AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS ®

SYNTHETIC MINERAL FIBRES (SMF) AND OCCUPATIONAL HEALTH ISSUES

Position Paper

Association number: A0017462L

ABN: 50 423 289 752

Approved by: 2016 AIOH Council

Prepared by: AIOH Exposure Standards Committee

Revised October 2011 (reformatted May 2016, January 2018)

Contact details: AIOH Office | 03 9338 1635 | admin@aioh.org.au

Table of Contents

AUSTRALIAN INSTITUTE OF OCCUPATIONAL HYGIENISTS, INC. (AIOH)

The Australian Institute of Occupational Hygienists Inc. (AIOH) is the association that represents professional occupational hygienists in Australia. Occupational hygiene is the science and art of anticipation, recognition, evaluation and control of hazards in the workplace and the environment. Occupational hygienists specialise in the assessment and control of:

- Chemical hazards (including dusts such as silica, carcinogens such as arsenic, fibrous dusts such as asbestos, gases such as chlorine, irritants such as ammonia and organic vapours such as petroleum hydrocarbons);
- Physical hazards (heat and cold, noise, vibration, ionising radiation, lasers, microwave radiation, radiofrequency radiation, ultra-violet light, visible light); and
- Biological hazards (bacteria, endotoxins, fungi, viruses, zoonoses).

Therefore, the AIOH has a keen interest in the potential for workplace exposures to synthetic mineral fibres (SMFs), as its members are the professionals most likely to be asked to identify associated hazards and assess any exposure risks.

The Institute was formed in 1979 and incorporated in 1988. An elected governing Council, comprising the President, President Elect, Secretary, Treasurer and three Councillors, manages the affairs of the Institute. The AIOH is a member of the International Occupational Hygiene Association (IOHA).

The overall objective of the Institute is to help ensure that workplace health hazards are eliminated or controlled. It seeks to achieve this by:

- Promoting the profession of occupational hygiene in industry, government and the general community.
- Improving the practice of occupational hygiene and the knowledge, competence and standing of its practitioners.
- Providing a forum for the exchange of occupational hygiene information and ideas.
- Promoting the application of occupational hygiene principles to improve and maintain a safe and healthy working environment for all.
- Representing the profession nationally and internationally.

More information is available at our website – http://www.aioh.org.au.

EXPOSURE STANDARDS COMMITTEE MISSION STATEMENT

The AIOH established the Exposure Standards Committee to provide expert guidance and comment to the exposure standards setting process at a State and National level and internationally, where appropriate, through development of AIOH Position Papers, AIOH guidance publications or comment on relevant Standards, Regulations and Codes of Practice. The Committee's remit is to confirm that the exposure standards numbers, and Standards and Codes of Practice, are changed for valid occupational hygiene and scientific reasons.

STATEMENT OF POSITION REGARDING AIOH POSITION PAPERS

The AIOH is not a standard setting body. Through its Position Papers, the AIOH seeks to provide relevant information on substances of interest where there is uncertainty about existing Australian exposure standards. This is done primarily through a review of the existing published, peer-reviewed scientific literature but may include anecdotal evidence based on the practical experience of certified AIOH members. The Position Papers attempt to recommend a health-based exposure value that can be measured; that is, it is technically feasible to assess workplace exposures against the derived OEL. It does not consider economic or engineering feasibility. As far as reasonably possible, the AIOH formulates a recommendation on the level of exposure that the typical worker can experience without adverse health effects.

Any recommended exposure value should not be viewed as a fine line between safe and unsafe exposures. They also do not represent quantitative estimates of risk at different exposure levels or

by different routes of exposure. Any recommended exposure value should be used as a guideline by professionals trained in the practice of occupational hygiene to assist in the control of health hazards.

Consultation with AIOH members

AIOH activities are managed through committees drawn from hygienists nationally. This Position Paper has been prepared by the Exposure Standards Committee, with comments sought from AIOH members generally and active consultation with particular members selected for their known interest and/or expertise in this area. Various AIOH members were contributors in the development of this Position Paper. Key contributors included: Alan Rogers, David Hughes, Phil Torley and Michael Shepherd.

Thirty-First AIOH Council

President:	Gary Rhyder (NSW)
President Elect:	Barry Chesson (WA)
Secretary:	Greg Oldfield (Vic)
Treasurer:	Beno Groothoff (Qld)
Councillors:	Michael Shepherd (Qld), Susan Reed (NSW), Dianne Allen (WA)

List of Abbreviations and Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
AES	Alkaline earth silicate
AIOH	Australian Institute of Occupational Hygienists
ACTU	Australian Council of Trade Unions
AS	Australian Standard
ASCC	Australian Safety and Compensation Council (previously NOHSC/Worksafe Australia, now Safe Work Australia)
ATP	Adaptions to Technical Progress (e.g. 31st version; EEC, 2009)
CAI	Confederation of Australian Industry
ECFIA	European High-Temperature Insulation Wool (HTIW) industry
EEC	European Economic Community
ES-TWA	Exposure standard, time weighted average
EURIMA	European Association of Insulation Manufacturers
FARIMA	Fibre glass and Rock Wool Manufacturers Association (changed in July 2004 to ICANZ)
Hazard	Means potential to cause harm
HSIS	Hazardous Substances Information System – a database for the hazardous substances classifications and occupational exposure standards set up by Safe Work Australia
HT	High temperature
HTIW	High Temperature Insulation Wool Coalition
IARC	International Agency for Research into Cancer - part of the World Health Organisation
ICANZ	The Insulation Council of Australia and New Zealand (ICANZ); formed in July 2004 to replace the industry association, FARIMA
µm	microns or micrometres (10^{-6} m)
mg/m^3	milligrams (10^{-3} gm) per cubic metre
mL	millilitre (10^{-3} litre)
MFM	Membrane filter method
MMF or MMMF	Man-made mineral fibre
MVF or MMVF	Man-made vitreous fibre
NAIMA	Trade association of North American manufacturers of fibre glass, rock wool, and slag wool insulation products
NATA	National Association of Testing Authorities
NIOSH	National Institute for Occupational Safety and Health
NOHSC	National Occupational Health and Safety Commission
Note Q/Nota Q	Note attached to classification of SMF to identify tests required to exonerate certain SMF types from Category 3 carcinogens
OEL	Occupational Exposure Limit

OH&S	Occupational health and safety
PPE	Personal Protective Equipment
RMAA	Refractory Manufacturers Association of Australia, body representing manufacturers and importers of high temperature performance SMF
RCF	Refractory ceramic fibre
SCOEL	Scientific Committee on Occupational Exposure Limits
SDS	Safety data sheet
SMF	Synthetic mineral fibre
SVF	Synthetic vitreous fibre
SWA	Safe Work Australia
TIMA	Thermal Insulation Manufacturers America, now NAIMA – North American Insulation Manufacturers Association
TWA	Time weighted average
WES	Workplace Exposure Standard
WHO	World Health Organization

AIOH Position on Synthetic Mineral Fibre (SMF) and potential for Occupational Health Issues

Key messages

- Synthetic mineral fibres (SMF), also known as man-made mineral fibres (MMMF), is a collective term used for amorphous vitreous fibres such as glass fibre, rock wool, slag wool and refractory ceramic fibres (RCF).
- Concerns that SMF will become the 'new asbestos' have not been substantiated by scientific studies. No form of SMF has been classified as being a confirmed human carcinogen, although some forms such as RCF are classified as being 'possibly carcinogenic to humans'.
- The new generation SMF that complies with Note Q testing (i.e. has low bio-persistence) are not classified as carcinogens and are not considered hazardous substances. The main health effect is irritation to the upper airways and skin and eye irritation.
- The AIOH believes that exposure may be adequately controlled by means of preferential use of the new generation of SMF, good ventilation practices and by maintaining a good standard of cleanliness and housekeeping.
- A standard to limit exposure to no more than 2.0 mg of SMF in each cubic metre of air is recommended for the inhalable low-bio-persistent forms of SMF. A standard of 0.5 fibres in each millilitre of air should be used for some of the old forms of SMF such as RCF.

Summary

This paper was compiled to give guidance on the assessment, evaluation and control of occupational exposure to synthetic mineral fibres (SMF), with an emphasis on recommending a health-based occupational exposure limit (OEL). SMF, known also in the international literature as man-made mineral fibres (MMMF), MMVF and SVF, is a collective term used for amorphous vitreous fibres such as glass fibre, rock wool, slag wool, and refractory ceramic fibres (RCF), as well as the new low bio-persistent[1] styles, which reflect all the SMF now manufactured in Australia.

