipment. Management estimates that the total cost of rationalising the business to a single manufacturing site, and converting from asbestos cement to cellulose fibre-based products has required an investment of approximately R100-million over the past three years. This investment programme will be completed during the 2002/3 financial year.

8.4 COMPETITORS

This business has only one direct competitor in the fibre-based building and construction product category: a Zimbabwean company. This company manufactures asbestos cement profiled roofing sheets (58% of its sales), flat sheets (27% of its sales), moulded products (i.e. barge boards, 14% of its sales) and water pipes.

The Zimbabwean manufacturer has been exporting asbestos cement products into South Africa for the past 5 years. In this time, it is estimated that they have captured 25% of the South African fibre cement roofing market. Table 24 reflects a breakdown of their current sales mix.

TABLE 24: ZIMBABWE MARKET SHARE

PRODUCT CATEGORY	UNIT SALES	SALES VALUE	SHARE OF THE FIBRE CEMENT MARKET SEGMENT	SHARE OF THE TOTAL PRODUCT CATEGORY
Roof Sheeting	774, 000 sq m	R22.3 million	25%	2.6%
Flat Sheet	563, 093 sq m	R10.4 million	21%	2.8%
Barge Boards	126, 696 units	R5.5 million	25%	10%

This analysis indicates that although imports of asbestos cement products from Zimbabwe represent a relatively small percentage of each product category's RSA sales, they do represent a significant proportion of the "Fibre Cement" product category and clearly represent a threat to the South African business.

8.5 SUBSTITUTE PRODUCTS

There are a number of substitute products that can be used in place of fibre cement products. Table 25 illustrates the range of products by product category.

TABLE 25: SUBSTITUTE PRODUCTS

PRODUCT CATEGORY	SUBSTITUTE PRODUCTS
Roofing Products	♦ Corrugated Metal Sheeting (galvanised and coated) ♦ Concrete Roof Tiles ♦ Pressed Metal Tiles
Flat Sheet products	♦ Gypsum Board ♦ Vermiculite Board ♦ Plastic products
Water and Sewage Piping	♦ Metal Piping ♦ (U)PVC Piping ♦ GRP Piping ♦ HDPE Piping ♦ Ductile Iron Piping

Many of these products provide a superior value-for-money proposition when compared to (asbestos) fibre cement products. This is evidenced by the fact that (asbestos) fibre cement products represent a very small proportion of new installations within each product category. Table 26 illustrates this point.

TABLE 26: (ASBESTOS) FIBRE CEMENT'S MARKET SHARE

PRODUCT CATEGORY	(ASBESTOS) CEMENT'S MARKET SHARE OF NEW INSTALLATIONS
Roofing Products	Less than 10%
Flat Sheet products	Less than 5%
Water and Sewage Piping	Less than 5%

8.5.1 Roofing

On average, the market for roofing products represents sales of approximately 30-million sq. m of various roofing products per annum. Table 27 reflects a breakdown of this market by type of roofing material.

TABLE 27: RSA ROOFING MATERIAL MARKET

ROOFING MATERIAL	MARKET SHARE	PRICE PER SQ. METER (MERCHANTS SELLING PRICE)	MARKET VALUE
Corrugated Iron & Coloured IBR Sheeting	51%	R16 to R32	R325 million
Concrete Roof Tiles	31%	R38	R425 million
Asbestos/Fibre Cement Sheeting	10%	R46	R166 million
Coated Pressed Metal Tiles	3%	R56	R60 million
Others	5%		

Table 28 reflects a breakdown of the roofing market by building type.

TABLE 28: RSA ROOFING TYPES

BUILDING TYPE	MARKET SHARE	APPROXIAMATE SQ. METERS
Non-Residential Buildings	10%	3 million
Residential	90%	27 million
♦ Standard/Suburban Housing	59%	
♦ Low Cost/Affordable Housing	31%	

Asbestos cement's roofing market share has declined from approximately 25% in the mid 1970's to its current 10% level. This decline has been caused by a number of factors, including:

- Industry resistance to asbestos (mainly amongst architects, engineers and building developers)
- Growing resistance to asbestos amongst property owners, and
- Developments by substitute product manufacturers that have made their products more durable, attractive and affordable.

