Reference: INQUIRY INTO ASBESTOS ISSUES AT WITTENOOM.

1. Thank you for your letter of 7 March 1992 and the accompanying dossier of papers. I understand the brief and can comply with most of your requests within the time available but I doubt if there is much information on "the control of the release of asbestos fibre from tailing dumps" which is relevant or helpful to the Wittenoom inquiry. Some fruitful inquiries might be made in Canada where I believe that reliable airborne fibre measurements in the general environment surrounding chrysotile mines have been undertaken. It is possible that consideration of "control of the release of asbestos fibre from tailing dumps [at Wittenoom]" may be premature. Appropriate studies should first be made to determine the magnitude of any current release, its significance and how the success or failure of any attempts at control might be evaluated. Indeed a methodology to evaluate the success of *any* proposed airborne crocidolite mitigation practices at Wittenoom ought to be established before any such practices are instituted.

PROLOGUE.

The toxicology of crocidolite.

2. Much of the public and political discussion concerning exposure to asbestos, and in particular crocidolite and other amphiboles, is coloured by the common belief that blue asbestos is an extraordinarily harmful substance and that a minute dose is sufficient to cause disease in some persons. Much of this (erroneous) belief flows from (erroneous) interpretations of the early reports concerning the association between exposure to airborne crocidolite and mesothelioma. One such erroneous interpretation can be found in the 1978 book "Asbestos & Disease" by Selikoff and Lee (Appendix 1 to this report).

" As Wagner *et al.* pointed out in their initial paper, one-third of their cases had merely lived in the vicinity of asbestos mines and mills, from which community air contamination was very probable. One case, 21 years of age, had been exposed briefly to cobbing as an infant." (pp265-6)

3. In fact Wagner's words to the 1964 New York Conference (Appendix 2) were "The youngest case diagnosed, aged 21, gave a history of a very brief exposure as an infant when he was taken to a "cobbing" site by his mother from the age of six weeks until he was weaned". It is likely that he was not weaned until he was about two years old but, in any case, Wagner used the words "gave a history" which is quite different from "had been exposed briefly". The earlier paper by Wagner et al (Appendix 3, p262) gives more detail of the exposure histories of the subjects of this investigation - "cobbing consists of separating the fibre from the banded ironstone by striking the rock cob with a small hammer". At least one cobbing site was close to a large mill and mention was made that "the children play on the dumps from the mine and mill". Selikoff & Lee clearly misrepresented this particular case in allowing their readers to infer that the young man was exposed to [low level] "community air contamination" when they knew nothing of his personal exposure to airborne crocidolite before he was weaned and until he was aged 7 years.

4. We are fortunate that Wagner elucidated the issue even further in 1991 (Appendix 4 p401). He emphasises the unreliability of the "original histories" obtained from the patients during the 1950s and also remarks:

> "The most sinister of the environmental exposures was the mill and its associated tailings dumps. The villages had grown around the mills and these dumps. Many of the patients recorded living in a blue haze and the schools were established near the dumps, which proved a fatal attraction for many of the children."

5. Wagner's views are similar to those of Schepers (Appendix 5) and Sluis-Cremer (Appendix 6) at the 1964 New York Conference. These authors clearly demonstrate that South Africans who suffered from mesothelioma in the years 1955-60 were likely to have experienced high levels of airborne crocidolite exposure twenty or more years before the disease was diagnosed and that the disease did not merely originate from exposure to [low level] community air contamination as implied by Selikoff & Lee.

6. Another early source document which is misinterpreted is the first publication derived from

European epidemiological studies of crocidolite and mesothelioma - Newhouse & Thompson in the British Journal of Industrial Medicine, 1965, 22, 261 (Appendix 7). It is from this paper that the view has arisen that merely living in the vicinity of a factory which uses asbestos is an abnormal risk for mesothelioma. Newhouse & Thompson state (page 261) "There is also evidence that neighbourhood exposures *may* (my emphasis) be important." because "among those with no evidence of occupational or domestic exposures, 30.6% of the mesothelioma patients ..... lived within half a mile of an [*i.e. one particular*] asbestos factory".

7. However this statement should be read in conjunction with the words on the second column of page 264 "One patient was 22 years old when she moved into the neighbourhood in 1915. She disliked it and, when interviewed, complained impartially about the dust from the asbestos factory and the rats in the house." Newhouse is saying, in a rather sardonic way, that the dust concentration was so great as to be as major a nuisance as the rats in the house.

8. Nearly ten years later, Newhouse was to write, concerning asbestos in the environment and the same group of people (Appendix 8, p101):

> "In these instances, exposure occurred usually more than thirty years before death, and it may have been considerable. A patient suffering from a peritoneal mesothelioma interviewed recently, recalled playing with handfuls of asbestos on waste ground near a factory as a small boy, some forty years before he developed his tumour."

9. Of course it is unwise to assert that "neighbourhood exposure" without well attested and substantial asbestos exposure has not resulted in cases of mesothelioma but it is quite wrong to infer that "neighbourhood exposure" or "ambient air concentration" in the vicinity of asbestos mines and factories is always at a level of concern. One investigation by some of our "prophets of doom" (Hammond et al Appendix 9) was unable to demonstrate any excess mortality amongst persons who lived in the vicinity of a factory which used amosite, was said to have been very dusty and induced mesothelioma in many employees.