The epidemiological and toxicological data base on SMF has expanded considerably since the NOHSC review in 1990. Concerns that SMF will become the 'new asbestos' have, by reference to a large number of scientific studies, not been substantiated. No form of SMF has been classified as being a confirmed human carcinogen, although concerns remain for specific types such as the more bio-persistent RCF.

IARC's (2002) latest overall evaluation of the extensive epidemiological studies and animal experimentation determined that glass fibre, rock wool and slag wool were 'not classifiable as carcinogenic to humans' (Group 3). For RCF and certain special purpose glass fibres, IARC continued with a Group 2B classification 'possibly carcinogenic to humans'. For the new generation of low bio-persistent fibres, IARC elected not to make an overall evaluation but noted the non-effect evidence from animal studies and the lack of epidemiological data.

EEC regulations for hazardous substances include categories for carcinogenic classification of SMF based on biodurability expressed as a function of fibre chemistry. The new generation low bio-persistent SMF fibres are exonerated from such classification providing they meet the criteria of specific animal bio-persistence tests (Note Q; EEC, 1997). Safe Work Australia (SWA), as part of the Global Harmonised System, has adopted the EEC classification of SMF of the 31st ATP shown under HSIS. RCF (Category 2) and older types of mineral wools pre early 1990s (category 3) remain classified as potential carcinogens and are hazardous substances according to SWA criteria. The new generation SMF forms that comply with Note Q testing are not classified as carcinogens and are not hazardous substances under the SWA system.

Other health effect risks such as upper respiratory tract irritation and skin and eye irritation (from the mechanical action of large diameter non-respirable fibres) may arise where materials containing old

[1] Bio-persistent / bio-persistence - The capacity of fibres to persist and conserve their chemical and physical features over time in the lung (Hammad, 1984).

or the new forms of SMF are disturbed such as during manufacture of SMF products, refurbishment / demolition activities, and installation of insulation.

Current OH&S legislation in the States and Territories contain specific provisions requiring risk[2] assessment and control of workplace exposures to all types of SMF. The introduction of the National Model Work Health and Safety Act and associated regulations in 2012 saw the existing SMF Code of Practice not replaced with an alternative. The Workplace Exposure Standard (WES) which applies to all forms of SMF should be revised[3].

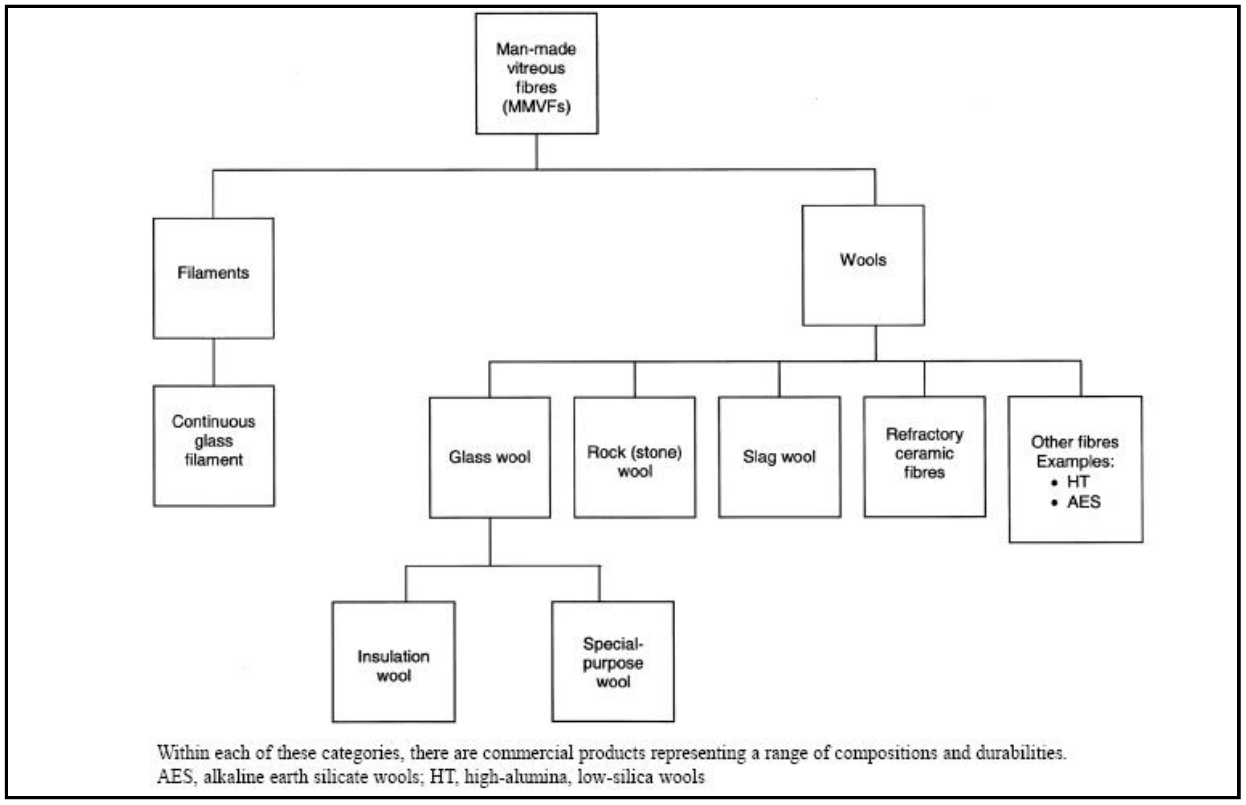
The AIOH supports the continuance of the provision of guidance material and safety data sheets (SDS) to define the safe handling practices for end users of products containing all forms of SMF.

The AIOH recognises that due to changes in the carcinogenic classification of some forms of SMF, the existing exposure standard based on respirable fibre numbers (0.5 f/mL) is not particularly appropriate to reflect the impact of upper respiratory tract irritation and hence a standard based solely on inhalable mass (2 mg/m^3) may be more appropriate for the low-bio-persistent forms of SMF. The existing WES (0.5 f/mL) should remain for some of the old forms of SMF such as RCF[3].

1. What are synthetic mineral fibres (SMF)?

Synthetic mineral fibres (SMF, a specific Australian term) are a heterogeneous group of fibrous inorganic materials that contain various proportions of magnesium, calcium and aluminium, silicate and other trace oxides and metals, formed from a molten mass of rock, slag, clay or glass or synthetic ceramic mixes which are spun, blown or drawn into amorphous fibrous forms.

The overall classification of SMF is difficult and complex due to the diverse composition and forms which are designed to meet specific insulation purposes rather than fit into specific chemical/biological/toxicological groupings. The following graphic (IARC, 2002) is useful to understand the various categories of SMF. Other more complex classifications are also applicable (TIMA, 1991).



Within each of these categories, there are commercial products representing a range of compositions and durabilities.
AES, alkaline earth silicate wools; HT, high-alumina, low-silica wools

[2] Risk - Means the probability of harm actually occurring.
[3] See the post script section.

As depicted above, there are two main forms of SMF: continuous filaments and wools. This includes the new generation fibre types introduced by the SMF industry in the mid 1980's and which have been in general manufacture since the early 1990s. Many of these new generation fibres are designed to have lower bio-persistence in the organs of the body. In the IARC classification, these newly developed fibres are shown as 'Other fibres' under 'Wools'; however, in reality they are subgroups within the glass wool and insulation wool categories.

The subsequent discussion of both low/moderate and high operating temperature SMF's will be defined in terms of:

- Older style SMF – types developed and in use prior to the early 1990s.
- Newer developed SMF – types developed and in commercial use since the early 1990s, mainly the lower bio-persistence types.

Older style SMF

'Continuous Filaments' consist of thin drawn continuous strands usually of glass or alumino silicate. They have typical mean diameters of 6 to 15 microns (µm) and are used extensively as reinforcing filaments and for spinning and weaving applications.

'Mineral Wools' consists of a layered matrix of randomly oriented SMF fibres and are used for insulation and fire protection purposes. The group is subdivided into glass wool, rock wool, slag wool and refractory ceramic fibres:

- Glass wool fibre is blown or spun from molten glass, having typical median length weighted diameters ranging from 3 to 5 µm. Special purpose glass fibres are also included in this category, having a median length weighted diameter less than 3 µm and very often less than 1 µm.
- Rock wool fibre is made from molten rock (historically in Australia, basalt with a minor amount of slag and ceramic waste), and have typical diameters ranging from 2 to 7 µm.
- Slag wool fibre is derived from metallurgical furnace slag, having typical fibre diameters similar to that of rock wool.
- Refractory ceramic fibre (RCF) is a high temperature performance type of SMF. RCF is made from the natural aluminosilicate mineral kaolin, or a synthetic mix of alumina and refined beach sand. So as to perform efficiently at higher temperatures they are manufactured with a lower median length weighted diameter typically around 1µm.