Table 29 reflects a cost comparison of roofing materials prepared by the Concrete Manufacturers Association that compares the costs of a complete erected roof structure on a 57m^2 house.

TABLE 29: ROOFING COST COMPARISON

ROOFING MATERIAL	TOTAL ROOF COST	COST PER SQ. METER
Corrugated Iron Sheeting	R7, 469	R108
Concrete Roof Tiles	R7, 647	R103
Profiled Asbestos Cement Sheeting	R8, 061	R115
Coloured IBR Sheeting	R8, 674	R126

Pressed Metal Tiles	R9, 624	R136

This comparison indicates that asbestos cement roofing is not the lowest cost alternative for low cost housing

Table 30 reflects a comparison of the advantages and disadvantages of asbestos cement, cellulose fibre and the most popular substitute roofing products.

TABLE 30: COMPARISON OF ALTERNATIVE FIBRES AND SUBSTITUTE PRODUCTS

	ASBESTOS CEMENT SHEETING	CELLULOSE FIBRE CEMENT SHEETING	CONCRETE ROOF TILES	CORRUGATED IRON SHEETING
Advantages	♦ Strong ♦ Durable (50 to 60 year lifespan) ♦ 7 m roofing span	♦ Non-asbestos	♦ Looks good ♦ Cost-effective	♦ Durable ♦ Lightweight ♦ Easy to install
Disadvantages	♦ Asbestos-related diseases	♦ Less durable (20 year lifespan) ♦ 3 m roofing span ♦ High maintenance	♦ Expensive installation	♦ High maintenance

8.5.2 Flat Sheets

Asbestos has been used as a key raw material in the manufacturing of flat sheets used for internal walling, and ceilings.

9.3.2.1 Internal Walling

Table 31 reflects an assessment of the market shares of the alternative products used for internal walling.

TABLE 31: INTERNAL WALLING MARKET

	FIBRE CEMENT SHEETING	GYPSUM SHEETING
Commercial Buildings	5%	95%
Hospital and Clinics	0%	10%
Manufacturers Selling Price per Sq M	R20 to R25	R20

The market for internal walling is estimated at approximately 2-million sq m per annum. These statistics indicate that fibre cement wall sheeting is already a very small proportion of this market segment. Furthermore, the South African fibre cement manufacturer has already converted its fibre cement wall sheeting range to a non-asbestos formulation. Therefore, the phasing out of asbestos will not have any impact on this market segment.

9.3.2.2 Ceilings

Table 32 on the following page reflects an assessment of the market shares of the alternative products used in the ceiling board market segment.

TABLE 32: CEILING BOARD MARKET

	FIBRE CEMENT BOARD	GYPSUM BOARD	MINERAL FIBRE BOARD
Residential Buildings	15%	80%	5%
Commercial Buildings	5%	45%	50%
Schools	85%	10%	5%
Hospitals and Clinics	85%	5%	10%
Manufacturers Selling Price per sq m	R8.50	R8.60	R30 to R60

The ceiling board market segment is approximately 18-million sq m per annum. Once again, the South African fibre cement manufacturer has already converted its fibre cement ceiling board range to a non-asbestos formulation and, as such, phasing out of asbestos will not have any impact on this market segment.

Table 33 reflects a comparison of the Merchant's Selling Price of the most popular flat sheet products used for ceilings.

TABLE 33: FLAT SHEET COST COMPARISON

FLAT SHEET MATERIALS	PRICE PER SQ. METER
Asbestos Cement (Zimbabwe)	R14.79
Gypsum Board	R16.34
Fibre Cement (South Africa)	R16.56
Masonite	R17.25
Isowhite Board	R19.51

Despite increased production costs, the South African manufacturer of fibre cement products proposes to sell its new, non-asbestos product range at the same price as their current asbestos cement products in order to retain market share.