10. I do not have ready access to all the publications concerning mesothelioma at Wittenoom but a 1980 article by Hobbs et al (Appendix 10) states that some of the workforce was "at relatively low risk" which suggests that very low concentrations - several orders of magnitude lower than those experienced by workmen in the mine and/or mill when it was operating - will not give

rise to a significant incidence of disease amongst persons who live at Wittenoom in the future. However, it must be noted that "the effects of childhood exposure cannot be predicted" - Peto (Appendix 11, p463) - and this may be very important to the Wittenoom issue.

> "The models described above imply a roughly fourfold increase in risk for mesothelioma, but not for lung cancer, when exposure begins soon after birth rather than at age 20, reflecting the cubic residence time assumption (Table 1). Such an age-related effect would be expected for any carcinogen which initiates the induction of a multi-stage carcinogenic process; but this prediction takes no account of the possibility that children are particularly susceptible to carcinogenesis by virtue of factors such as stem cell expansion during growth and development. The risks caused by exposure in childhood may therefore be substantially greater than those predicted for both mesothelioma and lung cancer."

MEASURING AIRBORNE FIBRE CONCENTRATION

The Membrane Filter Optical Microscope Method

11. It seems to be commonly believed that the act of measuring the concentration of airborne asbestos fibres in an environment results in a unique, objective determination, but this is far from the truth. It is not quite Alice in Wonderland "words mean what you want them to mean" stuff but the methodology and instrumentation for making the determination varies with the purpose for which the measurement is made. If, say, the purpose is to prove or disprove that a working environment in which raw, commercial asbestos is used (such as an asbestos cement or floor tile manufacturing plant) complies with the requirements of the industrial regulating authorities, the method is that published originally by the Australian National Health & Medical Research Council in 1976 (Appendix 12) and subsequently, somewhat modified, by Worksafe Australia in 1988 (Appendix 13, p91 ff). [Appendix 12 is included to enable me to criticise some of the measurements made in Wittenoom before the Worksafe publication was issued.] A further modification of NH&MRC is "The Reference Method for the determination of Airborne Asbestos Fibre Concentrations at workplaces by light microscopy (Membrane Filter Method)" published by the Asbestos International Association as RTM1 (Appendix 14) and adopted as the "standard" method by the E.E.C. (and, in consequence, forced upon the British). [Appendix 14 is included only to permit me to introduce an A.I.A. method which uses an electron microscope not a light microscope.

This is important in criticism of measurements made in Wittenoom.]

12. Briefly, the Membrane Filter Optical Microscope method (hereinafter referred to as the MF/OM method) draws a measured quantity of air through a special filter *(membrane filter)* on which most of the airborne particulates are deposited. The filter is taken to the laboratory where it is rendered transparent and examined with the *light microscope* using specified conditions of illumination and magnification. These conditions permit the investigator to report the number of "regulatory" fibres per millilitre of air (fpmL) in the environment sampled [for example, 2 fpmL]. The "regulatory" fibre is defined as a particle of length greater than 5 micrometres, diameter less than 3 micrometres and an aspect ratio of length to diameter of 3:1. Worksafe (and most other authorities) permit the investigator little discretion - "in the absence of other technically convincing information, all particles complying with the defined geometric conditions are to be considered as asbestos fibres and counted as such" (p102). The "defined geometric conditions" were adopted arbitrarily by the U.K. asbestos industry in 1958 and, not unreasonably, were taken into industrial regulations adopted, principally, to minimise the incidence of *asbestosis*. They remain today and are used not merely in considering *asbestosis* but by persons attempting to predict relative risk for lung cancer and mesothelioma at various levels of airborne asbestos contamination.

13. It is important to realise that the "defined geometric conditions" or "countable fibre" (Worksafe terminology) places no lower limit on the diameter of a fibre although one is effectively present because of the limitation imposed by the resolving power of the (defined) microscope system. Various estimates of the limit of resolution of individual fibres have been made - for crocidolite it is probably not less than 0.2 micrometres (Appendix 15, p146 line 4). Many of the airborne fibres and, perhaps 75% of those believed to be responsible for the induction of lung cancer and mesothelioma are so thin that they cannot be seen with the optical microscope (Appendix 15 p148).

14. It is clear that the MF/OM method does not "measure the airborne fibre concentration"; it measures only a truncated section of the size spectrum of the airborne fibres and, hence, produces a "figure of merit" only. It was, and is, of value for the mitigation of *asbestosis (and its complication, lung cancer)* and engineering control in occupational environments where asbestos processes are in operation and the airborne fibres which are present are known to be predominantly

asbestos. It is the method specified for permissible occupational exposure levels by regulatory authorities in Australia, U.K., E.E.C. and U.S. and will probably remain the method for asbestos and man-made mineral fibres in the foreseeable future. It is also used in a modified and less precise way in Australia and the U.K. to obtain a "clearance index" following the removal of sprayed asbestos coatings in buildings.