Newer developed SMF

From the 1980's as part of ongoing research and development, a series of high performance temperature HT SMF lines were trialled for various industrial applications. Some of these were subsequently found to exhibit a reduced bio-persistence in animal testing (i.e. dissolve and or are cleared more rapidly from the lung). Of particular interest were the HT alkaline earth silicate (AES) wools, which were found to test negative in long-term animal inhalation carcinogenic studies and in later testing were also found to meet the low bio-persistence requirements listed in Note Q. Low or moderate operating temperature AES wools that met Note Q were subsequently developed by other segments of the industry. From around 2002 all low performance temperature SMF wools and high performance temperature SMF wools manufactured in Australia were of AES composition and met Note Q low bio-persistence requirements.

2. How do we measure and identify SMF?

Since some of the various forms of SMF continue to be classified as 'hazardous substances', and have assigned WESs, there is a legislative requirement to identify, assess and control exposures in workplaces to these substances.

There may be a need or requirement to measure airborne exposures to employees in a workplace who may be exposed to SMF in a task or process. Assessment of exposure should also consider risk assessment associated with the potential for skin and eye exposure.

Prior to the demolition or refurbishment of buildings and structures, there is a legislative requirement to identify the presence of asbestos containing materials (ACM) (AIOH Position Paper, 2016). Some building owners require identification of other materials as part of a 'hazardous materials survey'. Although there is no regulatory requirement to do so, SMF is usually included in the scope of the typical survey with SMF products usually being identified visually. Bulk samples of suspected SMF can be taken and identified using microscopy techniques, although this is not done routinely.

Airborne SMF monitoring may be undertaken for various reasons including:

- To measure exposures to workers using SMF or SMF-containing products in a task or process.
- For the purpose of evaluating the degree of control measures required for a task or process.
- In specific situations such as where there are concerns that SMF insulation installed inside air-conditioning systems may have deteriorated.
- During the removal of SMF products from a building to evaluate whether adequate dust control measures are being used (this is neither a routine nor a legislative requirement).

Measurement of airborne levels of respirable SMF fibres is undertaken in accordance with the SMF Membrane Filter Method (NOHSC, 1989b) and if necessary the gravimetric inhalable dust method (AS 3640-2009). Using the MFM, respirable fibres are defined as being at least 5 µm long and no more than 3 µm wide with a length to width ratio of at least 3 to1. The results are compared against the WES for respirable SMF fibre (0.5 f/mL) or the complimentary gravimetric inhalable dust standard (2 mg/m^3).

The National Association of Testing Authorities (NATA) Australia accredits laboratories to carry out this testing. It is strongly recommended that occupational hygienists use laboratories accredited by NATA to conduct SMF fibre counting, and that such laboratories provide the airborne fibre results on NATA endorsed reports, so as to ensure some level of traceability and quality which will pass legal scrutiny.

In Australia many laboratories that are NATA accredited for the identification of asbestos fibres in bulk samples such as raw fibre and building materials etc (AS 4964-2004) are also able to report the presence of SMF in these samples. The resulting NATA endorsed bulk sample reports from the laboratory do not distinguish between types of SMF present but further information as to the likely type of fibre can be obtained from the analyst.

3. Hazards associated with SMF

Properties of SMF affecting toxicity - inhaled fibres

The inhalation toxicology (lung fibrosis and carcinogenic potency) of fibres such as SMF is defined generally in terms of the three D's:

- Dose (cumulative exposure of airborne respirable fibres);
- Dimension (fibre diameter and length); and
- Durability (residence time in the lung).

For fibrosis additional factors such as surface chemistry and surface activity in part explain variations in toxicity.

Historically the physical and chemical profile of SMF has been compared with that of the various asbestos types and other naturally occurring mineral fibres. Unlike asbestos, SMF does not have a crystalline structure, rather it is amorphous.

SMF fibres have different 'Dimensions' to asbestos as SMF does not split longitudinally (length wise) into smaller fibres/fibril, but breaks transversely (across the fibre) into shorter length segments while at the same time maintaining the original diameter. To be counted as a respirable mineral fibre (specific gravity of ~2.5), fibres need to have a diameter less than 3 µm, and by convention need to have a length greater than 5 µm with a length to width ratio of at least 3:1. Particle deposition models and animal experimentation show that the degree of penetration and deposition in the alveolar regions

of the lung is dependent mainly on fibre diameter and density, so that for fibres with a specific gravity of ~2.5, some 10-15 % of 1 µm diameter fibres penetrate and are deposited, while for 3 µm diameter fibres the penetration and deposition is only ~1% or less (Harris, 1976). The work of Stanton *et al* (1981) and a number of other researchers have demonstrated that it is the very fine long fibres which have the highest potency for carcinogenic effect.

In terms of 'Dose', the exposure to respirable SMF fibres is in most instances much less than that experienced when using asbestos due to most of the SMF material consisting of fibre diameters and lengths much greater than that of respirable size. As such there are lesser amounts of respirable size fibres in the bulk material and lower chance of creating respirable size fibres when handling the product.

'Durability' (bio-persistence) of the fibres is considered an important factor in indicating the potential toxicity of fibres. Bio-persistence is a complex interaction between fibre solubility and the natural clearance mechanisms in the lung. The fibre composition, length and diameter affect the rate of solubility and clearance. For longer fibres preferential element dissolution (particularly silicon) results in internal weakening of the amorphous fibre structure and subsequent transverse breakage to shorter fibres, which are subject to phagocytosis and removal. Clearance of deposited fibres is a multi-stage mechanism, with fibres shorter than the size of macrophages (15 µm) being totally phagocytised, and longer fibres partly engulfed then removed by either the mucocilliary system or temporary storage in the lymph nodes. *In-vitro* and *in-vivo* investigations have shown that amphibole asbestos is less soluble and more bio-persistent than RCF, which in turn is less soluble and more bio-persistent than old style glass wool and Rockwool. Both moderate and high temperature newer style AES wools of specific chemical composition when tested were found to be more soluble and less bio-persistent than their old style SMF counterparts. These findings of bio-persistence are reflected in the regulatory approach taken in the EEC and carried forward into an Australian classification system (refer later discussion).

Other effects – primary mechanical irritation

It is well documented that SMF can cause irritation of the eyes and skin. They can also irritate the upper respiratory tract (the nose and throat) and parts of the lung, causing sore throat, nasal congestion and cough (NOHSC, 1989a). The irritation caused by SMF is by a mechanical action caused by a 'splinter' type effect from thicker fibres rather than an inflammatory response. These acute irritant effects are generally temporary.

Previously SMFs were classified as irritants by Safe Work Australia (SWA) and assigned the classification Xi (irritant) and risk phrase R38 (irritating to the skin) [NOHSC: 1008 (2004)]. However, the EEC classification committee rescinded this decision as the irritation classification criteria is based on an inflammatory response rather than the mechanical response found with SMF. The 31st ATP adoption by SWA in the HSIS system reflects this change. As such a number of SMF types would not be classifiable as hazardous substances according to SWA criteria.

Devitrification - high performance temperature SMF

The amorphous fibres in high performance temperature SMF (RCF and the new generation HT alkaline earth glass wool) that has been subjected to temperatures exceeding ~1100°C for a long period (months to years in industrial applications) has the potential to undergo a phase change to a mix of mullite (synthetic alumino silicate) and cristobalite (a crystalline form of silica) (Gantner, 1986; Holroyd *et al* 1988). Low/moderate performance mineral wools simply melt at these temperatures and there is no phase change. **The form of cristobalite found in the high temperature conversion of the HT fibres has a highly disordered micro-crystalline structure. Cristobalite is classified by IARC as carcinogenic to humans (Group 1) (IARC, 1997). However, when these after-use devitrified cristobalite containing fibres were tested in long-term animal inhalation studies they were found not to cause micro fibrosis in the lung or excess lung tumours, whereas the same fibres which had not been subject to high temperature and phase change induced micro fibrosis and lung cancers in the animals (ECFIA, 2011).**

Monitoring data obtained during demolition and relining of RCF furnaces in Australia, United States and Europe indicate that the TWA levels of airborne cristobalite found during demolition of after-use RCF in high temperature furnaces in ferrous and non-ferrous smelters were very low, usually well below the OEL. This is thought to be due to the insulation wool mass restricting the transfer of heat to only the first centimetre or less of the insulation layer. For some of the monitoring results where cristobalite was detected it was thought to be likely associated with silica phase changes associated with the adjacent bulk refractory material such as bricks and blocks rather than the RCF fibres themselves (Maxim, 1999; NIOSH, 2006; **ECFIA, 2011**).