8.5.3 Water and Sewage Pipes

There are approximately 150,000 km of installed water pipelines in South Africa, of which approximately 75% carry water, with the remaining 25% carrying sewage effluent. Each year, this installed base is extended by approximately a further 4, 000 km of new piping.

The major customers of underground water and sewage piping include:

- Municipalities: 60%
- Irrigation projects: 35%
- Mining: 5%

Traditionally, asbestos cement piping has been particularly popular with municipalities, where as much as 80% of the installed base could be asbestos cement piping.

The following is a list of the substitute products that can be used in the place of asbestos cement piping:

- Carbon steel piping
- Ductile iron piping

- Stainless steel piping
- UPVC piping
- Concrete piping
- GRP (glass reinforced silica) piping
- HDPE piping

Of these, UPVC, HDPE and GRP are the most appropriate for replacing asbestos cement piping.

Asbestos cement piping's share of the water/sewage market has declined from approximately 60% in the mid 1970's to approximately 22% in the mid 1990's and to less than 5% in 2001.

Table 34 reflects a breakdown of the market shares held by the most popular piping materials for the 1991 to 1995 period.

TABLE 34: PIPING MARKET SHARES

PIPING MATERIAL	MARKET SHARE
Asbestos Cement	22%
Steel	17%
Plastics/Others	61%

Table 35 reflects a comparison of the manufacturers selling prices of the most popular piping products. For comparative purposes, a 200mm, class 6 pipe – one of the most popular pipe sizes/pressure ratings – has been used.

TABLE 35: COMPARATIVE PIPING PRICES

PIPING MATERIALS	MANUFACTURERS SELLING PRICE PER METER
UPVC	R110
HDPE	R110
Steel	R140
Asbestos Cement (Zimbabwe)	R85

The only manufacturer of asbestos cement piping in South Africa is scheduled to have discontinued distribution of asbestos cement piping by the end of 2002. A Zimbabwe manufacturer is able to offer South African customers a very competitive price and is still selling a significant quantity of asbestos cement water piping in South Africa.

8.6 DEALING WITH THE "INSTALLED BASE" OF ASBESTOS-CONTAINING MATERIALS

There are three broad possibilities for dealing with an installed base of asbestos-containing materials and/or products already in place in existing buildings:

- Do nothing
- Remove it
- Encapsulate, enclose it or repair it

The most appropriate approach to be adopted depends upon the condition and location of the asbestos material, and should be based on the following factors:

- The type of asbestos that is contained in in-situ materials and product
- How the materials/products are used and how friable the are
- The surface condition and age of the product
- The position of the asbestos-containing materials and/or products within the building

8.6.1 Option 1: Do Nothing

Throughout the literature, this is proposed as the best alternative where the asbestos is in an acceptable condition and is in a non-friable form. As one scientist put it: "*asbestos is like a big sleeping dog. If not stirred up, it does no harm. If hammered or sawed upon, it may bite anyone near It.*".

If asbestos is not removed or treated, information must be given to those who live or work nearby, on the potential dangers and how to monitor it. This alternative may be best until the skills and the resources are available to deal with it properly. This approach requires regular inspection and education with the associated cost implications.

8.6.2 Option 2: Removal

Removal and safe disposal is ultimately the long-term safest solution for asbestos-containing materials and/or products within existing buildings. However, it is the most costly and potentially the most dangerous option. The costs and skills involved in the removal of asbestos are significant.
Therefore, removal is only recommended when the asbestos is in poor physical condition, exposed to vibration or impacts, friable, and if the necessary pre-requisites for the removal are present (such as sufficient space and equipment).