15. Even the "figure of merit" derived by the MF/OM method is subject to considerable imprecision and the many sources of error have been studied closely and thoroughly discussed in Appendices 12-14 and similar publications by the U.K. and U.S. authorities. Some error is unavoidable under the best of controlled conditions in the most experienced laboratories. The "limit of reliable quantification", sometimes termed the limit of detection, of the method proper is about 0.1 fibres per millilitre (fpmL) and for "clearance monitoring" the less precise "practical lower detection limit is approximately 0.01 fibres/mL" (Worksafe, Appendix 13 page 113). [It is quite possible that the organisations which have undertaken dust sampling surveys at Wittenoom since 1985 have been trying to quantify airborne dust which includes crocidolite fibres with diameters predominantly less than 0.2 micrometre at concentrations of less than 0.01 fpmL - a rather hopeless task to which I will return later in this report.]

16. A limit of reliable quantification of 0.1 fpmL for the MF/OM method when used in asbestos mines and factories using raw asbestos is not unsatisfactory because the levels of concern to regulatory authorities and factory managements have been considerably higher than this. Indeed in 1968 the state of knowledge at the time led to the belief that a level (measured with MF/OM) of 2 fpmL (of chrysotile and amosite and probably crocidolite) all day every day for a working lifetime of 50 years would result in the first signs of *asbestosis* in not more than 1% of workers. In January 1979 6% of James Hardies employees were exposed to a level exceeding 1 fpmL [chrysotile and amosite] (Appendix 16 p5).

17. Most working environments from which knowledge of the toxicology of asbestos has been derived have been well in excess of 0.1 fpmL when measured with MF/OM (or with other instrumental systems which produced other "figures of merit" and correlate poorly with MF/OM results). Most of these measurements were made in environments in which the predominant fibre was chrysotile (which is scarcely, if ever, associated with mesothelioma other than in chrysotile mines, and then rarely) or mixtures of chrysotile and amphiboles in unknown proportions or of amosite alone. It is by

extrapolating these measurements over several orders of magnitude that investigators have produced risk estimates for lung cancer and mesothelioma - a further extrapolation is required to apply them to crocidolite and I return to that later in this report but it is necessary to emphasise here the imprecise nature of the measurements and extrapolations on which risk estimates are made.

Electron Microscopy

18. The short comings of the optical microscope were appreciated in the 1970s principally arising out of the reports concerning mesothelioma and asbestos contamination of the ambient environment. It became clear that optical microscopy could not differentiate between asbestos and other types of fibre (both natural and man made) and that these non-asbestos fibres were often at higher concentrations than the asbestos fibres. Nor could optical microscopy differentiate between a fibre and an acicular (non-fibrous) particle which complied with the defined geometric conditions of a "countable fibre" and these needle-like particles were sometimes in relatively large numbers when compared with true fibres. Identification can be undertaken by means of electron microscopy (Scanning Electron Microscope - SEM, or Transmission Electron Microscope - TEM/STEM) <u>together with</u> an X-ray analyser and/or electron diffraction facility (Appendix 17).

19. Although any investigator might, with profit, adopt his/her own methodology in the use of any form of scientific instrumentation, I feel more comfortable with methods which have been submitted to peer review or derived in consultation with others. Appendix 17, based on <u>scanning electronmicroscopy</u> for asbestos quantification and identification, is a consensus document derived, principally, from a meeting of experts in 1978. It is a compromise and some of the reasons for the compromise are set out in Section 2 - mainly the expense and poor availability of TEM and STEM systems. [STEM means "scanning transmission electron microscope" - an advanced type of TEM.]

20. Appendix 17 is therefore written around the fibres thought to be countable with the MF/OM system:

> "The method should be used where the concentration of fibres longer than 5 micrometres and with diameters between approximately 0.2 micrometre and 3 micrometres is appropriate as an index of exposure to airborne asbestos, or where measurements are required at low concentrations for comparison with measurements by the phase contrast optical method.

This may include sites close to emission sources [such as factories making asbestos-containing products and mines]. The larger fibres may settle out as air moves away from such sources, thus simply decreasing the number of countable fibres. A point will be reached, just like any other analytical method, when significant results are no longer obtainable." (Section 4.2.1 General Principles).

21. Appendix 17 is very similar to NH&MRC MF/OM and its derivatives - it sets out a standard method for sampling, counting, sizing and analysing the concentration of airborne *asbestos* fibres in the environment. SEM has some serious limitations in both visibility and identification and, in particular, "there is at present insufficient information available to determine the empirical precision of the method for the variety of practical conditions existing" so that only an investigator sufficiently experienced in the work can make a reliable estimate of the lower limit of quantification. SEM removes some of the sources of error concerning non-asbestos fibres which MAPROLABS appears to have found significant in Wittenoom samples but, in 1992, its use can be justified only if economic constraints and availability prevent the use of TEM. Of course MAPROLABS did not use the method of Appendix 17.