Older style SMF - epidemiology and toxicological testing

A number of detailed reviews of the epidemiological and toxicological studies have been published over the last 2 decades and it is not the intention of this position paper to provide a further detailed analysis of the extensive data. If required, members should familiarise themselves with the various references such as:

- the overview of epidemiology studies on the glass wool and rock wool manufacturing workforce (Doll, 1987);
- the technical report reviewing international studies and specific data from the Australian industry prepared by a number of occupational hygienists who are members of the AIOH (NOHSC 1989a) and subsequent updates on the status of SMF made to NOHSC commissioners up until 1996 (for example Rogers, 1995);
- the more recent publication assessing carcinogenic classification by IARC (2002);
- the health surveillance study of workers in the Australian RCF manufacturing industry presented by Rogers and Yeung (2000); and
- reviews specific to the animal inhalation studies and epidemiological studies on the production of RCF such as NIOSH (1996) and SCOEL (2010).

Newer developed SMF - epidemiology and toxicological testing

Some early experimental HT AES forms of SMF were included in a number of high quality detailed long-term animal inhalation studies conducted to test the effects of exposure to RCF. Results from these studies showed that AES fibres cleared rapidly from the lung such that accumulation in the lung was not to a level sufficient to result in any significant health outcome in the animals such as fibrosis and lung tumours (Brown, 1995; Muhle & Bellman, 1995; Bernstein, 1995; Brown, 2002). The cost, duration and the ethical issue associated with using animals in such studies lead to the development of short term lung fibre clearance tests that have become part of the requirements in the regulatory framework for classifying SMF (Nota Q; EEC, 2008).

Medical surveillance is being conducted on the manufacturing workforce in Europe but as yet there are no epidemiological results available from these early stages of the study. Any results may be confounded by the workforce's previous exposure during the manufacture of RCF.

Carcinogenic classification

Determinations of carcinogenicity for selected substances, groups of substances and exposure situations of concern, are made by various international bodies (IARC, ACGIH, NOHSC, etc). These bodies define criteria for carcinogenic classifications based upon the weight of evidence from human and animal studies, however the interpretations and conclusions they reach for various chemical and physical environmental, occupational and lifestyle agents can vary from agency to agency.

IARC

Traditionally the International Agency for Research on Cancer (IARC), which is part of the World Health Organisation (WHO), is the major world body that coordinates and conducts research into the causes of human cancer. The IARC assessment for classification of the carcinogenic potential for chemicals and other agents is in the form of a YES/NO finding without consideration as to the

relevance of the animal studies to human experience, or the degree of the hazard or risk relative to other occupational hazards present in the industry.

IARC (2002) in reviewing the epidemiological data and carcinogenic tests from animal experimentation found that there was '*inadequate evidence'* to suggest that certain forms of SMF (glass wool, continuous glass filament, and RCF) induced carcinogenicity in humans. IARC also determined that there is *'inadequate evidence'* of carcinogenicity in experimental animals for continuous glass filament, but *'limited evidence'* in experimental animals for the carcinogenicity of insulation glass wool, rock (stone) wool and slag wool. For refractory ceramic fibres IARC found there is *'sufficient evidence'* in experimental animals for carcinogenicity and this also applied to special purpose glass fibres (including E-glass and 475 glass fibres). There was *'inadequate evidence'* in experimental animals for the carcinogenicity of certain newly developed, less bio-persistent fibres including the alkaline earth silicate wool, the high-alumina low silica (HT) wool and fibres A, C, F, and G.

Based on the above considerations of epidemiological and animal experimental studies, IARC produced the following overall evaluation for SMF:

- Special-purpose glass fibres such as E-glass and '475' glass fibres are *possibly carcinogenic to humans (Group 2B).*
- Refractory ceramic fibres are *possibly carcinogenic to humans (Group 2B).*
- Insulation glass wool, continuous glass filament, rock (stone) wool and slag wool are *not classifiable as to their carcinogenicity to humans (Group 3).*
- the IARC working group elected not to make an overall evaluation of the newly developed fibres designed to be less bio-persistent such as alkaline earth silicate or high-alumina, low-silica wools on the basis in part that there was no human data available and the difficulty IARC found in categorizing these fibres into meaningful groups based on chemical composition.

Other systems of carcinogenic classification have been developed and applied in various occupational jurisdictions particularly relating to the manufacture and use of SMF.

European Commission

The European Commission regulates the classification, labelling and packaging of substances and mixtures via the Dangerous Substances Directive and its various amendments (EEC, 1997). This included classification for carcinogens being Category 1 (known or presumed human carcinogens) and Category 2 (suspected human carcinogens), with the distinguishing feature between the categories being strength of evidence and additional considerations such as weight of evidence.

During the period from around 1988 to 1997 a special committee reporting to DG XI debated the issue of creating a system for the carcinogenic classification of SMF. The final agreement was based on a system of fibre toxicity related to bio-durability expressed as a function of fibre chemistry. SMF fibres with 18% or less of alkaline earth oxides were deemed to be Category 2 carcinogens *'substances which should be regarded as if they are carcinogenic to man'* and those with more than 18% alkaline earth composition were classified as Category 3 carcinogens *'substances which cause concern for man owing to possible carcinogenic effect but in respect to which the available information is not adequate for making a satisfactory assessment'*. In addition, SMF's fitting into Category 3 could be 'exonerated from such classification (Category 0) if they were proven to comply with one of four tests as defined under EU protocols (one of the two forms of specific short-term bio-persistent tests or one of the two forms of specific carcinogenic tests as conducted in experimental animals).

Directive 67/548/EEC was subsequently repealed by EC Regulation No 1272/2008 and later amendments and included amongst other things an upgrade on the defined carcinogenic classification for various forms of SMF based on fibre chemistry including Category 3 exoneration which was listed as Nota Q (EEC, 2008).

Safe Work Australia

The regulatory management of chemicals at work in Australia from the mid 1990's was via the hazardous substances package contained in the National Model Regulations for the Control of Workplace Hazardous Substances [NOHSC:1005 (1994)]. In this early stage the classification of hazardous substances was based on early EEC determinations which were further moulded by the tripartite committee decision making system that existed in Australia at the time. A substance was deemed 'hazardous' if the manufacturer or importer deemed that it met the listed classification criteria [NOHSC:1005] or it was contained in the List of Designated Hazardous Substances [NOHSC:10005]. To confuse the issue some NOHSC documents and some State regulations included the existence of a WES as an additional criterion for deeming a chemical as a hazardous substance. Despite the existence since 1990 of a Code of Practice and Exposure Standard for SMF, no types of SMF were contained in the original list of hazardous substances [NOHSC:10005 (1994)]. In addition, the NOHSC criteria for determining if a substance such as SMF was 'hazardous' due to carcinogenic effects was somewhat generic in nature and open to interpretation as to where the boundary of Category 1, 2 or 3 was placed, as these were dependent on the emphasis and weighting placed on the then available epidemiological and animal test data.

The List of Designated Hazardous Substances issued by NOHSC on their website in 1999 contained a group consisting of 'Synthetic mineral fibres (SMF), Glass fibres, Ceramic fibres, Glass wool (including superfine glass fibre) and Rockwool', with the statements that 'No NOHSC Classification Available', 'This substance is UNDER REVIEW' and 'Responsibility for classification remains with supplier'. At the end of the NOHSC (1999) document there were Notes including for the first time in Australia, Note Q (Nota Q in EC documents) and Note R. No explanation was provided by NOHSC (1999) as to how, why or to what substance these Notes applied.

"Note Q**:** Classification as a carcinogen need not apply if it can be shown that the substance fulfils one of the following conditions:

- A short-term bio-persistence test by inhalation has shown that the fibres longer than 0,00002 m (changed to 20 µm in 2009) have a weighted half life less than 10 days, or
- A short-term bio-persistence test by intratracheal instillation has shown that the fibres longer than 0,00002 m (changed to 20 µm in 2009) have a weighted half-life less than 40 days, or
- An appropriate intra-peritoneal test has shown no evidence of excess carcinogenicity, or
- Absence of relevant pathogenicity or neoplastic changes in a suitable long-term inhalation test.'

