Scientific publications from 1979 to 2008 on the use of chrysotile, showing that when properly controlled, chrysotile can be be used without detectable excess risk.

Weill, H., Hughes, J. and Waggenspack, C. (1979). Influence of dose and fibre type on respiratory malignancy risk in asbestos cement manufacturing. American Review of Respiratory Disease 120(2):345-354.
An investigation on 5,645 asbestos-cement manufacturing workers, showing no raised mortality resulting from exposure for 20 years to chrysotile asbestos at exposure levels equal to or less than 100 MPPCF.years (corresponding to approximately 15 fibres/ml.years).
The authors state*:"...However, the demonstration that low cumulative and short-term exposures did not produce a detectable excess risk for respiratory malignancy may be of assistance in the development of regulatory policy, because a scientifically defensible position based on these data is that there are low degrees of exposure not associated with a demonstrable excess risk*".

Thomas, H.F., Benjamin, I.T., Elwood, P.C. and Sweetnam, P.M. (1982) . Further follow-up study of workers from an asbestos cement factory. British Journal of Industrial Medicine 39(3):273-276.
In an asbestos-cement factory using chrysotile only, 1,970 workers were traced, and their mortality experience was examined. There was no appreciably raised standardised mortality ratio (SMR) for the causes of death investigated, including all causes, all neoplasms, cancer of the lung and pleura, and cancers of the gastrointestinal tract. The authors indicate: " *Thus the general results of this mortality survey suggest that the population of the chrysotile asbestos-cement factory studied are not at any excess risk in terms of total mortality, all cancer mortality, cancers of the lung and bronchus, or gastrointestinal cancers*".

Berry, G. and Newhouse, M.L. (1983). Mortality of workers manufacturing friction materials using asbestos.
British Journal of Industrial Medicine 40(1):1-7.
A mortality (1942-1980) study carried out in a factory producing friction materials, using almost exclusively chrysotile. Compared with national death rates, there were no detectable excess of deaths due to lung cancer, gastrointestinal cancer, or other cancers. The exposure levels were low, with only 5% of men accumulating 100 fibre-years/ml. The authors state: "*The experience at this factory over a 40-year period showed that chrysotile asbestos was processed with no detectable excess mortality*".

Ohlson, C.-G. and Hogstedt, C. (1985). Lung cancer among asbestos cement workers. A Swedish cohort study and a review.
British Journal of Industrial Medicine 42(6):397-402.
A cohort study of 1,176 A/C workers in a Swedish plant using chrysotile asbestos showing no excess related mortality at exposures of about 10-20 fibres/ml.years

Gardner, M.J., Winter, P.D., Pannett, B. and Powell, C.A. (1986). Follow up study of workers manufacturing chrysotile asbestos cement products. British Journal of Industrial Medicine 43:726-732.

A cohort study carried out on 2,167 subjects employed between 1941 and 1983. No excess of lung cancers or other asbestos-related excess death is reported, at mean fibre concentrations below 1 f/ml, although higher levels had probably occurred in certain areas of the asbestos-cement factory.

Newhouse, M.L. and Sullivan, K.R. (1989). A mortality study of workers manufacturing friction materials: 1941-86.
British Journal of Industrial Medicine 46(3):176-179.

The study referred to in the preceding slide has been extended by seven years. The authors confirm that there was no excess of deaths from lung cancer or other asbestos related tumours, or from chronic respiratory disease. After 1950, hygienic control was progressively improved at this factory, and from 1970, levels of asbestos have not exceeded 0.5-1.0 f/ml. The authors conclude: *"It is concluded that with good environmental control, chrysotile asbestos may be used in manufacture without causing excess mortality"*

Liddell FDK, McDonald JC and McDonald A. Ann. Occup. Hyg. 41:13-35 (1997)

This study is undoubtedly the largest cohort of asbestos workers ever studied and followed for the longest period is that of the miners and millers of the chrysotile mines in Québec. The cohort, which was established in 1966, comprises some 11,000 workers born between 1891-1920 and has been followed ever since. The authors have updated their study several times, with a total of 9,780 men traced into 1992. Results from exposures below 300 mpcf x years, roughly equivalent to 900 fibres/ml x years - or, say, 45 fibres/ml for 20 years - lead the authors to conclude: *"Thus it is concluded from the point of view of mortality that exposure in this industry to less than 300 mpcf.years has been essentially innocuous"*.

McDonald JC, Case BW, Churg A, Dufresne A, Gibbs GW, Sébastien P, McDonald AD (1997) Mesothelioma in Quebec Chrysotile Miners and Millers: Epidemiology and Aetiology. Ann. Occup. Hyg. 41: 709-719

…in which the authors state : *"At present-day levels of dust controls, whether or not contaminated with tremolite, the mesothelioma risk must be vanishingly small".*

Hodgson JT and Darnton A. The Quantitative Risks of Mesothelioma and Lung Cancer in Relation to Asbestos. Ann. Occup. Hyg. 2000, 44(8) : 565-601)

In a benchmark publication the authors have estimated that a cumulative exposure of 1 f/ml.year for crocidolite yields a lifetime risk for mesothelioma of 650/100,000, 90/100,000 for amosite and 5/100,000 for chrysotile. For an exposure of 0.1 f/ml.year, the numbers are 100/100,000 for crocidolite, 15/100,000 for amosite and "insignificant" for chrysotile. Most authors nowadays, when referring to the study by Hodgson and Darnton at the 1 f/ml.year, round up the numbers to 500:100:1 respectively for crocidolite, amosite and chrysotile.