22. The airborne crocidolite (or chrysotile or amosite or mixture thereof) fibre concentration can be determined completely if TEM is used for counting and identification. This instrument places no restrictions on the lower limit of detection or identification of fibres because of their diameter and so permits the *quantification and identification of all crocidolite* fibres collected on a membrane filter (of special type). It is known that fibres with a diameter less than 0.25 micrometres appear to be more carcinogenic than thicker ones and the TEM can identify reliably fibres much thinner than that - 0.01 micrometre diameter fibres can be identified positively by a skilled investigator with a good instrument (Appendix 15 Table 1.11). Although frequently not stated, most of the "risk estimates" at low fibre levels in the literature are in terms of "optical equivalent fibres" obtained by the application *of "fudge factors"* to T.E.M. *measurements* because the "models" have been derived from (unsatisfactory) optical microscope estimations in occupational environments.

23. TEM is the method demanded by the U.S. E.P.A. for the estimation of airborne asbestos fibres in accordance with the Asbestos Hazard Emergency Response Act (AHERA) and it may be demanded for measurements at Wittenoom by activists such as the W.A. Asbestos Diseases Soociety. It could be argued that only a reliable and complete

description of the airborne crocidolite contamination has any value in leading to rational decisions on any changes to the status quo at Wittenoom. TEM is appropriate to comparisons between environments - "does the level of asbestos in this building differ from that in the street outside?" or "is this school more or less contaminated with airborne asbestos now that the sprayed asbestos has been removed?" or "is the environment 10 km from the (old) Wittenoom post office more or less contaminated with crocidolite than that 40 km distant?" or even "has the *removal* of tailings added to the airborne level of crocidolite?"

24. In essence, use of the (expensive and uncommon) Analytical Transmission Electron Microscope (TEM/STEM with the appropriate ancillary equipment) by persons with the appropriate skills can differentiate between two environments with relatively minor differences of airborne crocidolite contamination. However it would be difficult to support an assertion that the risks of living in the environment with the higher level of contamination are greater than those at the lower level as appears to be implied in the last paragraph of the W.A. Department of Conservation and Energy Study concerning airborne fibres at Wittenoom. Experts in the subject of asbestos and health (Appendix 18) support the view that:

> "The linear dose-response model for the prediction of asbestos-induced lung cancer is questionable, because it assumes that any exposure to asbestos will result in some increase in disease - an unproved hypothesis."

The same argument may be applicable to crocidolite and mesothelioma and I return to that issue later in this report but it is important to note that the inherent imprecision in all methods of measuring the airborne fibre concentration, particularly the "historical" measurements on which most of the toxicology of asbestos has been based, makes the derivation of dose-response models unsafe.

25. I do not know of a publication equivalent to Appendix 17 for the use of TEM-STEM in airborne asbestos sampling and analysis but there is a Draft International Standard which should be available from the Standards Association of Australia (ISO/DP10312; ISO/TC 146/SC 3/WG1 of 1989). Australia is obliged to follow International Standards in the absence of any equivalent Australian document. No doubt this Draft Standard will indicate clearly how labour intensive TEM work can be - the preparation of the specimens for examination is much more complex than that for the light microscope. There

are many literature references on the subject; those by J. Lebel and another by Sebastian et al concerning airborne asbestos in Quebec asbestos mines might be useful at Wittenoom.

Dust Sampling at Wittenoom in the Future

26. In my opinion no airborne fibre sampling should be undertaken at Wittenoom in the future without the preparation of a detailed program setting out the purpose of the samples and the information which they are expected to convey. Any action which might arise from the sampling should be identified in advance. Then, and only then, can a rational decision on methodology for the measurement of airborne fibre concentration be considered. Beach-combing, entrepreneurial, "background", "range finding", "reassuring", "research" and other adjectival programs of dust sampling would then be identified as such and treated as such. If the sampling is asserted to be for "health reasons" an estimate of the number of lives expected to be saved by the sampling program should be given. If the derivation of a "risk estimate" for disease amongst any group of future residents at Wittenoom is contemplated, the methodology of the "risk estimate" ought to be defended by the protagonist; it could affect any sampling strategy.

26A. There may be a need for true occupational and even para-occupational sampling (in Worksafe's terminology) at Wittenoom in the future if large scale disturbance of tailings either at Colonial Gorge or in the township is contemplated. This is the only application of light microscopy I can envisage in future dust sampling at Wittenoom. The light microscopy must be done by a laboratory registered by the National Association of Testing Authorities and the field sampling should also be done by experienced principals or employees of that laboratory - preferably under the supervision of full members of the Australian Institute of Occupational Hygienists. The rather flawed dust sampling at Wittenoom undertaken during the period 1977-86 points to the need for experienced personnel and I return to that aspect later in this report.

27. Para-occupational sampling (in Worksafe's terminology) is a rather unsatisfactory practice - "Most informed authorities consider much of this paraoccupational sampling to be wasteful of resources and money" (Appendix 13 p101) and it seems possible that if this type of sampling is necessary at Wittenoom in the future it may be necessary to supplement the light microscope with some SEM work. All SEM work should follow Appendix 17 unless good reasons for departing from it can be demonstrated.