Note R: The classification as a carcinogen need not apply to fibres with a length weighted geometric mean diameter less two standard errors greater than (*sic)* 0.000006 m (changed to 6 µm in 2009)."

An on-line Hazardous Substances Information System (HSIS) was added by NOHSC in January 2005 with updates at approximately yearly intervals. Even though Note Q and Note R were included in various NOHSC document appendices (NOHSC, 2009) and the various forms of SMF were listed on the HSIS system, entries relevant to Note Q and Note R were not included to these SMF listings.

Following the period of public comment Safe Work Australia updated the HSIS online system in December 2010 to reflect changes listed in the EC 31st Adaptions to Technical Progress to Directive 67/548/EEC (ATPs) (EEC, 2009).

SMF is currently listed by SWA in two classes:[3]

- **Mineral wool** with the exception of those specified elsewhere in HSIS [Synthetic mineral fibres (SMF); Glass wool] (Note; man-made vitreous (silicate) fibres with random orientation with alkaline oxide and alkaline earth oxide (Na2O+K2O+CaO+MgO+BaO) content greater than 18% by weight), **Carcinogen Category 3 Notes Q and R.**
- **Refractory Ceramic Fibres, Special Purpose Fibres**, with the exception of those specified elsewhere in HSIS [Synthetic mineral fibres (SMF)] (Note; man-made vitreous (silicate) fibres with random orientation with alkaline oxide and alkaline earth oxide

(Na2O+K2O+CaO+MgO+BaO) content less or equal to 18% by weight), **Carcinogen Category 2**.

- In practice for products manufactured and used in Australian this amounts to three groups:
- **RCF**, which is classified as a **Carcinogen Category 2**. *Substances which should be regarded as if they are carcinogenic to man.*
- **Old style Mineral wools (Glass wool and Rockwool),** which is classified as a **Carcinogen Category 3.** *Substances which cause concern for man owing to possible carcinogenic effects but in respect to which available information is not adequate for making a satisfactory assessment.*
- **New generation low bio-persistent fibres** that have an alkaline oxide and alkaline earth oxide content greater than 18% by weight and have been tested to Note Q compliance are **exonerated from being classified as a carcinogen**.

Further information as to the non-carcinogenic classification and regulation of SMF is contained in the 'Current applicable legislation and standards' section of this position paper.

4. Major uses / potential for exposure (in Australia)

While SMF is a stand-alone material it has also become an important replacement for asbestos in a variety of products where thermal insulation, acoustic insulation, or electrical or fire protection is required.

Glass wool and rock wool represent the bulk majority of SMF use, being used extensively in thermal and acoustic building insulation products such as batts, boards, blankets, and sheets and loose fill for ceilings, walls and air-conditioning systems.

Continuous glass filament is used as reinforcement in plastics and building products, and in industrial fabrics. Continuous glass filament is used as chopped strand and is often woven into yarn or mats for such applications as reinforcing in 'fibreglass-resin' boat hulls and decks, nose cones for aeroplanes, surfboards and motor vehicle bodies.

A very small proportion of the market is occupied by the use of special purpose glass fibres such as E-glass and '475' glass. These special purpose glass fibres are used as acid battery separators and high-efficiency air filtration media.

RCFs and high temperature performance AES blankets, boards and shapes are used primarily in industry as insulation for high-temperature applications such as furnaces, boilers and other heating equipment subjected to temperatures up to 1350°C. They are also used as insulation in aerospace, automotive and appliance industries, and in marine fire protection applications.

Potential for exposure - older style SMF

Older style SMF has been used for all of the applications as described above. The fibres are manufactured to specific fibre length weighted diameters so as to achieve specific insulation performance. For low temperature forms such as glass wool and Rockwool, the weighted diameters are around 2-5 µm and with a specific density of ~2.5, most of the fibre mass is non-respirable. However, in the blowing or spinning forming process, the ends of some fibres are drawn out into finer diameters and when these are snapped off during handling, small amounts of respirable size fibres may be released.

High performance temperature forms of SMF require finer fibre diameters, typically around 1 µm, and with a specific density of ~2.5, many of the fibres fit into the upper level of the respirable size range. Since the products are to be used in high temperature situations the products are mostly not bonded as the organic bonding agents become pyrolyzed and may release volatile toxic and irritant components into the work area.

Studies both in Australia and overseas have reviewed SMF sampling data profiling manufacturing and end user tasks. Yeung & Rogers (1996) reviewed 1572 SMF sampling results obtained from across a range of Australian SMF manufacturing and user industries. They found that the geometric

mean was low (0.02 f/mL) and that 97.7% of the results were below the exposure standard of 0.5 f/mL. The application and removal of non-bonded products was identified as a task likely to expose workers to fibre concentrations around or above the exposure standard. Typical task exposures for SMF use in the building industry can be found in the appendix of the industry Code of Practice (FARIMA, 2003).

Potential for exposure - newer developed SMF

The newly developed SMFs (AES, Note Q compliant) are now used extensively in building insulation and in higher temperature applications throughout Australia. However, some imported SMF products that claim to be low bio-persistent have not been tested or based on their chemical composition do not meet Note Q requirements.

Since 2000, low/moderate temperature (building/construction style insulation) and all high performance temperature SMF manufactured in Australia is 'low bio-persistent' and usually is clearly identified as being 'bio-soluble/low bio-persistent' on external labels, packaging and the SDS.

Low bio-persistent SMF products manufactured and used in the construction industry can be identified in Australia by the FBS-1 logo on the packaging (FARIMA, 2003).

*FBS-1 Glass Wool symbol

**FBS-1 Rock Wool symbol

Both moderate and high temperature newer style AES wools have been developed to match the same types of insulation applications as did older style SMF products. Current forms of high temperature performance AES SMF products have an operating temperature up to 1250^{o}C. It is expected that by 2011 new product lines on the market will have increased this temperature limit to 1350^{o}C, and hence match the specification for old style RCF.

Since newer developed SMF products are manufactured to similar fibre diameter specifications and if appropriate incorporate similar binding agents as the older forms, it would be expected that the exposures recorded with the usage of older style SMF will also be experienced when using the newer developed forms. The potential similarity in exposure data between the old and newer forms has been confirmed by monitoring conducted in the manufacture and application of moderate/low temp and HT, AES, Note Q compliant SMF forms.

5. Risk of health effects

The hazard and or risk of developing adverse health effects of SMF from inhalation or direct contact with the skin and eyes will depend upon:

- The type of SMF – as defined by carcinogenic classification and bio-persistence (i.e. the differences between continuous glass filament old style SMF, RCF, special purpose and superfine fibres, and low bio-persistent types which conform to Note Q testing).
- The range and proportion of various size fibres in the bulk SMF material – a larger proportion of fibres with widths of less than 3 µm provides a greater potential for release of higher quantities of respirable or inhalable fibres. Thicker fibres provide greater potential for mechanical irritation to the skin and eyes during handling.
- Dose – duration of exposure and the concentration of respirable fibres which depend on factors such as:
    - Whether the SMF containing material is bonded into a matrix – SMF materials that contain a bonding agent such as phenyl formaldehyde resin (e.g. insulation batts and

blankets used in the building industry) are less likely to release airborne fibre if disturbed than say unbonded SMF products such as RCF loose fill.
    - Potential for disturbance – batts and blankets secured behind a plasterboard wall have less potential for disturbance than say deteriorated SMF blanket used as a liner inside air-conditioning ducts.
    - Nature of the disturbance – demolition of RCF lined furnaces using a jackhammer is likely to liberate greater concentrations of airborne respirable fibre than the careful removal of SMF batts from wall cavities or ceiling voids using hand tools.

As part of risk assessment, the potential exposure levels can be scoped via reference to the various exposure data available in the literature (Yeung & Rogers, 1996; FARIMA, 2002).

Similarly, if skin and eye contact with SMF is prevented by careful handling techniques and or the use of suitable clothing, gloves and eye protection the risk of irritation effects will be minimised.

If SMF materials are in good condition and remain undisturbed, then the airborne related health risk will be negligible.

Risk assessment relating to SMF should take into account the wide variation of health impacts associated with exposure to different types. An approach consistent with the AIOH risk guidelines (AIOH, 2006) would be the allocation of 'consequence' according to EC carcinogenic category and Note Q in the EEC/SWA criteria, such that exposure to the various SMF types may be rated as:

- Group 2, then the consequence would be defined as 'Major'.
- Group 3, then the consequence would be defined as 'Minor'.
- Group 0 > 18% alkaline earth chemistry and exonerated by Note Q testing, then the consequence would be defined as 'Negligible'.