In the United States, the cost of removing asbestos is significant: "Sprayed on for about 25 cents a foot in the 1960s, it can now cost $25 or more a foot to remove, owing to the safety precautions that must be taken to protect the remover and occupants of the building."[lxv]

The risks of inappropriate asbestos removal and/or disposal can be more dangerous than no intervention at all as these can result in high concentrations of fibres being released into the air. Studies have shown that spraying or injecting of wetting agents into asbestos-containing materials and/or products reduces the hazard associated with the removal process by aggregating the fibres together.[lxvi]

The internationally recommended steps for removal of asbestos material include[lxvii]:

- When renovating or removing asbestos cement products, appropriate control measures should considerably reduce risks of developing asbestos related illnesses. Data from industries where such measures have been introduced demonstrate the feasibility of keeping exposure at levels generally below 0.5 fibres/ml of air.
- Although suppression of asbestos emissions from roof sheets by wetting or sealing of weathered surfaces is partly effective, additional precautions such as respiratory protection and clothing decontamination are considered to be essential for the demolition of roofing containing asbestos[lxviii].
- Only if damaged asbestos cannot be managed in place by sealing it or enclosing it, should it be removed

- The contractor should enclose the work area in a plastic bag (for small jobs) or in plastic sheets attached to the floor and ceiling with duct tape. The work area should be enclosed completely, including the floor, ceiling, and any air vents.
- Everything inside the area should be washed and then vacuumed with a special asbestos vacuum. Furniture should be removed
- No one should go into the work area without proper equipment (including approved respirators), protective clothing, and training. No one should leave the work area unless they have taken the proper steps to make sure that the asbestos fibres will not be taken out with them. This means that any equipment or clothing in the work area must be cleaned or taken off before leaving the area.
- The asbestos material must be kept wet during removal to reduce the amount of asbestos fibres entering the air.
- As the asbestos is removed, it should be placed in two heavy-duty plastic bags that are sealed and labelled. For larger jobs, asbestos waste may be placed in specially designed drums or boxes that must also be labelled. All wastes must be kept moist until they are deposited at the landfill Asbestos wastes must not be considered reusable and their incineration is not allowed.

In South Africa, the requirements for the removal and safe disposal of asbestos-containing materials (and the demolition of buildings containing asbestos) are laid out in the draft Asbestos Regulations 2001[lxix]. These regulations require that:

- All asbestos and asbestos-containing materials likely to become airborne must be identified and a plan of work must be submitted for approval to an approved inspection authority
- All asbestos-containing materials must be handled and disposed of in a safe manner
- Asbestos cement sheeting must be carefully removed before demolition.
- All employees exposed to asbestos-containing materials must be given appropriate personal protective equipment
- The premises, structure or area must be thoroughly checked to ensure that all asbestos waste has been removed.

The regulations also specify that a contractor that has been accredited by the Department of Labour must carry out work involving the installation or removal of asbestos-containing materials and/or products from existing buildings. (Except for asbestos cement materials that may be removed by a building contractor.)

8.6.3 Option 3: Encapsulation or Enclosure

Some researchers contend that damaged asbestos can be made safe by repairing it and, either sealing it to prevent further damage, or enclosing it, if the asbestos product is in good condition and is not likely to be disturbed.

Enclosure, encapsulation, and even spot repairs should be performed by someone trained in the proper handling of asbestos, and may require enclosure of the work area and use of protective clothing and approved respirators.

- **Encapsulation** involves treating the asbestos with a sealant (like paint) that can temporarily keep the fibres within the matrix or in their original state. This method is used in situations where the asbestos product has a hard, sealed surface and is not worn through as a result of repairs or impacts. If the material is crumbling and deteriorating, encapsulation can do more harm than good. This is because the sealant pulls down the loosened asbestos material and can allow additional fibres to be released into the air.

- o **Enclosure** involves isolating the asbestos-containing materials from potential damage by using a sturdy, airtight barrier such as spraying on a coating of cement. It is considered a suitable, but temporary remedy for some asbestos problems and is usually recommended for friable forms of asbestos. This method is preferable when the asbestos product is in good condition, is easily accessible and lies in an area not associated with physical impact.
- o **Repairs** can be undertaken in situations where there are minor damaged areas, such as holes in roof sheets. In these cases the sheet can be removed and replaced with an alternative sheet. Sealing material can also be glued in place on asbestos sheets.
- o **Maintenance**: if asbestos materials are left in place, they should be monitored and treated with respect. Household members should avoid exposure to asbestos and inspect the material regularly to see if its condition changes.

