Risk from asbestos products

1 Introduction

The HSC has asked for a further assessment of risk based on a wider range of asbestos product types to help inform its deliberations on which products fall within the scope of the asbestos licensing regime. As it has been estimated that there are between two to three thousand asbestos products, it is necessary to arrange the data into a smaller number of product groups. In the first instance, to give an overview of the risk by asbestos type, this has been done by assuming a single group of all asbestos containing materials (ACMs). A more detailed analysis has then been undertaken based on product groups with the assumption that no asbestos licensing regulations existed and only limited compliance with the current control of asbestos at work regulations (CAWR, 2002) took place (e.g. dry removal and poor controls with no use of respiratory protective equipment (RPE)).

2 Overview

There are three main types of asbestos used in commercial products, these are:

- Chrysotile (white) asbestos,
- Amosite (Brown) asbestos and
- Crocidolite (Blue) asbestos

The epidemiological evidence from asbestos workers and well-conducted animal tests shows that while all types of asbestos share the same hazards (e.g. the potential of an early death from lung cancer, asbestosis and mesothelioma) they have varying degrees of risk (the likelihood that death from one of the hazards will occur). The relative risk from the same level of exposure but to different asbestos fibre types is shown in figure 1(as derived by Hodgson and Darnton, 2000). The relative risk from crocidolite asbestos is some 500 times greater than chrysotile asbestos and the relative risk from amosite asbestos is 100 times greater than chrysotile asbestos. This means that the type/s of asbestos in the product are particularly significant when assessing risk.

If the estimated usage of asbestos in GB from the published RIA (CD 205, see figure 2) is combined with the risk factors for each asbestos type in figure 1, it is possible to obtain an assessment of the relative risk for each asbestos type installed (figure 3). The values in figure 3 have been normalised to the asbestos type with the lowest overall calculated risk (i.e. chrysotile = 1). Therefore it can be seen that amosite represents a risk some 18.5 times greater than chrysotile and crocidolite represents some 9.3 times the risk of chrysotile.

Although this is an initial estimate and does not take any account of whether the materials are present in a product type that will be worked on, or the magnitude of the concentration of airborne fibres that would be released, it clearly shows that amosite and crocidolite asbestos need more consideration than chrysotile, if a risk based approach to licensing is to be followed.