6. Available controls

Control of risk is based upon consideration of control measures in a hierarchy, in which the focus should be to eliminate risk at the source or engineer it out rather than rely on controlling exposure at the receiver. The selection of the appropriate control method will depend on the specific SMF use or application (e.g. manufacturing, installation or removal of insulation products, refractory blankets, etc). Control measures may include:

- Substituting traditional forms with low bio-persistent SMF materials.
- Eliminating or reducing the airborne fibre hazard for the end user. For example, dust suppressors and binders may be used in insulation products.
- Using ventilation (local, dilution, natural) in processes.
- Maintaining a good standard of cleanliness and housekeeping in plants and processes.
- Handling raw products in sealed packages and containers.
- Where higher order control measures cannot satisfactorily reduce exposures, selection of appropriate personal protection will be required. This may include respiratory protection, skin and eye protection. The type of protective equipment required will be dependent on the nature of the task and professional advice should be sought from a competent person.

The Schedules contained in the National Code of Practice for the Safe Use of Synthetic Mineral Fibres (NOHSC, 1990a) provide detailed work methods for handling glass wool, rock wool and RCF. However, these are somewhat generic in nature and require experience in application to fit specific site needs. Safe Work Australia will rescind the Code of Practice in January 2012.

The International Labour Organisation document (ILO 2001) and the Industry Code of Practice for the Safe Use of Glass Wool and Rock Wool Insulation (FARIMA, 2003; ICANZ web page) provides useful advice on the safe use and handling of glass wool and rock wool. Similar advisory documents are available from web pages of the RCF and HT low bio-persistent silica wool manufacturers (e.g. the web pages of ECFIA, Thermal Ceramics and Unifrax). Less detailed information is also available from the SMF manufacturer's SDS.

Since newly developed low bio-persistent insulation wools are not classified as carcinogens and may not be classified as hazardous substances, there may be no requirement for industry to label and provide SDS. It is recommended that the SMF manufacturing and import industry be encouraged to continue to label and provide SDS with the relevant data regarding SWA hazard criteria and to provide these to the users of their products.

7. Current applicable legislation and exposure standards

Occupational health and safety legislation in States and Territories require that substances in workplaces are controlled to prevent risks to health. Specific provisions regarding hazardous substances require employers to assess and control workplace exposures to SMFs defined as hazardous substances. In some state legislation there is specific mention of SMF under a specific Hazardous Substances section and the call up of the Code of Practice (NOHSC, 1990a) and the National Exposure Standard (NOHSC 1990b). Due to the previous classification of SMF as a 'hazardous substance' some states include SMF in the regulations relating to provisions for disposal of industrial waste.

SWA code of practice

The SWA Code of Practice for SMF was also developed within the NOHSC tripartite committee system (NOHSC, 1990a). It contained an overview of areas such as the responsibilities of manufacturers, employers and employees; work practices; personal protective equipment; education and training; health surveillance; and removal procedures. Individual schedules for working with Rockwool, Ceramic Fibre and Glass wool were attached as was an appendix on respirators for protection against SMF, and a summary of the health effects from SMF exposure extracted from the Technical Report (NOHSC, 1989a). The SMF Code of Practice is generic in nature and the practical and efficient application of controls is reliant on the experience and expertise of the occupational hygienist.

In 2011 during the development of the Model Work Health and Safety Act, Regulations and model Codes of Practice a decision was made not to update the 20 year old NOHSC SMF Code of Practice. It was further decided on the basis of a reduced health concern by IARC and the specialised nature for use of RCF, that a generic Code of Practice for SMF will not be included in the new National OH&S legislation.

The AIOH supports the provision of guidance material to define safe handling provisions for end users of SMF products.

SWA workplace exposure standard

The basis of this 1990 exposure standard arose from information contained in a review of the health effects of SMF prepared by the state-based expert working group (NOHSC, 1989a). This report found that there was an increased lung cancer risk in the early days (pre 1950) of the Rockwool and slagwool manufacturing industry, and a suggestion of a similar trend in the glass fibre industry. These risk trends from the early industry were not associated with duration or intensity of exposure, and were not anticipated to be applicable under currently experienced working conditions. The theoretical possibility of lung cancer risk was expected to be eliminated with a time weighted average (TWA) exposure standard of 1 f/mL, and irritation essentially caused by non-respirable fibre is controlled using a 2 mg/m^3 inhalable dust level.

Following publication of the Technical Report the tripartite Standards Development Standing Committee system debated on a suitable exposure standard around two approaches, the ACTU position (0.1 f/mL, equivalent control strategy as to asbestos) and the CAI (1 f/mL, nuisance dust type control strategy). A compromise mid-point position was eventually reached which was deemed applicable to all forms of SMF (respirable fibres TWA 0.5 f/mL, and in situations where almost all the material is fibrous a secondary complementary value of TWA 2 mg/m^3 inhalable dust applied to minimise upper respiratory tract irritation from largely non-respirable fibre, and the application of stringent control procedures). Apart from observations of eye and upper respiratory tract irritation at

high dust levels, there is no toxicological or dose response risk basis for the current exposure standard.[3] The WES has remained as the regulatory exposure standard throughout Australia for the last 20 years or more (NOHSC, 1990b).

Despite the widespread commercial use of Note Q compliant low bio-persistent forms of SMF for in excess of 15 years, which are classified in the regulatory framework as non-carcinogenic and possibly non-hazardous, no specific occupational exposure standards for Note Q compliant fibres has been ventured by occupational health authorities.

International exposure standards - SMF

Prior to 1990 a number of countries had exposure standards for SMF which were based on gravimetric measurement of 'total' or inhalable dust. A few of these countries also had existing or proposed exposure standards for SMF expressed in terms of respirable fibres (page 39 NOHSC, 1989a). The 0.5 f/mL value set by NOHSC in 1990 (or a number close to this) appears to have been adopted reasonably quickly by other countries. AIOH recognises that various international regulatory and advisory bodies have differing considerations and approaches by which they arrive at suitable exposure standards.

The following tables indicate the range of values which exist in some countries.

Occupational exposure 'Limit Values' for mineral wools (as at Oct 2011)

Country	OEL	Reference
France	1 f/mL	Circulaire DRT N° 95-4 du 12 01 1995
Germany	3 mg/m^3 (General respirable nuisance dust)	TRGS 900
Italy	1 f/mL	ACGIH
New Zealand	1 f/mL 5 mg/m^3 (inhalable dust)	Workplace Exposure Standards & Biological Exposure Indicies 6th Ed NZ Department of Labour
Netherlands	1 f/mL	Ministerie van Sociale Zaken en Werkgelegenheid Directoraat Generaal van de Arbeid 'Maximaal Aanvaarde Concentraties'
Poland	1 f/mL	Dz.U.02.217.1833 Rozporządzenie Ministra Pracy i Polityki społecznej
Spain	1 f/mL	Limites de exposición profesional para agentes químicos en España
Sweden	1 f/mL	Arbetsmiljoverkets författingssamling AFS 2005:17
UK	2 f/mL 5 mg/m^3	HSE EH40 Workplace Exposure Limits
USA NIOSH ACGIH	5 mg/m^3 (respirable dust) 15 mg/m^3 (total dust) 5 mg/m^3 (total dust), 3 f/mL. 1 f/mL	OSHA Regulatory value OSHA Regulatory value 2002 Recommended value 2010 Recommended value

Occupational exposure 'Limit Values' for refractory ceramic fibre

Country	OEL	Reference
Austria	0.5 f/mL	
Belgium	0.5 f/mL	
Czech Republic	1.0 f/mL	
Denmark	1.0 f/mL	
Finland	0.2 f/mL	
France	0.1 f/mL	Décret n°2007-1539 du 27 octobre 2007
Germany	No OEL but a "tolerated" level of 0.1 f/mL.	Bekanntmachung für Gefahrstoffe 910 „Risikowerte und Exposition-Risiko-Beziehungen für Tätigkeiten mit krebserzeugenden Gefahrstoffen"
Italy	0.2 f/mL	ACGIH
Poland	0.5 f/mL	Dz.U.02.217.1833 Rozporządzenie Ministra Pracy i Polityki Społecznej
Spain	0.5 f/mL	Limites de exposición profesional para agentes químicos en España
Sweden	0.2 f/mL	Arbetsmiljoverkets författingssamling AFS 2005:17
The Netherlands	0.5 f/mL	Ministerie van Sociale Zaken en Werkgelegenheid Directoraat Generaal van de Arbeid 'Maximaal Aanvaarde Concentraties'
UK	1.0 f/mL	HSE EH40 Workplace Exposure Limits
USA NIOSH ACGIH	0.5 f/mL 0.5 f/mL 0.2 f/mL	2002 OSHA guideline agreement with RCF industry 2006 Recommended value 2010 Recommended value

AIOH Position on an exposure standard

The current respirable fibre exposure standard of 0.5 fibres/mL and 2 mg/m^3 inhalable dust applicable to the 'hazardous' forms of SMF listed as Category 2 carcinogens should remain in force.