There are no regulations in North America requiring the immediate removal of in-place friable insulation materials, however, building owners are required to put in place appropriate management programmes[lxx]. Moreover, any work, which disturbs in-place friable insulation materials, must be undertaken according to very strict workplace standards. This applies not only to removal operations, but also maintenance and custodial work.

8.6.4 Friable Asbestos Insulation in North American Buildings

In North America, the policy debate over management versus immediate universal removal of in-place friable asbestos insulation materials was effectively concluded in September 1990, following the publication of the US EPA Green Book entitled "Managing Asbestos In Place".

The authors of this reference state: "Consistent with many scientific reviews on the subject, it is now generally agreed that intact, undisturbed asbestos-containing materials generally do not pose a health hazard. Therefore, unless asbestos-containing materials are in a poor condition or located where they can be easily disturbed, the best approach is to manage the problem and defer removal until the time of major renovation or demolition of a building".

Their conclusions, based on the "EPA's Five Facts", is:

- o Although asbestos is a hazard, the risk of asbestos-related disease depends upon exposure to airborne asbestos fibres
- o Based on the available data, the average airborne asbestos levels in buildings seem to be very low. Accordingly, the health risk to most building occupants also appears to be very low.
- o Removal is often not a building owner's best course of action to reduce asbestos exposure. In fact, improper removal can create a dangerous situation where none previously existed
- o The EPA only requires asbestos removal in order to prevent significant public exposure to airborne asbestos fibres during building demolition or renovation activities
- o The EPA recommends a proactive, in-place management programme whenever asbestos-containing material is discovered in a building

8.7 ANTICIPATED IMPACTS OF PHASING OUT ASBESTOS

8.7.1 Investment

The sole South African manufacturer of asbestos cement building and construction products has been involved in a conversion process for the past 20 years. As such, nearly all of the investment impacts associated with this conversion process have already been absorbed. It is estimated that this conversion process has cost this business in excess of R100-million.

These impacts included:

- Significant downsizing and disinvestments of capital plant
- A significant retrenchment of staff
- A significant investment in research and development
- Rationalisation of the product range
- A significant investment in new production equipment

In most instances, the manufacturers and marketers of substitute products have used this restructuring phase as an opportunity to capture market share. As such, nearly all of the investment in product development and expansion of manufacturing capacity of substitutes has already occurred.

8.7.2 Employment

The South African manufacturer of asbestos cement building and construction products will retrench a further 44 people as part of the final phase of its conversion process. In total, this business will have retrenched approximately 750 people over the past three years as part of its conversion and business rationalisation programmes.

8.8 BUSINESS VIABILITY

The sole South African manufacturer of fibre cement building and construction has almost completed converting its entire product range from asbestos cement to alternative fibre cement formulations. This business has already absorbed most of the impacts of conversion and has transformed itself into a viable new entity.

The only factor threatening this business is the presence of a Zimbabwean competitor that continues to market a range of asbestos cement building and construction products in South Africa. This business is exploiting the advantage which the weakening SAR/Z$ exchange rate gives it.

This Zimbabwean business is easily able to undercut the South African fibre cement business's pricing and, as a result, is continuing to capture an ever-increasing share of the South African market. If this trend continues, the South African business's survival will soon be jeopardized.

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[i] Safe Use of Asbestos. A Manual on Preventative and Control Measures. The Asbestos Institute. 1998

[ii] Asbestos Overview and Handling Recommendations

[iii] Chrysotile Asbestos in Zimbabwe, The Health Risk Story. February 1999

[iv] South Africa's Mineral Industry. Department of Minerals and Energy. 1998/99

[v] Asbestos Statistics. David A. Buckingham and Robert L. Virta

[vi] Safe Use of Asbestos. A Manual on Preventative and Control Measures. The Asbestos Institute. 1998

[vii] ILO Convention 162 Safety in the Use of Asbestos. 1986

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