March 12, 1974

Mr. A. A. Cross
The Cape Asbestos Company Limited
114 Park Street
Lond W1Y 4AB England
4EAB

Dear Alex:

I apologize for the delay in responding to your letter of January 14 to Gerry Morgan, which he forwarded to Bob Mereness on January 21. I saw the correspondence in Bob's office shortly after he received it and told him I would reply to you.

Shortly thereafter I spoke with Gerry Morgan on the telephone and told him I thought you had a valid point and that AIA/NA should be much more circumspect in commenting on variations in hazard potential between various types of fiber.

Unfortunately, the correspondence on this subject apparently then drifted to the bottom of the pile and surfaced only recently. I have no excuse other than my own inefficiency.

As you probably know from Stephen Holmes, I shall be in the U.K. the weeks of March 25 and April 1. I hope we shall have a chance to get together to discuss this and other matters of mutual interest.

Sincerely,

(signed) John H. Marsh

CC: Messrs. R. H. Mereness
C. G. Morgan

NAAC NORTH AMERICAN ASBESTOS CORPORATION

150 NORTH WACKER DRIVE, CHICAGO, ILLINOIS 60606 • PHONE: (312) 726-8515 • CABLES: NORAMCO, CHICAGO

December 18, 1973

Mr. R. H. Mereness
Asbestos Information Association
1660 L Street, N.W.
Washington, D. C. 20036

Dear Bob,

During my recent visit to your offices you will recall our discussion pertaining to a position paper which Cape Asbestos asked permission to submit to the AIA/NA. We are enclosing copies of the document as received today.

We believe there have been tendencies in some areas to segregate Blue and Amosite asbestos into a separate category, as opposed to Chrysotile, when related to health hazards. From this point of view, it would appear that Cape has endeavored to fairly and fully present all the known facts as regards Blue and Amosite asbestos.

These documents are for your files and information, and may be circulated to all members of the AIA/NA should you so desire. In the event you believe they would serve a useful purpose, copies may be distributed to selected people in OSHA.

If you have any questions relative to this matter, please contact me.

Sincerely yours,

NORTH AMERICAN ASBESTOS CORPORATION

C. G. Morgan

Vice President/General Manager

CGMorgan/jc
encl.

HAI 01025

2.2 Possible Association between Crocidolite and Mesothelioma

2.2.1. For some time there has been a belief, though not universally accepted, that there are greater risks to health from crocidolite than from other types of asbestos, especially chrysotile. This view predominated in the U.K. during the period when the U.K. Asbestos Regulations were being formulated and led to the inclusion of discriminatory provisions regarding the use of crocidolite. When the subsequent interpretive document establishing working guides for safe levels of exposure was prepared, this also included a separate standard for crocidolite based, it was admitted, on an entirely arbitrary assumption that 1/10th of the normal standard would ensure ample protection. At that time, the results of Harries' detailed and thorough investigations were not available and, as far as the U.K. was concerned, the principal and limited use of crocidolite asbestos had been in the form of mattresses, thermal insulation and, especially, sprayed insulation. For mainly technical reasons, crocidolite was little used in the U.K. for A/C pressure pipe manufacture.

The report of the Advisory Committee on Asbestos Cancers to the Director of the International Agency for Cancer Research (Lyon 1972) said "The risk (of mesothelioma) is greatest with crocidolite, less with amosite and apparently less with chrysotile". It also states that "there is evidence that all commercial types of asbestos except anthophyllite may be responsible".

2.2.2. The evidence upon which these beliefs are based rests heavily on the study in South Africa reported by Wagner in 1960. The results of further studies associating crocidolite with mesothelioma (particularly in manufacturing situations) are less specific but all of the significant evidence is reviewed below.

2.3 Mesothelioma in Association with Crocidolite Mines

2.3.1. Wagner (1960) (6) investigated an unusual frequency of the rare tumour, mesothelioma, in the Cape Province of South Africa. Of 33 cases, 8 had evidence of asbestosis, but, of the remaining 25, 24 had a probable exposure to crocidolite mostly through residence from birth or early age in the vicinity of crocidolite mines in N.W. Cape. Subsequent studies enlarged this study to 120 cases, 110 of which were said to have been exposed to crocidolite, more than half through living in the vicinity of mines and mills.

2.3.2. Wagner's is the only epidemiological study where there is no other type of asbestos than crocidolite known to be present. The conditions prevailing during the exposure period of his series, of which he says the average latent interval was 40 years, were extremely dusty - in a dry and arid region. The exposure level and the duration of exposure for the great majority of those living in the immediate neighbourhood, playing and freely moving about the tailing dumps and stockpile areas, would have been considerable in those days. Hand cobbing (freeing fibres from the rock capping) was done by female labour accompanied by their children.