Fig 1: Risk factor by fibre type

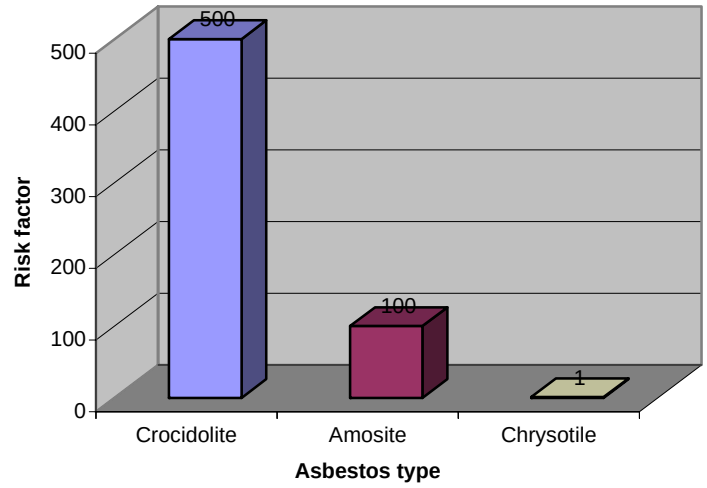


Fig 2: Amount of asbestos installed

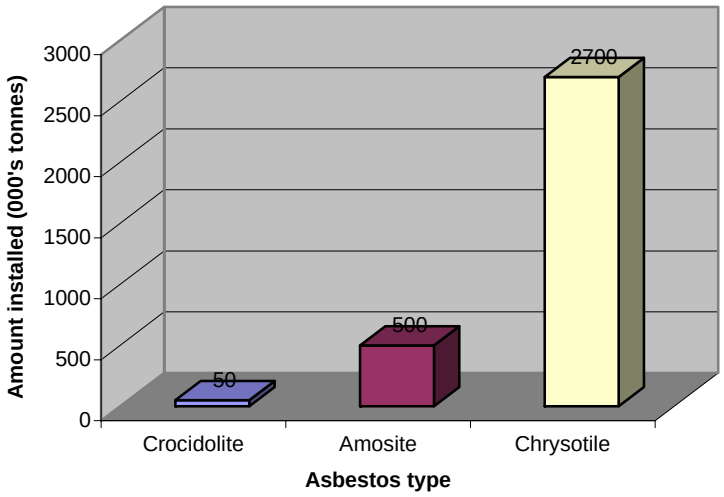
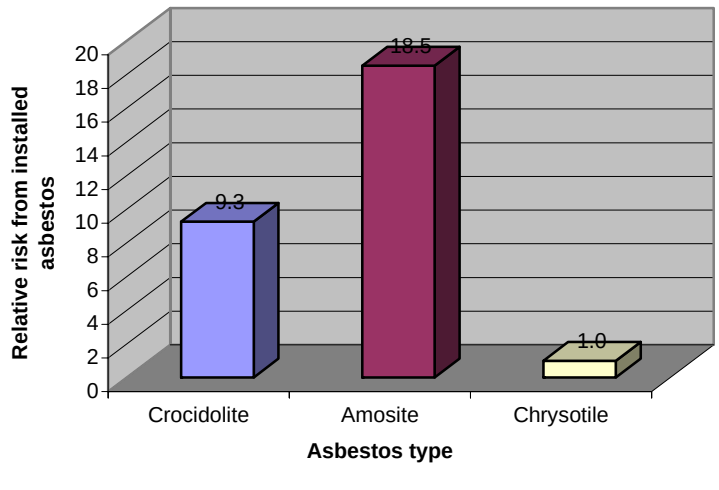


Fig 3: Relative risk from asbestos intalled



3 Estimation of exposure and risk by product group.

The exposure from each product group was assessed by determining:

- The overall usage of each product group;
- The types asbestos in the product;
- The airborne fibre concentration produced when the product is disturbed / removed with good control and with limited controls.
- The exposure has been taken to be the same as the airborne concentration and therefore assumes no use of RPE.

3.1 Selection of product groups

Evidence on asbestos usage submitted to the Advisory Committee on Asbestos in the 1970s (Simpson, 1977) has been used as the initial basis for determining the product groups. The product groups listed in table 1 have the advantage that both amount and type of asbestos usage is known. Jointings and packing include: various sealing materials such as raw asbestos, asbestos gaskets, sheets, strings and ropes, and resin products containing asbestos paper. Fillers and reinforcements includes: textured coatings (TC), paints, mastics asbestos paper and millboard. Asbestos paper was widely embedded in bitumen for use as roofing felt and damp proof products and in some flooring products.

Both in the current (CAWR,2002) and in the proposed asbestos regulations (CD205), no product groups are defined, but the ACOP refers to three groups of licensed materials and four groups of non-licensed materials. The licensed materials are:

A. Asbestos insulation used for thermal, acoustic or other insulation purposes including fire protection;
B. asbestos insulating board (including wallboards and millboards);
C. asbestos surface coatings, which contain asbestos for fire protection or as both heat and sound insulation.

The groups of asbestos products specifically excluded from licensing are:

D. Asbestos cement;
E. asbestos containing textured coating (paints and plasters used to produce visual effects);
F. any article of bitumen, plastic, resin or rubber where its thermal or acoustic properties are incidental to its main purpose (e.g. vinyl floor tiles, electric cables roofing felt);
G. asbestos materials such as paper linings, cardboards, felt, textiles, gaskets, washers and rope where the products have no insulation purposes

Table 1: Summary of asbestos product groups and type and amount of UK asbestos usage in 1973

Product group (ACoP group)	Asbestos type used (000's of tonnes)		
	All	Chrysotile	Amosite
1. Asbestos cement for buildings (D)	55.6	55.6	0
2. Fillers and reinforcements incl. TC (E,G)	25.7	25.3	0.4
3. Asbestos insulating board -AIB (B)	22.5	3.8	18.7
4. Friction materials (F)	18.5	18.5	0
5. Flooring (F)	16.2	16.2	0