28. Ambient air samples - such as most of those collected by the Department of Conservation and Environment and the Geraldton Building Company - require TEM which was expensive and time consuming but I am uncertain about today's prices, particularly if an overseas laboratory were selected to do the counting and analysis. I believe that there are now several laboratories equipped and experienced to do this work in the U.S. since the E.P.A. indicated that it might require that instrumentation for AHERA - the market may determine the price.

Previous Airborne Fibre Estimations at Wittenoom.

29. 1977 was not a good year for dust sampling at Wittenoom - the purpose of dust samples taken "while driving around the town at 40 km/hr with the sampling head protruding from the boot of the car" (your document reference 3252) is unknown and its interpretation unfathomable. Similar comments apply to the examination of vacuum cleaner bags whilst I presume that the words "In November, 1977, a sample of dust from a personal sampler worn by a Mines Inspector for half an hour outside the school and one hour outside the hotel was found to contain approximately 0.2 fibres per cc of filtered air" is merely an example of inadequacy in the use of the English language and not an index of the technical competence of its author. However the next paragraph on page 6 of that document requires some comment because similar, erroneous, opinion appears in some of the other dust sampling reports; this is an appropriate place at which to make the comments.

30. Many persons who are not occupational hygienists have no understanding of the (almost) synonymous terms "threshold limit values" or "occupational exposure limits" or "Exposure Standards for Atmospheric Contaminants in the Occupational Environment" (Worksafe terminology). In general they are concentrations to which nearly all workers may be exposed habitually for extended periods without any irreversible adverse effects. But not <u>all</u> entries on <u>all</u> lists of such values have that meaning. On page 6 of your document 3252 some person (probably Dr Cumpston but the document is unclear) contains the words "This figure equals the threshold limit set for crocidolite by the British Occupational Hygiene Society for occupational exposure". In truth, the British Occupational Hygiene Society did not set ANY threshold limit for crocidolite at any time - in 1968 it recommended a limit for chrysotile and amosite but explicitly excluded crocidolite. However, in 1969 or 1970 the U.K. Factory Inspectorate issued Technical Data Note 13 which dealt with the matter (Appendix 19).

31. In 1969 the U.K. introduced the Asbestos Regulations 1969, principally because the 1931 Asbestos Industry Regulations were seen to be outmoded. The only parts of Technical Data Note 13 of concern to us are the first paragraph "In this note guidance ..... decisions in these matters" and the section headed "Crocidolite". The subtlety of this document evades most inexperienced people but the British did not decide that an airborne crocidolite concentration of 0.2 fpmL was or was not harmful. The Factory Inspectorate issued guidance "on how HM Inspectors of Factories will interpret the expression 'dust consisting of or containing asbestos to such an extent as is liable to cause danger to the health of employed persons'" - the words used in the Regulations (and in the 1977 N.S.W. Asbestos Regulations but without the guidance note). Amongst other things, respirators were required when the level of crocidolite exceeded 0.2 fpmL when measured over a ten minute sampling period because "the concentration of this mineral that is believed to be liable to be dangerous to health, is very small indeed".

32. That Dr Cumpston did not understand this is clear from the words which are attributed to him on page 6 of document 3252: "The problem to be resolved is whether such exposure could produce asbestos related disease. If we take the allowable community exposure to be 1/10 of the British occupational figure for blue asbestos (0.2 fibres per cm3) it is unlikely that the resultant figure of 0.02 fibres per cm3 would represent the continuing exposure of any individual in the community.....". There is no need to pursue this further; Dr Cumpston was wrong to attribute any significance to the British 0.2fpmL level other than that which appears in T.D.N.13 (Appendix 19). He is not the only person to take occupational exposure limits out of their workplace context and apply them inappropriately to the general environment. Care should be taken to ensure that results of any future airborne fibre sampling at Wittenoom are correctly interpreted. [Geraldton Building Company made reference to the Australian National Health & Medical Research Council recommendation for crocidolite exposure in one of its volumes.]

33. The sampling survey of the W.A. D.C.E. in 1986 is flawed in places and demonstrates that the investigator was inexperienced in occupational hygiene. I am not prepared to argue statistics of community air contaminant observations with the author because that is not one of my strengths but I believe him to be quite wrong in his interpretations of his observations. I do know that temporal variations in such observations are mostly taken to be log-normally distributed whereas the D.C.E.

document takes them to be normally distributed (normal in this case is a statistical term). I do not think, for example, that the airport observations would look quite so "bad" if the analysis were in terms of the geometric mean (or even median) and geometric standard deviation which are appropriate to the log-normal distribution. In any case the airport observations are biased by that one very high result - 0.1050 fpmL on 6.2.86. I would reject that result on the grounds that it was the result of *gross systematic error* and suggest that it arose because a few kangaroos staged a boxing match in the tailings around the sampler resulting in airborne crocidolite fibres and fur fibres. If the results are normally distributed (as the author accepts) an observation more than three standard deviations from the mean is highly suspect - it is too improbable and should be rejected. [Some forms of contamination other than the kangaroos can also be suggested for the 6.2.86 result - people who have sampled dust in mines are only too familiar with the miner who "gives them something to measure".]