2.3.3. Subsequent surveys (Sluis-Cremer (33); Webster, Lyon 1972 (34)) and investigations by the South African Bureau of Mines have not produced evidence of a growth of cases corresponding to growth in production anticipated by Wagner. 360 cases have been reported, 155 with no known exposure, 117 with definite industrial or environment exposure. They have also indicated that, where there has been a positive exposure to asbestos in mining, the majority of cases (83 out of 88 reported since 1956) appear to be confined to the south and central part of the N.W. Cape crocidolite mining areas.

2.3.4. In Canada, a research team led by Doctors Corbett and Alison McDonald, started in 1967 a study of the health of workers in the Quebec asbestos mines and mills, with the primary purpose of assessing what risk of lung cancer there might be in persons exposed to Canadian chrysotile asbestos. Reports covering various aspects of the survey have been and will continue to be published, but a progress report issued by Dr. Corbett McDonald in 1970 (18) conveys an impression which does not seem to have been changed materially by subsequent reports.

The study of some 12,000 employees in the Quebec mines and mills born between 1890 and 1920 showed a death rate for lung cancer among those in the highest category of dust exposure three times greater than that of employees with minimal exposure. The employees in the lowest dust categories apparently had little or no increased mortality from asbestos-related disease.

As far as mesothelioma is concerned, few cases were found (13). Only 165 cases were recorded by pathologists in the entire country during the period 1960 - 1968 and only in a minority of these was there a definite history of having worked with asbestos (11 definite, 9 probable). Ten of these, including 3 engaged in mining or milling, would apparently have only been exposed to chrysotile asbestos; 10 were involved with insulation materials and so may have been exposed to other types of asbestos.

In comparing McDonald's surveys in the Quebec mining area with Wagner's findings in South Africa, it must be remembered that climatic and working conditions were entirely different. Comparison is further confused by the difficulty of retrospective case finding and diagnosis together with uncertainty of exposure history in such widely differing locations.

2.3.5. Considerable efforts have been made to confirm more positively the association between crocidolite exposure and mesothelioma in the N.W. Cape. The results have been inconclusive. An extensive survey conducted by the Pneumoconiosis Research Unit throughout the N.W. Cape in 1961/62 did not reveal new cases, and after further extensive research, Professor I. Webster (35) has recently suggested that crocidolite "must be associated with another factor before malignant change occurs".

2.3.6. There continues to be difficulty in establishing conclusive evidence in this area. As an example of this, experience at the crocidolite mine of Cape Asbestos at Koegas may be quoted. This is probably the oldest commercially significant mine, having been worked for 80 years and with many long serving employees. As with all South African mines, regular health checks are compulsory but, at the time of writing, no cases of mesothelioma have been notified to us as from former employees and we are not aware of any.

2.4 Mesothelioma in Asbestos Manufacturing

2.4.1. Newhouse in 1964 (3) undertook the first attempt to investigate a connection between crocidolite and mesothelioma in a manufacturing situation. She looked for a possible connection with exposure to crocidolite asbestos among mesothelioma cases recorded by a hospital in East London. Of 76 cases, she established that 23 had worked in asbestos factories, 7 had worked in the application of thermal insulation, 10 had probable exposure of an indirect nature. 11 others lived within ½-mile of a large asbestos factory. The remaining 25 had no traceable connection with asbestos. While the positive or probable exposure was to asbestos of all types, it was believed that in all cases crocidolite could have been present. Subsequent studies (1968 (9), 1972 (29), 1973 (30)) all related to similar industrial exposure.

2.4.2. The further study by Newhouse (1972 (29)) of a group of 716 women employed between 1936 and 1942 revealed 11 mesothelial tumours; over 40% of those in the cohort had worked in textile processing departments and 10% in mattress making. Crocidolite and chrysotile were largely used in the former and amosite in addition to these in mattress making.

2.4.3. In another survey (30) of over 4,500 male workers in an asbestos factory making textiles, insulation products of various kinds, jointings and brake linings, Dr. Newhouse reported that there was no excess mortality among those who worked in jobs where exposure was low or moderate, though where work entailed heavy exposure, there was a significant excess from cancer of lung and pleura, in some cases where total period of employment had been less than two years. Occupations in these categories included insulation manufacture, textiles, fibre opening and disintegrating, mattress making, asbestos store and dust and waste collection.