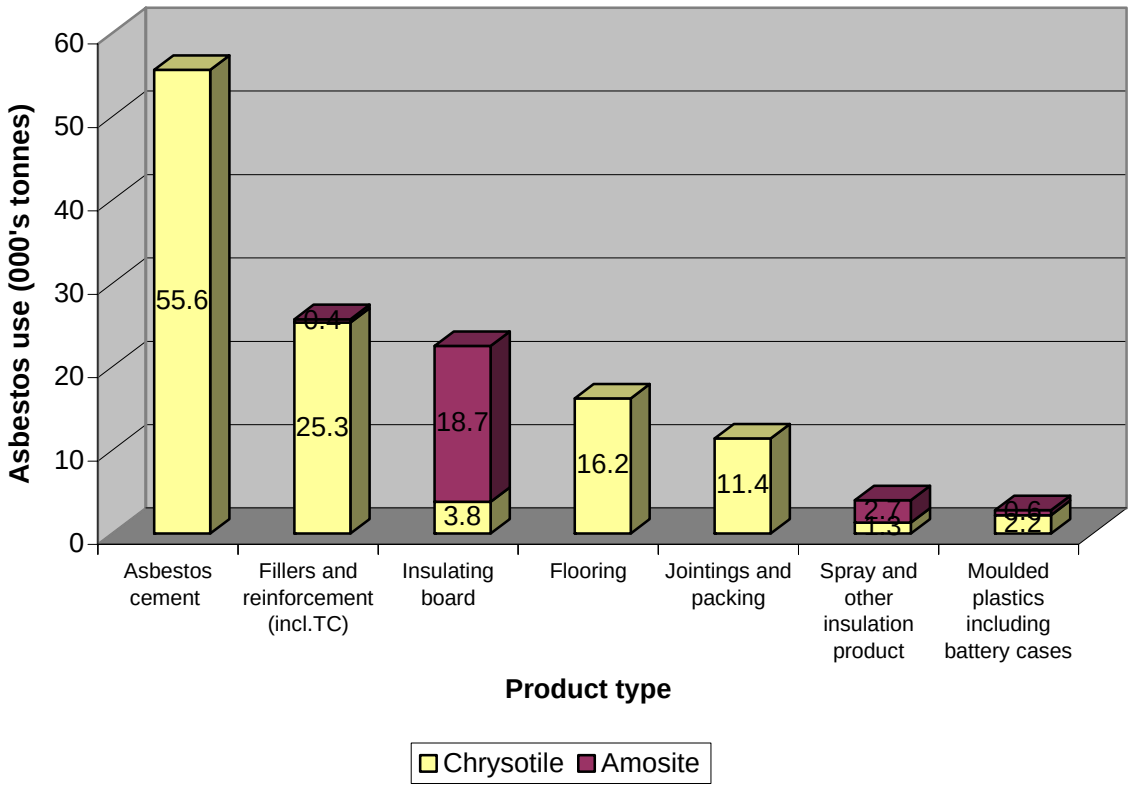
6. Jointings and packing (G)	11.4	11.4	0
7. Asbestos cement pressure pipes	9.0	7.8	1.2
8. Textile products (other than J &P's) (G)	8.3	6.0	2.3
9. Spray and other insulation product (A,C)	4	1.3	2.7
10. Moulded plastics & battery cases (F)	2.8	2.2	0.6

The approximate relationship between the two groups is given in table 1 but as two of the product groups are unlikely to be encountered (i.e. 4 & 7) and textiles can be grouped with jointing and packings, it is possible to combine the two systems, into 7 similar product groups, with textured coating (TC) forming part of the fillers and reinforcement group and millboards considered with AIBs.