34 Other sampling sites also have unexplained "outlier" observations which if "massaged" out would lead to more acceptable mean or median or other parameters of central tendancy and variability. If further airborne fibre sampling is undertaken at Wittenoom, the sampling strategy should be submitted to an expert statistician and experiment designer *before* observations are commenced to ensure that the interpretations are made correctly. I have other substantial disagreements with D.C.E. which need not be expounded here other than to say that the scanning electron microscopy appears to have been done by an inexperienced person although insufficient information is given in the report to confirm this.

35. Figure 2 on page 33 of the D.C.E. report requires some explanation - the horizontal broken lines bear some relationship to the Worksafe exposure limit as though there is some intention to appeal to it - see G.B.C. Report Volume A p13. The last paragraph of the D.C.E. study is the dangerous type of arbitrary decision made by officials inexperienced in toxicology and to which I drew attention earlier - "it assumes that any exposure to asbestos will result in some increase in disease - an unproved hypothesis" (Appendix 18 p1728 first column). D.C.E. asserts that "crocidolite fibres were observed in all samples taken at the townsite; this was not the case with the 43 km and 9 km sites ..... (therefore) the current levels are unacceptable". D.C.E. is clearly not prepared to accept *any* level of risk for asbestos-related disease at Wittenoom which is a dangerous (and unacceptable) dogma, particularly if it is the policy of the Department of Conservation and Energy. It is a cost-benefit absurdity in a town which previously mined

crocidolite; if measured with a sufficiently sensitive instrument system, the Wittenoom township will always be more highly contaminated than a site 43 km distant.

36. The MATPROLABS data indicate little more than that a method of estimation based on the optical microscope appears to produce very low results. There is no indication of who took the samples, how the samples were taken, where the samples were taken or why the samples were taken. No doubt all that information could be provided but the results are decidedly unsatisfactory without it. We can presume that the filter preparation and microscope examination were satisfactory because the investigators appear to be approved by NATA. We do not know which laboratory did the SEM work - I do not think that MATPROLABS has that equipment. Although observed in other environments, that so many of the fibres on filters exposed at Wittenoom were not crocidolite will surprise many people - it warrants duplication by another laboratory, using filters specially selected for electron microscopy. Of course it is possible that the environment at Wittenoom is contaminated with very few fibres with a diameter greater than 0.2 micrometres, pointing up the value of some TEM observations if any further airborne fibre sampling is done at Wittenoom. Some of the MATPROLABS material might be quite useful if supplemented by the missing data on the sampling scheme. Unlike D.C.E. and G.B.C., MATPROLABS gives an indication of how it derived its "detection limit" - it appears that any observation which yielded less than 10 fibres per 100 microscope fields is recorded as less than 0.001 fpmL. "Relative risk estimates" based on the use of such observations may be no "rougher" than some of those which appear in the literature.

Surveys of Readily Available Literature Concerning:

37. ASBESTOS RELATED ENVIRONMENTAL POLLUTION.

The International Agency for Research on Cancer conducted a symposium on 8-10 September 1987 on the subject of Non-Occupational Exposure to Mineral Fibres which contain several papers of concern to us. On page 9, a paper by J. Bignon contains:

> "*Urban ambient exposure.* The contamination of the ambient air, particularly in large cities, can be deduced from the constant finding of asbestos fibres in the lungs of urban dwellers. However, as discussed later, the background levels of such urban air pollution are extremely low, and we do not know to what extent they contribute to the low asbestos fibre pulmonary burden observed in the non-occupationally exposed general population.

Non-asbestos mineral fibres are also present in the lung in the general population.

"*Neighbourhood industrial exposure.* Airborne asbestos fibre concentrations were measured in various mining areas in Canada and South Africa in 1983 and 1984 and in the vicinity of asbestos processing plants in Austria (World Health Organization, 1986b). These data indicated that the concentrations of airborne asbestos fibres longer than 5 micrometre in the vicinity of industrial sources were within the ranges of those observed in cities (from 0.1 to 10 fibres/litre)(f/litre) [0.1 fpL equals 0.0001 fpmL and 10 fpL equals 0.01 fpmL]. Higher concentrations have been observed under certain conditions (up to 300-600 f/litre downwind of an asbestos mill in South Africa [i.e. 0.3-0.6 fpmL])".

38. These two extracts are important to us; expert opinion is that general environmental pollution by asbestos is "extremely low" and even in mining areas and the vicinity of asbestos processing plants the concentration is neither abnormal nor alarming. However these extracts led me to WHO Environmental Health Criteria 53, "Asbestos and other Natural Mineral Fibres" published in 1986. Table 10 on page 51 contains the material on mining areas of Canada and South Africa. The analysis was done with S.E.M. and all "optical equivalent" results in "Residential areas near asbestos mines" in South Africa were less than 0.001 fpmL. All except one of the "residences of asbestos mine workers" (which were probably on the mine site) were less than 0.01 fpmL. One reading of 0.6 fpmL was measured "downwind of an unprotected tailing dump" but there is no indication whether it was an "active" tailing dump on which tailings had been deposited on the day of sampling nor whether it was a full-shift sample. It may be valuable if a copy of the reports by Robock et al and Selles et al (cited in the W.H.O. bibliography) were sought for future study; they are probably available from the South African Chamber of Mines or even some of the Australian Clean Air or Environment authorities. [Perhaps the W.A. Department of Conservation & Energy has copies - the 0.6 fpmL observation is mentioned in the August 1990 W.A. Report on Asbestos Cement.]