2.4.4. Dr. Newhouse's work as a whole represents a very thorough study of the effect upon workpeople and those living in the vicinity, of conditions in an asbestos factory where, it is now realised, there was insufficient control of asbestos dust in earlier years and particularly for a period during and immediately following the last war. All types of asbestos were used in this factory - frequently on the same machines - and it is certainly not possible to pinpoint specific types of asbestos dust to which particular workers were exposed. For this reason, Dr. Newhouse's work cannot be used as a means of assessing relative hazards of different kinds of asbestos.

2.4.5. Dr. Gilson (31) refers to nine cases of mesothelioma in a group of workers employed in the assembly of crocidolite asbestos filter pads in gas masks during the war. Information concerning the asbestos content of these filters is now imprecise but the nature of the process was such as to generate appreciable and possible heavy dust clouds in the immediate breathing zone of the operatives. Dr. Gilson also quotes information from Dr. Lewinsohn that a group of mesotheliomas were discovered among men working in a factory in the mid-20's where possible heavy exposure to crocidolite occurred.

2.4.6. Crocidolite has been used for at least fifty years throughout the world in the manufacture of asbestos cement, which accounts for the largest use of asbestos, but two possible cases only have been reported from this sector of industry. Another use has been as reinforcement in plastics (e.g. battery boxes). No cases of mesothelioma are known to have occurred in this connection.

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2.5 Mesothelioma in Naval Dockyards and other Shipyards

Harries' (7) (22) studies of pleural mesotheliomas among workers in UK naval dockyards, indicated exposure to all types of asbestos. Heaviest concentrations recorded were in stripping sprayed asbestos, normally crocidolite which, up to that time, had been used in very large quantities for insulation in naval vessels.

This was possibly the first study to recognise the very severe exposures to asbestos dust that occurred when asbestos insulation was stripped within confined spaces on ships. Dust levels exceeding 1,000 fibres/ml were recorded at some points. Subsequent work has confirmed this and the relationship between incidence of mesothelioma in the country (U.K.) as a whole and areas where shipbuilding and ship repair work has been carried out has been illustrated on a map by Wagner (36).

2.6 Comments on the Evidence Concerning Crocidolite

2.6.1. The only evidence based upon exposure to crocidolite alone is that supplied in Wagner's papers. Subsequent work has not confirmed the conclusions that were at one time drawn from Wagner's findings.

2.6.2. Other exposures that are quoted in this connection have been both mixed and heavy. No conclusions regarding the specific contribution of a particular type of asbestos can therefore be drawn.

2.6.3. There is no evidence of mesothelioma in association with the use of crocidolite where the form of product or nature of use has not resulted in excessive dust. The idea that only minimal exposure is necessary to produce mesothelioma has developed by suspicion and there are no facts to substantiate this idea.

2.6.4. A detailed study of cases of mesothelioma associated with exposure to asbestos throughout the world (excluding mining) (see Appendix A), which prompts the above reservations, indicates that, of 763 reported cases, 664 are said to be definitely associated with occupational exposure. (Most of these studies are, of course, of groups of workers in occupations where an exposure to asbestos dust is expected. This obviously weights the sample heavily.) Of these, 290 are positively stated to have occurred where chrysotile and crocidolite and/or amosite has been in use; in 361 cases, no details of the type of asbestos are given but it is apparent from the general references to the type of exposure that more than one type was likely to have been present.

Further scrutiny of the occupations recorded in these studies also indicates that of those listed as occupationally exposed, directly or indirectly, 553 were engaged in or in close association with insulation work, either on land installations or ship repair and construction. The remaining cases were also associated with manufacturing processes such as textile manufacture, mattress making and other insulation manufacture, where dust concentrations were known to have been heavy.

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3. AMOSITE

3.1 General

As indicated in Table I, amosite asbestos also contains approximately 50% silica, with about 40% of ferrous oxide. Its characteristic is the springiness of the fibres and the high bulk volume produced when processed. It is also highly resistant to corrosion. These characteristics made amosite fibre the preferred material for heat insulation applications and consequently the most frequently used by insulation workers. The preference for amosite-based thermal insulation material spread to most industrial countries, and such materials were used in greatly increased quantities from the mid-1940's to the late 1960's. Chrysotile asbestos was also used in this field as the reinforcing fibre in calcium silicate section and 85% magnesia.

3.1.2. Amosite has come under particular scrutiny in the United States because of its extensive use as an insulating material during and after the war years.