3.2 The overall usage of each product group

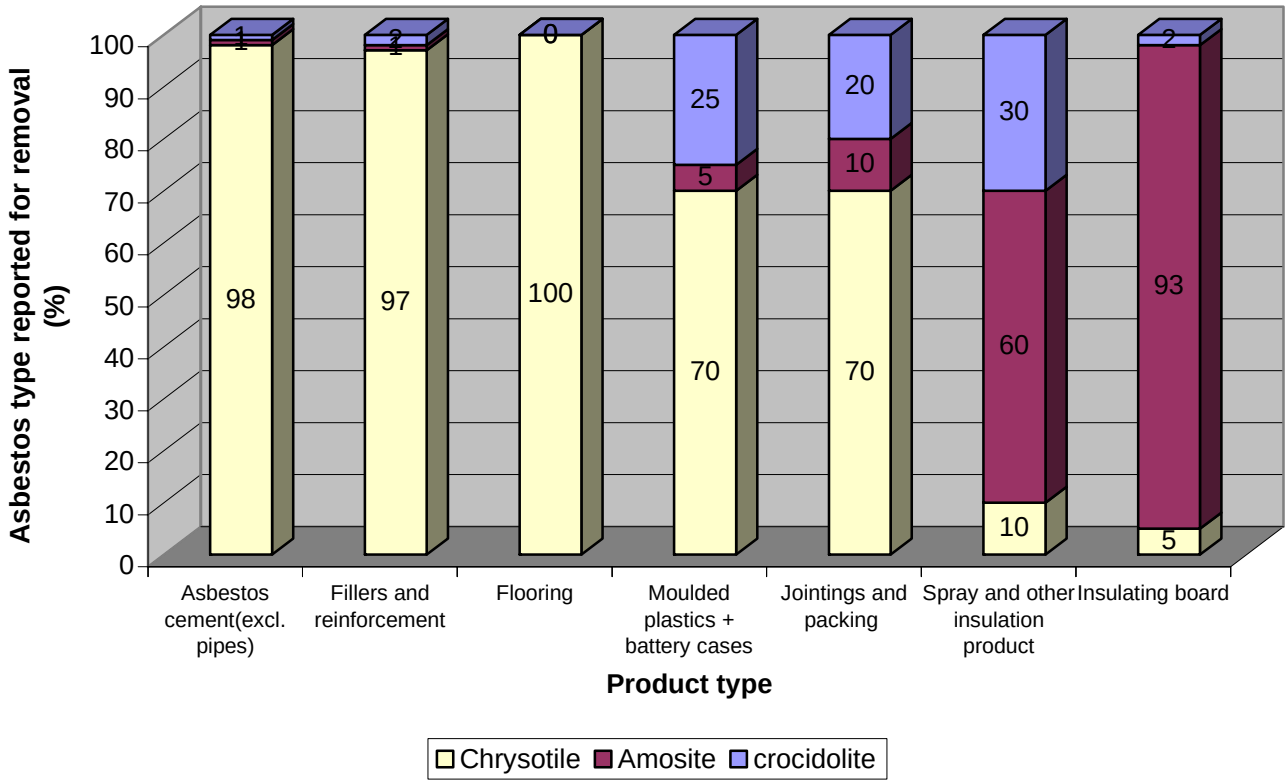
Table 1 and figure 4 summarises the main asbestos product groups and gives the estimate amount (in tonnes) of asbestos used during the peak of asbestos usage in products (1973). As different products have been introduced at different time and the rate of importation also varied with time, the distribution during the 1970's is unlikely to be fully representative of the products remaining in buildings etc. However, the distribution of products manufactured and installed in 1973 may not be far from the actual situation remaining. For example, a greater amount of thermal insulation spray and lagging was installed in the 50 and 60's but a significant proportion of this would already have been removed as the plant aged. Also as the buildings in which the asbestos was installed in the 1970's are due for major refurbishment or demolition over the next decade, and this mix of products is likely to become more representative of the products being removed. The type of asbestos in the remaining products (see Table 1 and figure 4) also give the relative use of amosite and chrysotile in 1973.

Fig 4. Product groups and asbestos usage in 1973



Usage of crocidolite effectively ended by 1970 and had been imported and used in much smaller quantities than chrysotile and amosite asbestos. Its main use was for textiles, sprayed and other insulation products, battery cases and asbestos cement pressure pipes but may also occasionally be found in board materials. Amosite was used widely for thermal insulation blocks, lagging, asbestos insulating boards and asbestos cement pressure pipes and its use effectively ended by 1980. Chrysotile was widely used in most products and although its use declined rapidly from 1980 its used continued until late 1999.

Fig 5: Estimated mix of asbestos types in main product groups



Taking into account previous usage the percentages of the different types of asbestos in the seven main groups has been estimated in figure 5. The groups containing licensed products have been arranged at the end of the graph. Non-licensed moulded plastics were estimated to contain a relatively high amount of crocidolite because of its acid resistance and hence its widespread use in lead-acid battery cases. To an extent the higher temperature and chemical resistance offered by crocidolite and amosite products, lead to a wider use of these types for jointings and packing. Although many of these may have been replaced, so it is probable a conservative estimate of what remains has been made.

3.3 Exposure during removal

The exposure from disturbing an asbestos product depends on a number of product, disturbance and environmental variables, such as the:

- Type of matrix in which the asbestos is present;
- amount of asbestos and whether the asbestos is evenly dispersed throughout the matrix or is present as a layer on the surface;
- type, rate, amount and area of disturbance inflicted on the asbestos containing material;
- frequency which disturbance or work on the asbestos material is carried out;
- controls applied to reduce airborne emissions;
- local conditions and the use of personal protective equipment.

Clearly, the number of variables will mean that for each product, a range of exposures to airborne asbestos fibres will occur. Whilst accepting that there are many potential biases in any sampling data, analysing the available personal sampling data, to estimate the mean exposure during the work, offers the most realistic chance of assessing the risk that workers would be subject to.

Table 2 summarises the estimated mean airborne asbestos fibre by product type for both controlled (e.g. wet) removal and results from removal using more limited controls (e.g. dry removal). The data available for non-licensed products is much more limited than for some licensed products.

Table 2: Assessment of average personal airborne concentration of regulatory asbestos fibres during removal of ACMs.