39. W.H.O. E.H. Criteria 53 in Table 11 presents "recent data on levels of asbestos in outdoor air, determined by currently-accepted techniques" and interprets it for us thus: "on the basis of these data, it can be concluded that levels of asbestos fibres (length >5 micrometre) at remote locations are generally less than 1 fibre/litre. Levels in urban air generally

range from <1 up to 10 fibres/litre (occasionally, levels exceed this value). Mean concentrations of other inorganic fibres of the same dimensions are generally up to an order of magnitude higher, or occasionally more" (page 52). [This W.H.O. publication is a consensus report prepared by a number of international experts on the subject and their views can be accepted without serious reservations.]

40. The Report of the Royal Commission on Matters of Health & Safety Arising from the Use of Asbestos in Ontario (1984) includes a section on Asbestos in the Environment. "We conclude that in the outdoor air it would be quite unusual to observe more than the optical microscope equivalent of 0.001 f/cc longer than 5 microns"(p662). The Report discusses briefly the use of asbestos mine tailings for road surfacing and concludes "If in the future the Ministry of the Environment should learn of the use of asbestos-containing tailings on gravel roads it should conduct tests to determine the ambient fibre levels that result. If a significant problem is detected at that time, regulations prohibiting the use of asbestos-containing tailings on road surfaces should be developed." This suggests that the Royal Commission had an open mind on dispersed tailings but, of course, they would be chrysotile tailings in Ontario.

41. The IARC Symposium proceedings referred to in para 36 above contain a paper on mineral fibre levels in the non-occupational environment by a Japanese reporter who made 19 observations on "an isolated island in the Pacific Ocean" with a mean of about 0.0002 fpmL (>5 micrometres) and a range of 0.0001 to 0.001 using an ATEM but I do not place too much reliance on that material because the length and diameter of the fibres are not reported in a satisfactory manner. Suffice to say that mineral fibres (asbestos) were found on an isolated island in the Pacific Ocean.

42. FIBRE RELEASE FROM TAILINGS DUMPS:

I have no information on fibre release from tailings dumps other than that in paragraph 36 above. It would be helpful if we receive the reports referred to in paragraph 36 and those by Lebel and Sebastien to which I have made previous reference. I suspect that the one by Robock, who played a major part in the introduction of my Appendix 17, is a mere description of the sampling and analytical method but it might be useful if access to TEM is difficult - the only suitable instrument known to me is that used by Mr Alan Rogers at Worksafe which cost about $400,000 without the building to house it. I do not think that the German asbestos industry had access to TEM in 1978 or they may have judged it to be too expensive!

TEM requires specially trained people to prepare the specimens and operate the equipment.

A VIEW ON RELATIVE RISK ESTIMATIONS

43. I know that the people who have developed the "relative risk models" for lung cancer and mesothelioma from asbestos exposure are not fools - I refer to such scholars as Peto, Doll, Hughes, Weill, and one or two others - and I feel sure that they would not contemplate the application of their work to quantitative estimates in a small population such as can ever be envisaged at Wittenoom. However it would not be helpful to you if I were merely to dismiss the matter out of hand and the following is offered as a basis for future discussion.

44. When considering the possibility of asbestos-related diseases at Wittenoom, two major questions should be directed to those who advocate disturbance of the status quo or are inclined to make quantitative assessments of risks from airborne asbestos exposure:

1. "If 100 men aged 25 are to work at Wittenoom for one year returning tailings to the abandoned underground mine, how many of them in the next 55 years are likely to die of excess lung cancer and mesotheliomas arising out of exposure to airborne crocidolite? How many will die of traumatic injury due to mining accidents? How many more lives would be lost than saved by returning the tailings to the mine?"

2. "If 1000 babies are born in Wittenoom and live there for 10 years, how many of them are likely to die of mesotheliomas before the age of 80? How many will die from known childhood risks such as bicycle and other transport accidents, inhalation or ingestion of foreign objects and poisons, passive smoking, drowning, playing school football and other sports, adverse reactions to immunisations and medications? How many of them will die from lifetime smoking (I am not as sanguine about the cessation of cigarette smoking as is Dr deKlerk of the W.A. NH&MRC Epidemiology Unit) and excess alcohol consumption and other adult behaviour such as bush walking, mountaineering, motorcycle riding, hunting, sexual practices, suicide etc?" (Appendix 20). Birth at Wittenoom may be an imposed risk but the others are all adopted voluntarily.

45. I do not have the answer to any of those questions but they must be addressed by persons who advocate "returning the tailings to the mine" and support their advocacy by pseudo-scientific quantitative risk estimates. Qualitative thought leads me to believe that, if answered realistically, my question 1 would result in

an answer that, judging from the experience of the "overalls washing women", at least one death from mesothelioma is likely - it will be a very dusty undertaking. I find it difficult to believe that respiratory protection will be so effective in manual workers at a place like Wittenoom that sufficient protection will be achieved to prevent mesothelioma in all of them. I think that the old underground workings at Wittenoom present at least as great a risk for accidental death as any other mine - an experienced miner might think the risk would be somewhat greater. I refrain from speculating on the last part of the question other than to say that it is crucial to the issue.