3.1.3. Amosite has not been associated with mesothelioma to the extent that has crocidolite and this probably results from the almost complete absence of any history of mesothelioma in the Northern Transvaal, the only area in which amosite is mined. The question to be decided is whether exposure to amosite involves a greater hazard than exposure to chrysotile so far as asbestosis and lung cancer are concerned.

3.2 Amosite and Insulation Workers

3.2.1. The extensive investigations of Dr. Selikoff and his co-workers are well known and no attempt is made to summarise these in this memorandum. The important point for present consideration is that the workers upon whose history the investigations are based were involved in the thermal insulation industry. There are two sectors of this, the first being concerned with manufacture of products and the second being concerned with the fitting and stripping of insulation on site.

3.2.2. For a period during and immediately after the last war, a number of factories in the United States and Europe were involved in the manufacture of preformed insulating blocks, pipe sections and mattresses. In the United States, these materials were largely based either upon chrysotile asbestos in the form of "85% magnesia" (containing 15% of asbestos) or upon amosite in the form of "Unibestos" (containing 80 - 100% of asbestos). It is now clear that conditions in many of these factories were very bad by today's standards. The products were in great demand during the war, particularly by the U.S. navy. Hours were long and safety standards were relaxed in the interests of obtaining vital materials in time of war. Dust concentrations were undoubtedly heavy and the health of many workpeople has suffered in consequence of this.

3.2.3. Similar conditions have applied in the sector of the industry concerned with the fitting and stripping of insulation either in the form of moulded pieces or as sprayed fibre. In the United Kingdom, such work was not subject to control by the U.K. Asbestos Industry Regulations 1931, and dust measurement (Harries 1968 (7)) showed that even with calcium silicate insulation containing only 15% asbestos, together with asbestos

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rope, cloth and plastic mixes, mean concentrations in the general atmosphere in boiler rooms where lagging was taking place were 22.4 fibres/ml. Some individual operations concerned with fitting insulation give average breathing zone samples as 256 fibres/ml, none was less than 43.1.

In operations particularly associated with crocidolite, Harries quotes mean concentrations of over 300 fibres/ml at the place of work, while in adjacent areas and passageways two or three decks away from the work site, mean concentrations in excess of 30 fibres/ml and as much as 177 fibres/ml were recorded. It is clear that men in occupations in no way connected with the asbestos work, and whose occupation would be assumed normally not to expose them to asbestos dust, would have been exposed to concentrations which would be considered very heavy in an asbestos factory.

3.2.4. Such concentrations are also likely to apply to such occurrences of asbestos related disease in areas of shipyard repair and construction reported by McEwan (19), Stumphius (11), Bohlig (21) and others.

Selikoff has suggested (28) that average dust concentrations to which American insulation engineers had been exposed would have been low. He bases this on some measurements of various operations commonly performed by these men quoting levels from 0.3 to 8.4 fibres/ml. He refers to similar results in another survey with higher levels noted during spraying; "average level of all operations approximated 6 fibres/ml". He further assumes that, since observations in 1969 showed that asbestos materials constituted less than half of insulating materials then used, the time weighted average of exposure would be under 3 fibres/ml.

The levels of dust concentrations quoted for such operations bear no relation to those meticulously observed and measured in the United Kingdom, notably by Harries and H.M. Factory Inspectorate. In the same paper Selikoff himself agrees that the effect of peak exposures may be considerable, and that ten minutes of hard work in an atmosphere of 100 fibres/ml may overshadow the biological effect of the rest of the working day in environmental concentrations of 1 fibre/ml. This would agree with personal observation of those who have practical experience of fitting and stripping preformed insulation and asbestos spray work. Under conditions prevailing in the past, the nature of the work made it inevitable that there was frequent but irregular exposure to very high concentrations of dust - at the moment of breaking away an old section of lagging, for example. The TLV used in the U.K. based on the recommendations of the B.O.H.S. Standards of Hygiene for Chrysotile Asbestos Dust (32) fully recognise the significance of peak exposures and qualifies the average of 2 fibres/ml over four hours to the extent that excess above 12 fibres/ml for any ten minute period is unacceptable.

4. CONCLUSIONS

4.1 Apart from the study by Wagner, which subsequent surveys suggest have not been repeated on the same scale in other crocidolite mining areas, there are very few cases of mesothelioma where the cause can be said with certainty to relate exclusively to crocidolite exposure.

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4.2 Cases of mesothelioma reported throughout the world where an occupational exposure to asbestos, usually both amphibole and chrysotile, is definite or possible, have invariably occurred where concentrations have been very heavy - much heavier than have occurred in U.K. manufacturing industry for very many years.