Product group	Controlled wet removal / good practice (f/ml)	Limited controls / dry removal (f/ml)
Asbestos cement	0.02	0.08
Fillers and reinforcements in a flexible matrix (incl. TCs)	0.02	0.08
AIB (incl millboards)	0.41	15
Flooring	0.01	0.05
Jointings and packing	0.05	0.2
Spray and other insulation products	14.4	358
Moulded plastics & battery cases	0.001	0.01

3.4 Calculation of risk

To calculate risk several essential pieces of information are required:

1. the type/s of ACMs being disturbed or removed;
2. the type/s of asbestos in the product / product group;
3. airborne fibre concentration (exposure) for the particular work practice;
4. the duration which the asbestos is being actively disturbed / removed
5. the frequency of the work;
6. the starting age and the number of years spent doing the work.

The data collected above for each product group were used to calculate the lifetime risk to persons using the Hodgson and Darnton risk estimates. These calculations were based on 10% of time being spent actively removing ACMs from the age 20 for 40 years, based on limited controls being applied and no use of RPE. This is therefore an assessment of the risk, as if no asbestos licensing regulations existed and only very limited compliance with the existing CAWR (2002) took place. The 10% of active removal time, has been used, as (≥10%)this has been used in previous RIAs as a definition of regularly exposed asbestos workers. (Note: about one third of asbestos removal workers are estimated to be on site each working day. Active asbestos removal is estimated to be between half to two thirds of the available time on site. This equates to about 15% to 20% of available time being spent actively removing asbestos).

To calculate risk, the airborne concentrations in the "limited controls" column in table 2 was first adjusted by the relative amounts of ACMs in each product group (see table 1) to calculate the proportional exposure for each product group over the 10% active removal time. The risks from the proportional exposure for each product group was calculated by inputting the proportional exposure into the Hodgson and Darnton model and adjusting by the mix of fibre types in each product group (figure 5).

4 Results

The results for the lifetime risk in figure 6 for 40 years exposure from the age of 20 represent a worst case continuous exposure situation. It can be seen that the highest risk is by far with the spray and other insulation group (risk 11,419 per 100,000) and AIB (risk 1,642 per 100,000). These are the two licensed groups. The next highest group is the jointings and packings, (risk 55 per 100,000) but as the risk is mainly associated with the amount of crocidolite and amosite asbestos products remaining and many gaskets and packings are replaced during routine maintenance and servicing, this is likely to be an overestimate of the remaining risk. Some of the products in this group if present for thermal insulation would be regarded as licensed materials. All the other groups are essentially non-licensed products (textured coating –i.e. some fillers and reinforcements are currently licensed). It can be seen the non-licensed product groups have a risk of over a thousand times lower than licensed sprays and other insulations group and over a hundred times lower than the licensed AIB and millboard groups.

The same exposure situation was used to calculate the annual risk of death based on an average survival age of 80 (see figure 7). The annual risk of death for the two licensed groups comes out at 1903 and 273.5 per million, the non-licensed groups are all below 1 per million.

Figure 6: Lifetime risk per 100,000 based on 10% of time spent actively removing ACMs from age 20 for 40 years with limited controls: no RPE.