For forms of SMF that are classified as Category 3 carcinogens (old style glass wool and rock wool, and newer style low performance temperature forms that do not meet Nota Q requirements) only the inhalable dust exposure standard of 2 mg/m^3 should be applied. In particular the AIOH holds the position based on existing monitoring data that an inhalable dust standard of 2 mg/m^3 should be applied in situations such as during the refurbishment and demolition of structures containing bonded and non-bonded forms of these materials, on the basis that the surface of the SMF forms may be contaminated with general building and environmental dust and grit, which if released into the air during handling may result in upper respiratory tract irritation and temporary effects such as rhinitis and bronchio-spasm in some individuals.

For new generation low bio-persistent SMF products that meet the chemical composition requirements and Note Q testing requirements, the AIOH recommend that the concept of a respirable fibre standard for health protection is not applicable and a more rational approach is to apply the value of 2 mg/m^3 inhalable dust suggested by the original NOHSC technical committee (NOHSC, 1989a)

so as to minimise the effect of upper respiratory tract irritation, which may occur in the manufacturing and user industry.

Although the epidemiological studies on the RCF manufacturing workforce provide some limited confidence of minimal fibrogenic and minimal carcinogenic risk, the AIOH suggests a cautious approach with the continuation of the application of the technical control standard of 0.5 f/mL (8-hour TWA) applicable in the manufacture, use and removal of RCF fibre and its formed products. The use of RCF in Australian industry is now minimal as it has been replaced by high temperature AES note Q compliant exonerated fibres.

In situations where it is deemed necessary to conduct monitoring during the demolition of refractory structures such as furnaces and kilns which have been running at temperatures in excess of 1000^{o}C and contain high temperature performance SMF (RCF and HT Note Q forms), the AIOH suggests the additional exposure standard of 0.1 mg/m^3 for crystalline silica (quartz and cristobalite) is suitable (AIOH Position Paper - Respirable Crystalline Silica, 2009).

8. AIOH recommendation

The AIOH recognises that the 1990 national documentation comprising the Code of Practice, Working Schedules and the National Exposure Standard for SMF was a tripartite compromise position of the then existing technical information which was made during a time of differing industrial relations and political climate than exists today.

The AIOH understands that recent adoptions made by Safe Work Australia will mean that most forms of SMF used in Australia will not be classified by SWA as 'hazardous' and hence not listed in the HSIS system. With the adoption of the uniform National OH&S legislation it is expected that the current SMF Code of Practice (1990) will not be replaced with an alternate code.[3] The term SMF is likely to be replaced with a more specific and internationally recognisable term. Given these changes the national exposure standard and its application to specific SMF product lines should be reviewed.

The AIOH recognises the improved information on the epidemiological studies on SMF manufacturing workforce made since the 1989 NOHSC Technical Report and agrees with the reclassification of carcinogenicity made by IARC (2002). AIOH also agrees with the system of testing and classification (Nota Q) that is operating in the EEC in regard to old style fibres, RCF and new generation low bio-persistent fibres.

The AIOH position is that forms of SMF deemed as non-carcinogens according to IARC (2002) and EEC Note Q testing (NOHSC 1999) are deemed as being not hazardous according to Safe Work Australia classification.

While the above considerations relate to potential carcinogenic risk, the issue of primary 'tickling' irritation of the upper respiratory tract, which is felt when elevated levels of thicker fibres are inhaled, and mechanical 'splinter type' irritation of the skin and eyes after contact with fibres and lumps of SMF still needs to be addressed.

- As a minimum guidance material along the line of that currently available in some industry sectors, an SDS needs to be provided to the users to assist them in handling and protective procedures, which will minimise potential for such irritation.
- The exposure standard applicable to these 'non-hazardous' forms of SMF, which was based on respirable fibres (presumably on the basis of controlling previous concerns of potential risk of fibrosis and lung cancer), is not particularly applicable since the carcinogenic and fibrotic risk has been deemed exonerated via the various recent studies. Except in the manufacture and application of some non-bonded forms, almost all of the air monitoring data suggests that airborne levels of SMF in manufacture and use of bonded product are well below the exposure standard of 0.5 respirable fibres/mL. Based on risk assessment, reference to existing task-specific exposure data, and the fact that most of the fibre product has a larger than respirable fibre diameter, in the majority of instances air monitoring of respirable fibre levels will not provide a meaningful value on which to assess compliance with safe handling procedures so as to minimise irritation. A more relevant approach to minimising irritancy should be adopted where risk assessment determines

the application of a gravimetric exposure standard such as the existing complementary exposure standard of 2 mg/m^3 of inhalable dust.

In contrast the forms of SMF such as RCF and special purpose fibreglass that do not meet the above criteria, these should remain classified as hazardous. As such:

- Guidance material along the line of that currently available in some industry sectors and, labelling and SDS needs to be provided to the users to assist them in handling and protective procedures which will minimise potential for inhalation and irritation.
- The current exposure standard of 0.5 fibres/mL applicable to these 'hazardous' forms of SMF should remain in force.
- Particular attention should be paid to control procedures during the demolition and repair of plant which contains RCF and other non-fibrous silicate insulation materials, which may have been subjected to high temperatures in excess of 1000^{o}C, so as to prevent possible overexposure to excess levels of airborne embrittled fibres and cristobalite formed in the bulk non-fibrous refractories.

Airborne exposure assessments for SMF should be conducted by professional occupational hygienists and all volume measurement and analysis conducted by NATA laboratories accredited for SMF work, with the results issued on NATA endorsed certificates.

9. References and sources of additional information

AIOH (2006). Simplified Occupational Hygiene Risk Management Strategies. Australian Institute of Occupational Hygienists Inc, (available from http://www.aioh.org.au/).

AIOH (2016). Position Paper – Asbestos. Australian Institute of Occupational Hygienists Inc. (available from http://www.aioh.org.au/).

AIOH (2009). Position Paper – Respirable Crystalline Silica. Australian Institute of Occupational Hygienists Inc. (available from http://www.aioh.org.au/).

AS 3640-2009 Workplace atmospheres - Methods for sampling and gravimetric determination of inhalable dust. Standards Australia, Sydney (available from http://www.saiglobal.com/).

AS 4964-2004. Method for the qualitative identification of asbestos in bulk samples. Standards Australia, Sydney (available from http://www.saiglobal.com/).

Bernstein, DM, *et al* (1995). Evaluation of the Oncogenic Potential of Man Made Vitreous Fibres: The Inhalation Model, *Ann Occup Hyg, 39 (5)*; pp 661-672.

Bernstein, DM (2007). Synthetic vitreous fibers: A review toxicology, epidemiology and regulations. *Crit Rev Toxicol 37(10)*; pp 839 – 886.

Brown, RC, *et al* (1995). The *in vivo* Biological Activity of Ceramic Fibres. *Ann Occup Hyg, 39 (5)*; pp 705-713.

Brown, RC, *et al* (2002). Subchronic Studies on Man-made Vitreous Fibres: Toxicity Results. *Ann Occup Hyg, 46 (Supp 1)*; pp 102-104.

Doll, R (1987). Symposium on MMMF, Copenhagen, October 1986, Overview and Conclusions. *Ann Occup Hyg*, *31*; pp 805-19.

ECFIA (2011). Crystalline silica in High Temperature Insulation Wool (HTIW) products after use in high temperature applications, June 2011, www.ecfia.eu

EEC (1997). European Commission Directive 97/69/EC Official Journal L 343, 13/12/1997 pp 0019 – 0024, European Union.

EEC (2008). Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008, on classification, labelling and packaging of substances and mixtures etc Annex 1, Section 3.6, Official Journal of the European Union L351/103-107, 31 December 2008.

EEC (2009). Commission Directive 2009/2/EC 31st ATP Council Directive 67/548/EEC, Official Journal of the European Union L 11/6-82, 16 January 2009.

FARIMA (2003). Industry Code of Practice for the Safe Use of Glass Wool and Rock Wool Insulation Products, and Field Handbook - Working with Glass Wool and Rock Wool Insulation Products, April 2003 edition.