Paustenbach D.J., Finley B.L., Lu E.T., Brorby G.P., and Sheehan P.J. (2004). Environmental and occupational health hazards associated with the presence of asbestos in brake linings and pads (1900 to present): A 'state-of-the-art review'. J Toxicol Environ Health, Part B 7 : 33-110

This publication is a « state-of-the-art » review of the risk associated with the use of asbestos in the manufacture of friction materials and their use in the general automotive service industries. This review, covering studies and observations published over several decades, demonstrate that in general, exposures have been minimal and did not show any demonstrable risk when chrysotile was used, and that the relatively few instances of increased health risks were always associated with the use of amphiboles.

Yarborough C.M. (2006). Chrysotile as a Cause of Mesothelioma : An Assessment Based on Epidemiology. Critical Reviews in Toxicology 36: 165-187

This is an extensive review of the epidemiological cohort studies undertaken to evaluate the extent of the evidence related to free chrysotile fibers, with particular attention to confounding by other fiber types, job exposure concentrations, and consistency of findings. This review of 71 asbestos cohorts exposed to free asbestos fibers does not support the hypothesis that chrysotile, uncontaminated by amphibolic substances, causes mesothelioma.

Carel R, Olsson AC, Zaridze D, Szeszenia-Dabrowska N, Rudnai P, Lissowska J, Fabianova E, Cassidy A, Mates D, Bencko V, Foretova L, Janout V, Fevotte J, Fletcher T, 't Mannetje A, Brennan P, Boffetta P. International Agency for Research on Cancer, Lyon, France. Occupational exposure to asbestos and man-made vitreous fibres and risk of lung cancer: a multicenter case-control study in Europe. Occup Environ Med. 2007 Aug;64(8):502-8. Epub 2006 Oct 19 http://oem.bmj.com/cgi/content/full/64/8/502

The multi-centre case-control study was carried out in six regions of Eastern and Central Europe and in the U.K. Comparison of odds ratios for asbestos exposure has shown that occupational exposure to asbestos does not appear to contribute to the lung cancer burden in men in Central and Eastern Europe while in contrast, the lung cancer risk in the UK is increased following exposure to asbestos. The authors conclude : "*In this large community-based study occupational exposure to asbestos and MMVF does not appear to contribute to the lung cancer burden in men in Central and Eastern Europe. In contrast, in the UK the authors found an increased risk of lung cancer following exposure to asbestos. Differences in fibre type and circumstances of exposure may explain these results."*

L. Sichletidis D. Chloros D. Spyratos A.-B. Haidich I. Fourkiotou M. Kakoura, D. Patakas (2008) Mortality from occupational Exposure to Relatively Pure Chrysotile:: A 39-Year Study. Respiration, Published Online: October 9, 2008. http://content.karger.com/ProdukteDB/produkte.asp?Aktion=AcceptedPapers&ProduktNr=224278

An investigation covering a span of almost 40 years on the mortality rate among workers exposed to relatively pure chrysotile in an asbestos cement factory that opened in 1968 in Greece. The factory used approximately 2,000 tonnes of chrysotile annualy until 2005. Fiber concentration was measured regularly, and was always below permissible levels. Date and cause of death were recorded among all active and retired workers.

No case of mesothelioma was reported. Overall mortality rate was significantly lower than that of

the Greek general population. Conclusions of the authors : *« Occupational exposure to relatively pure chrysotile within permissible levels was not associated with a significant increase in lung cancer or with mesothelioma*

White N., Nelson G. and Murray J. (2008) South African experience with asbestos related environmental mesothelioma : Is asbestos fiber type important?
Regulatory Toxicology and Pharmacology 52 : S92 – S96

South Africa, like Australia, represents a very particular situation in the history of the use of asbestos. Both these countries have been historically the major sources of amphiboles (crocodolite and amosite), and have used these varieties of asbestos locally along with chrysotile.

In both these countries, the number of mesothelioma cases have been much higher than anywhere else in the world. The authors have indicate that 23% of cases in South Africa were found in persons never employed in mining, but were found associated with living in neighborhoods close to amphibole mining facilities, thus associated with « environmental » exposure. However, there were no case of mesothelioma associated with exposure to chrysotile.

The authors conclude :**:** ***« No cases were associated with South African chrysotile. Consequently, in the vast majority of cases of mesothelioma, environmental exposure to asbestos occured in the North Cape province, in proximity to mines, mills and dumps where crocidolite was processed. Crocidolite appears more mesotheliomagenic than amosite, and chrysotile has not been implicated in the disease. This is true for both occupationally and environmentally exposed individuals. »***