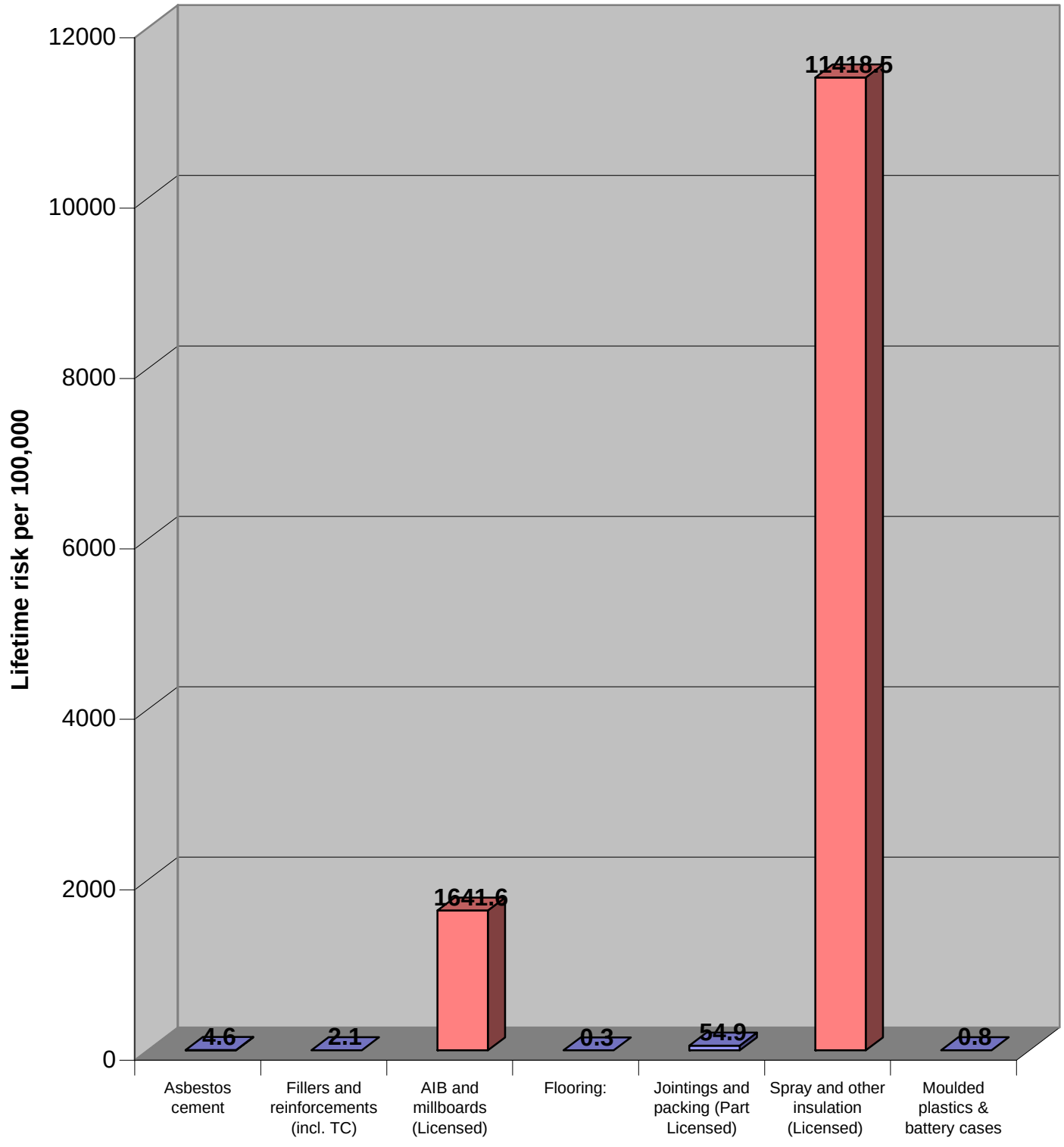
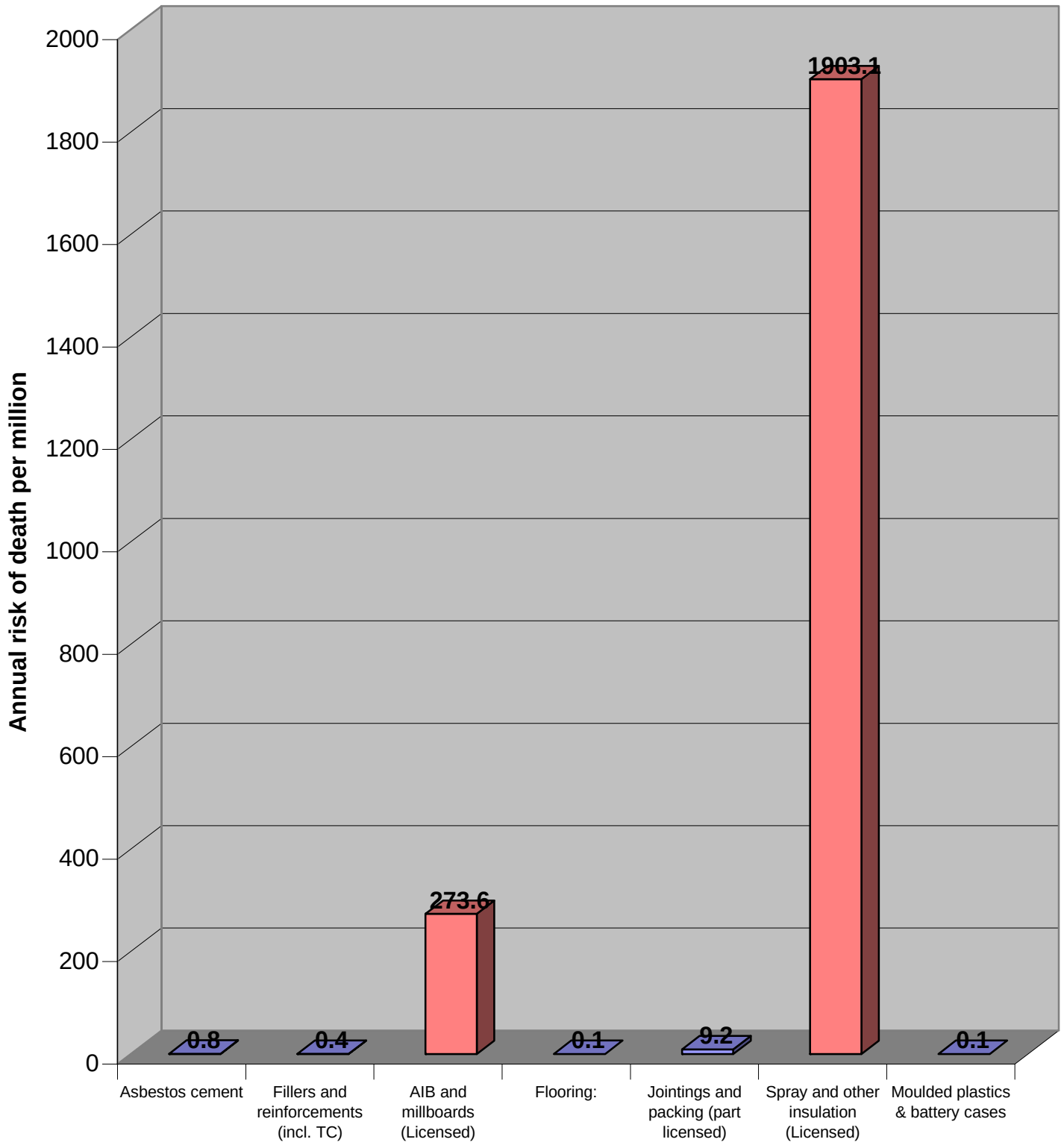