46. I do not present my views on my question 2 as those of an expert in risk assessment but I am inclined to agree with the experts who prepared WHO E.H. 53 in writing (p133):

> " ... the risk of cancer has recently become the health risk of main concern in relation to asbestos. This concern has been increased by the belief that there may be no threshold for many carcinogens below which there is no risk, but this "no threshold" hypothesis has not been proved in the case of asbestos. (see also Appendix 18) It may be that the risk is epidemiologically undetectably low at the concentrations of airborne asbestos that can be measured only at the high sensitivity of electron microscopy"

and they go on to discuss the issue of risk assessment in an intelligent and well-informed way with which I cannot disagree. Effectively, in my opinion, the WHO experts would agree that "it is not possible to derive quantitative estimates of risk" for the Wittenoom children (p134).

47. The difficulty (impossibility) of deriving reliable quantitative estimates of risk for the Wittenoom children seems to be confirmed on p460 of Appendix 21. Julian Peto might be thought of as "the father" of risk estimate models for asbestos-related diseases and he writes (recently):

"The widespread adoption of these or similar models as a basis for asbestos risk assessment has created the false impression that they are reliably established. They were originally proposed on the grounds that they were qualitatively consistent with available data and corresponded to plausible models of carcinogenesis, but both observation and common sense suggest that they are at best useful approximations, and cannot provide reliable predictions far beyond the observed range of

dose, age or duration of exposure." (They do not consider crocidolite or young children; according to Peto (page 463) "the risks caused by exposure in childhood may therefore be substantially greater than those predicted for both mesothelioma and lung cancer".) I will not tire you with other, similar, statements. The main value of rough risk estimates is for the making of public policy when populations of 50 to 100 million are under consideration.

48. I offer you Appendix 22 pp39-51 as a likely opinion which might be presented to the Inquiry into Asbestos Issues at Wittenoom (PO Box 1098, Kalgoorlie). Although it contains some material with which I do not concur entirely, it is the type of review which I would expect from industrious students of the literature. (The Inquiry should ensure that all literature citations presented to it in submissions are made available to other interested parties. Reference 13 (in my Appendix 22) is not available in the open literature and the author of Appendix 22 cites his own PhD thesis in other publications.) Appendix 23 is another view which you might care to have.

49. In conclusion, in consideration of the terms of reference of the Inquiry, I offer you the words of Senator Evans in The Sydney Morning Herald for 31 March 1987 p6 (Appendix 24) concerning an arbitrary decision relating to a tailings dam at the Ranger uranium mine "The social factors so-called, which include community and interest group reaction to water management, have to be considered and were considered by the Government because they are part of the definition of best practicable technology". Novel forms of "best practicable technology to protect and promote the health and welfare of Wittenoom residents and visitors" might be presented to Mr Mark Neville.

50. In this report, I have endeavoured to comply literally with the brief which you sent me and trust that I have done so. If there are any aspects which are ambiguous or require amplification please do not hesitate to seek information by telephone or in writing.

Yours sincerely,

Gersh Major

Gersh Major,
for G.M. Consultants Pty Limited.

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LIST OF APPENDICES

I regret that I do not have time to list these appendices in a manner which would please a librarian.

1. Extract from book by Selikoff & Lee pp262-66
2. J.C. Wagner in Annals N.Y. Acad Sci, 132, 1965 p575
3. J.C. Wagner in Brit J industr Med 1960, 17,260
4. J.C. Wagner in Brit J industr Med 1991;48,399-403
5. G.W.H. Schepers in Annals N Y Acad Sci, 132, p246
6. Sluis-Cremer in ditto p220-1
7. Newhouse & Thompson in Br J ind Med 1965,22,261
8. M L Newhouse in Ann occup Hyg 16,pp97-107 (1973)
9. Hammond & Garfinkel in Annals NYAS, 330, p ,(1979)
10. Hobbs & al in IARC Scientific Pubs. No 30 vol 2 1980
11. Peto J in IARC Scientific Pubs. No 90, 1989 p457
12. NH&MRC Membrane Filter Method etc Oct 1976
13. Worksafe Australia. Asbestos: Code etc 1988
14. AIA Reference Method for ... RTM1 1979
15. Henry Walton in Ann occup Hyg 25,pp119- 1982
16. asbestos and Health. Jas Hardie Jan 1979
17. AIA Reference Method No 2 (RTM2) SEM
18. Brooke T Mossman & Gee, NE JOUR MED 320,p1721 1989
19. U.K. Dept of Employment TDN 13
20. J M Hughes & Hans Weill, Am Rev Resp Dis 133 p5-13
21. same as reference 11 - sorry
22. Nicholas de Klerk, General Environment, WA Asbestos Cement Products Report Aug 1990
23. D.A. Ferguson in M.J.A. 152, p617 June 18 1990
24. G Major & G F Vardy in IARC 90

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