Gantner, BA (1986). Respiratory hazard from removal of ceramic fibre insulation from high temperature industrial furnaces. *Am Ind Hyg Assoc J, 47*; pp 530 – 534.

Harris, RL (1976). Aerodynamic Considerations: What is a Respirable Fibre of Fibrous Glass, in Occupational Exposure to Fibrous Glass, A Symposium, NIOSH 76-151, 51-56.

Hammad, YY (1984). Deposition and elimination of MMMF. In: Biological Effects of Man-Made Mineral Fibers, Vol 2. World Health Organisation, Copenhagen, pp 126 – 142.

Holroyd, D, *et al* (1988). Health-related Aspects of the Devitrification of Aluminosilicate Refractory Fibres during use as a High-temperature Furnace Insulant, *Ann Occup Hyg 32(2)*; pp 171-178.

IARC (1997). Silica, Some Silicates, Coal Dust and *para*-Aramid Fibrils. In IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 68. World Health Organization International Agency for Research on Cancer, IARC Press, Lyon, France, pp. 41-242 (available from http://monographs.iarc.fr/).

IARC (2002). Man-Made Vitreous Fibres. In IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 81. World Health Organization International Agency for Research on Cancer, IARC Press, Lyon France, (available from http://monographs.iarc.fr/).

ILO (2001). Safety in the Use of Synthetic Vitreous Fibre Insulation (glass wool, rock wool, slag wool), International Labour Organisation, Geneva.

Maxim, L, *et al* (1999). Respirable crystalline silica exposures associated with the installation and removal of RCF and conventional silica-containing refractories in industrial furnaces. *Regil Toxicol Pharmacol. 29(1)*; pp 44-63.

Muhle, H & B Bellman (1995). Biopersistence of man-made Vitreous Fibres. *Ann Occup Hyg, 39 (5)*; pp 655-660.

NIOSH (2006). Criteria for a Recommended Standard: Occupational Exposure to Refractory Ceramic Fibers. Publication No. 2006-123: http://www.cdc.gov/niosh/docs/2006-123/.

NOHSC (1989a). Technical Report on Synthetic Mineral Fibres and Guidance Note on the Membrane Filter Method for the Estimation of Airborne Synthetic Mineral Fibres. [ISBN 0 644 091886] June 1989, Australian Government Publishing Service Canberra.

NOHSC (1989b). Guidance Note on the Membrane Filter Method for the Estimation of Airborne Synthetic Mineral Fibres. [NOHSC:3006 (1989)] June 1989, Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (1990a). National Code of Practice for the Safe Use of Synthetic Mineral Fibres [NOHSC: 2006 (1990)] May 1990, Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (1990b). National Standard for Synthetic Mineral Fibres [NOHSC: 1004 (1990)] May 1990, Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (1994). Control of Workplace Hazardous Substances, National Model Regulations [NOHSC:1005(1994)] and National Code of Practice [NOHSC:2007(1994)] March 1994, Australian Government Publishing Service Canberra.

NOHSC (1995). Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment 3rd Edition [NOHSC:3008(1995)] [ISBN 9 780644 451475] May 1995. Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (1995). Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:1003(1995)]. Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (1999). List of Designated Hazardous Substances [NOHSC: 10005 (1999)] April 1999, Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (2004). Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008 (2004)] 3rd edition October 2004, Australian Government Publishing Service Canberra (available from http://www.safeworkaustralia.gov.au).

NOHSC (2009). HSIS Classification System Introduction, Appendix 1 A, Abbreviations used in the 'Classification' and 'Labelling' columns.

Rogers, A & R Fornasari (1988). Refractory Ceramic Fibre. Is there Need for Special Concern? Proceedings Annual Conference of the Australian Institute of Occupational Hygienists, Leura NSW.

Rogers A, J Leigh & A Bonin (1995). June 1995 Update on the Health Effects of SMF. National Occupational Health and Safety Commission meeting, Information Paper, October 1995.

Rogers A & P Yeung (2000). Dust Exposure and Respiratory Health of Workers in the Australian Refractory Ceramic Fibre production Industry, Proceedings Occupational Health in Developing Countries, IOHA Conference Cairns, Australia, 2000.

SCOEL (2010). Recommendation from the Scientific Committee on Occupational Exposure Limits for Refractory Ceramic Fibres, SCOEL/SUM/165 October 2010.

Stanton, MF, M Layard, A Tegeris, E Miller, *et al* (1981). Relation of Particle Dimension to Carcinogenicity in Amphibole Asbestos and Other Fibrous Minerals. *Journal National Cancer Institute, 69*; pp 965-75.

TIMA (1991). Nomenclature of Man-Made Vitreous Fibres, Thermal Insulation Manufacturers America, 72 pp, April 15, 1991.

Yeung, P & A Rogers (1996). A comparison of synthetic mineral fibres exposures pre- and post- the NOHSC national exposure standard and code of practice. *J Occup Health Safety - Aust NZ, 12*; pp 279-288.

Industry and government websites:

ECFIA: European High-Temperature Insulation Wool (HTIW) Industry – http://www.ecfia.eu/.

EURIMA: European Insulation Manufacturers Association - http://www.eurima.org/.

NAIMA: Trade association of North American manufacturers of fibre glass, rock wool, and slag wool insulation products - http://insulationinstitute.org/.

ICANZ: Insulation Council of Australia and New Zealand - http://www.icanz.org.au/.

HSIS: Hazardous Substances Information System - http://www.safeworkaustralia.gov.au/sites/swa/whs-information/hazardous-chemicals/hsis/pages/hsis.

HTIW: High Temperature Insulation Wool Coalition - http://www.htiwcoalition.org/.

10. Post script

SWA has since amended the WES values for SMF (man-made vitreous (silicate) fibres) in line with this position paper's recommendations, as follows:

- RCF(h) special purpose glass fibres(i) and high biopersistence MMVF(l) (Carcinogen 1B(o)) - 0.5 f/mL (respirable) and 2 mg/m^3 (inhalable dust)(j); and
- [Glass wool, rock (stone) wool, slag wool and continuous glass filament](i)(k) and low biopersistence MMVF(m) (Carcinogen 2(i)(k) or exempt(m)(n)(o)) - 2 mg/m^3 (inhalable dust)(j).

Where:

(h) = MMVF with random orientation, alkaline oxide and alkali earth oxide ($Na_2O+K_2O+CaO+MgO+BaO$) content less or equal to 18% by weight.

(i) = As described in *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 81, Man-Made Vitreous Fibres*, pp. 45-54, 2002, IARC Press, Lyon, France.

(j) = Where almost all the airborne material is fibrous MMVF, an inhalable dust exposure standard of 2 mg/m^3 (8-hour TWA) must also be applied to minimise mechanical irritation from largely non-respirable fibre. This inhalable standard is not to take precedence over the respirable fibre standard, where applicable. For those applications where MMVF is combined with other material such that the proportion of respirable fibres is extremely low or is difficult to measure because of the larger portion of non-fibrous MMVF material, it is appropriate to apply the exposure standard for nuisance dusts of 10 mg/m^3, measured as inhalable dust (8-hour TWA).

(k) = MMVF with random orientation, alkaline oxide and alkali earth oxide ($Na_2O+K_2O+CaO+MgO+BaO$) content greater than 18% by weight.

(l) = Any MMVF which have not been tested according to the test protocol *Methods for the Determination of the Hazardous Properties for Human Health of Man Made Mineral Fibres*, April 1999 and Note Q in EC Regulation No. 1272/2008 page 353/335 (CLP regulations) or fibres which have been tested and failed to comply with these tests.

(m) = Any MMVF which have been tested according to the test protocol *Methods for the Determination of the Hazardous Properties for Human Health of Man Made Mineral Fibres* April 1999 and Note Q in EC Regulation No. 1272/2008 page 353/335 and found to comply with these tests.

(n) = Any MMVF that meet the requirements of Note Q in EC Regulation No. 1272/2008 page 353/335 are exempted from mandatory classification in the European Union as a carcinogen under the *Globally Harmonized System for Classification and Labelling of Chemicals* (GHS). Note IARC has classified mineral wools (glass wool, rock wool (stone wool), slag wool and continuous glass filament) as IARC Category 3: not classifiable as to carcinogenicity in humans.

(o) = Any MMVF that meet the requirements of Note R in Regulation EC No. 1272/2008 page 353/335 are exempted from mandatory classification as a carcinogen under the GHS in the European Union.

Cautionary note: Importers should be asked to supply valid laboratory test data from a recognised group in Europe indicating that their product satisfies Note Q.