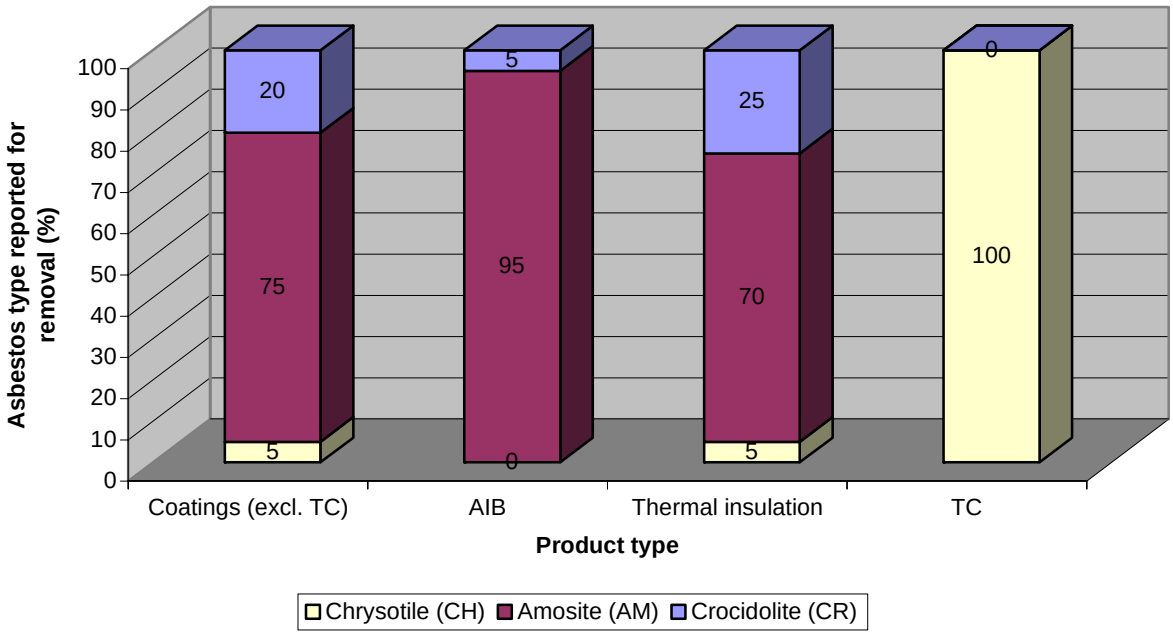
Figure 7: Annual risk of death per million based on 10% of time actively removing ACMs from age 20 for 40 years with limited controls: no RPE



5 Discussion

The overview analysis based on asbestos imports (see figure 3) found that despite the vast majority of the imports being chrysotile the main risk resides with the amosite (x18.5 higher than chrysotile) and the crocidolite (x 9.3 higher than

Fig 8. Reported types of asbestos being removed by in a sample of licensed asbestos removal contractors plans of work in 2004



chrysotile). Given the importance of asbestos type it is worth looking at the mix of asbestos types in the licensed removals of ACMs. Figure 8 summarises the asbestos content of a sample of over 900 licensed removals in 2004, shows that in terms of the asbestos type, textured coatings appear as anomalous in a risk based licensing regime, containing only chrysotile compared to the other licensed material types which in at least 95% of the removals were reported to contain amosite and/or crocidolite.