4.3 Although there continues to be lack of satisfactory evidence, the suggestion is still occasionally made that mesothelioma can be associated with short duration of exposure. It is acknowledged that mesothelioma is not always caused by asbestos and in the absence of an occupational history, there is a temptation to attribute a particular case to some slight and often unspecified exposure in the past. Recent work (Newhouse (30)) indicates mesothelioma is dose related and it is believed that where asbestos is involved - and here again the type of asbestos cannot usually be specified with certainty - a high degree of exposure took place, possibly many years ago and in the early years of life.

4.4 Crocidolite and amosite fibres, by their nature, have tended to be the most favoured for use in thermal insulation, particularly during the war years and years of reconstruction after the war. The various diseases associated with asbestos use are clearly mostly found in areas where such work has been concentrated (Wagner (36)). The incidence of the various diseases are therefore more likely to be associated with the excessive concentrations and relatively uncontrolled working conditions, whether of chrysotile or amphiboles, than with the type of asbestos. There does not seem to be any evidence that where such high concentrations are prevented or do not arise, that there is any greater risk of asbestos-related disease with one kind of asbestos than with another.

TABLE I

Physical and Physico-Chemical Properties of the Asbestos Minerals

Property	Amosite	Crocidolite	Chrysotile
Colour	Ash Grey	Blue	White
Natural Fibre Length	3 to 70 mm.	3 to 70 mm.	1 to 40 mm.
Fibre Diameter (micron)	0.1 to 1	0.1 to 1	0.01 to 1
Crystal System	Monoclinic	Monoclinic	Monoclinic and Orthorhombic
Occurrance	Banded ironstones	Banded ironstones	Serpentines
Optical Properties	Biaxial positive extinction parallel	Biaxial positive or negative. extinction parallel	Biaxial positive extinction parallel
Refractive Index	1.657–1.698 non-pleochroic	1.685–1.698 pleochroic	1.50–1.55 non-pleochroic
Specific Gravity	3.2–3.45	3.37	2.55
Hardness (Mohs' scale)	5.5–6.0	4.0	2.5–4.0
Specific Heat k-cal/gm/°C	0.193	0.201	0.266
Tensile Strength kg/cm ^{2}	25,000	35,000	31,000
Youngs Modulus kg/cm ^{2}	1.65×10^6	1.9×10^6	1.65×10^6
Heat resistance:			
% residual strength at 200°C	100	100	100
400°C	37	38	100
600°C	7	18	16
Fusion point °C	1,100	1,000	1,500
Surface Charge	negative	negative	positive

TABLE II

Chemical Compositions of the Asbestos Minerals

(Typical data)

	Amosite	Crocidolite	Chrysotile
SiO_2, silica	49.7	50.9	38.9
FeO, ferrous oxide	39.7	20.5	2.0
Fe_2O_3, ferric oxide	trace	17.45	1.6
Al_2O_3, alumina	0.4	—	3.1
CaO, calcium oxide	1.3	1.5	0.9
MgO, magnesium oxide	6.4	1.0	40.0
MnO, manganese oxide	0.2	0.05	0.1
Na_2O, sodium oxide	0.1	6.2	0.1
K_2O, potassium oxide	0.6	0.2	0.2
H_2O, water	1.3	2.0	12.6
CO_2, carbon dioxide	0.1	0.2	0.5
	100.3	100.0	100.0

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APPENDIX A

Bibliography ref.		Number of cases reported	Definite association with asbestos occupational exposure	Number known exposed to asbestos	Exposure attributed or assumed to chrysotile or amphiboles	Exposure unspecified as to type	Exposure associated with insulation/ shipyard work	Exposure associated with manufacture
1	*	42	32	10	32		32	
2		6	6	-	6			6
3		76	30	36	30		7	23
4	*	95	95		A 95		95	
5	*	6	6		6			6
8		23	23			23	23	
10	*	52	52		52		52	
11		21	21			21	21	
14		15	12	3	B (4) 8			12
15		119	119			119	119	
16		29	29			29	29	
17		3	-	3				
19		80	49			49	49	
20		6	5	1		5		5
21		55	55			55	38	17
23		25	25			25	25	
24		40	35	5		35	33	2
25		15	15		15			15
26	*	7	7		7		7	
27	*	5	5		C 5			5
28	*	23	23		23		23	
29		11	11		11			11
30		9	9		B (9)			9
		763	664	58	290 B (13)	361	553	111

Notes :

* These series cover other cancers, inclusive of mesothelioma

A Little possibility of crocidolite exposure

B Exposure said to be likely to crocidolite

C Exposure said to be most likely to amosite

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