The more detailed assessment by product group again showed that by far the highest risk resides in the two product groups that contain licensed asbestos materials. The next highest risk group is jointings and packings, which contain some materials that would in some situations be regarded as licensed. The calculated annual risk of death for 40 years of exposure from age 20 are compared to the risk from other workplace fatalities in figure 9 (and HSE statistics 2004) and the lower rates for non-licensed materials are compared to public / societal risks in figure 10 (see R2P2 (2001) and Royal Society, 1981). Again it is important to remember that the estimated asbestos risk to a population of frequently exposed workers has been based on the use of limited controls and no use of RPE with a 40 year duration of exposure and must be regarded as an upper estimate.

Figure 9: Comparisons of asbestos product group annual risk of death per million to other workplace fatalities. (asbestos risk based on 10% of time actively removing ACMs from age 20 for 40 years with limited controls and no RPE)

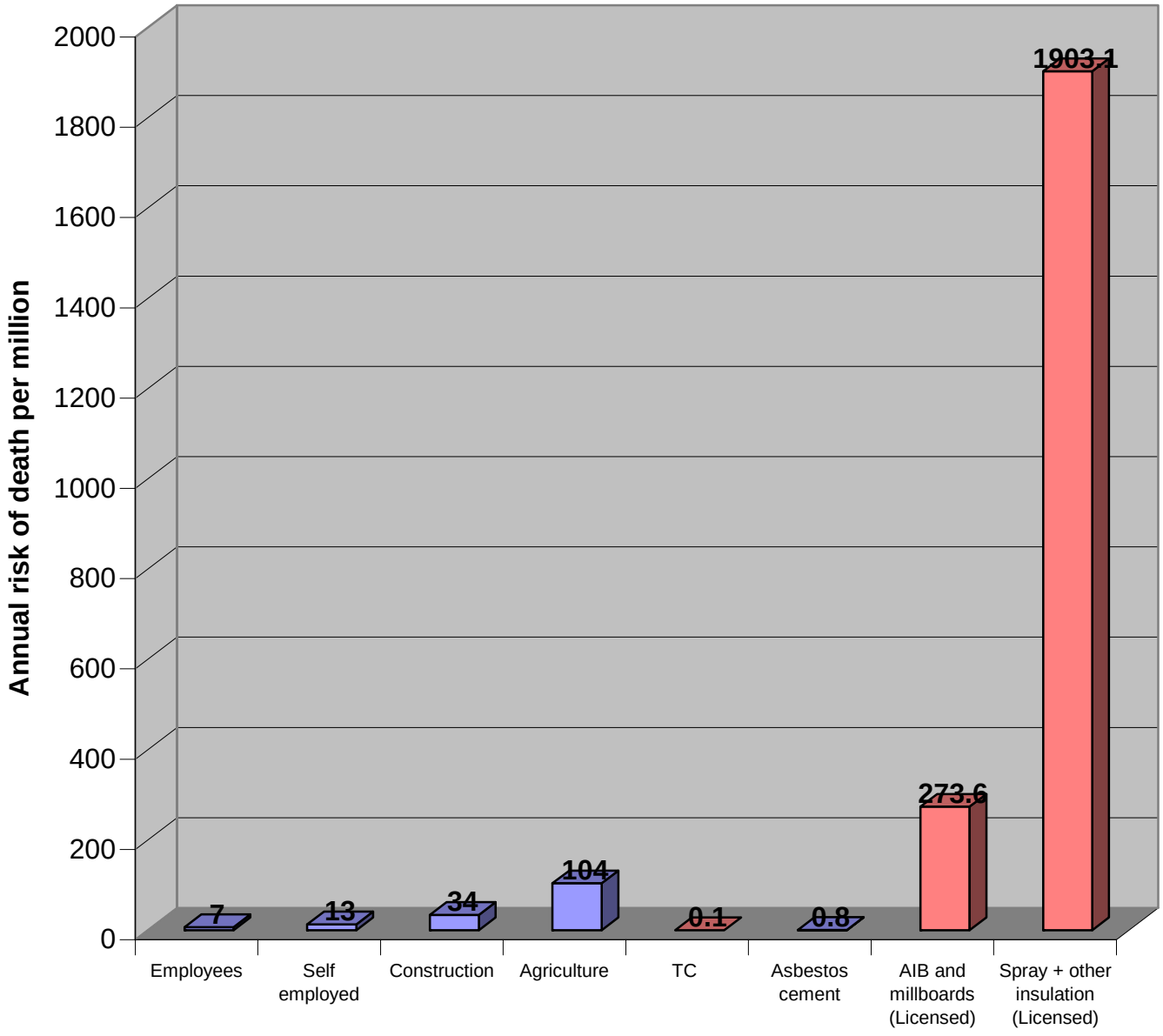
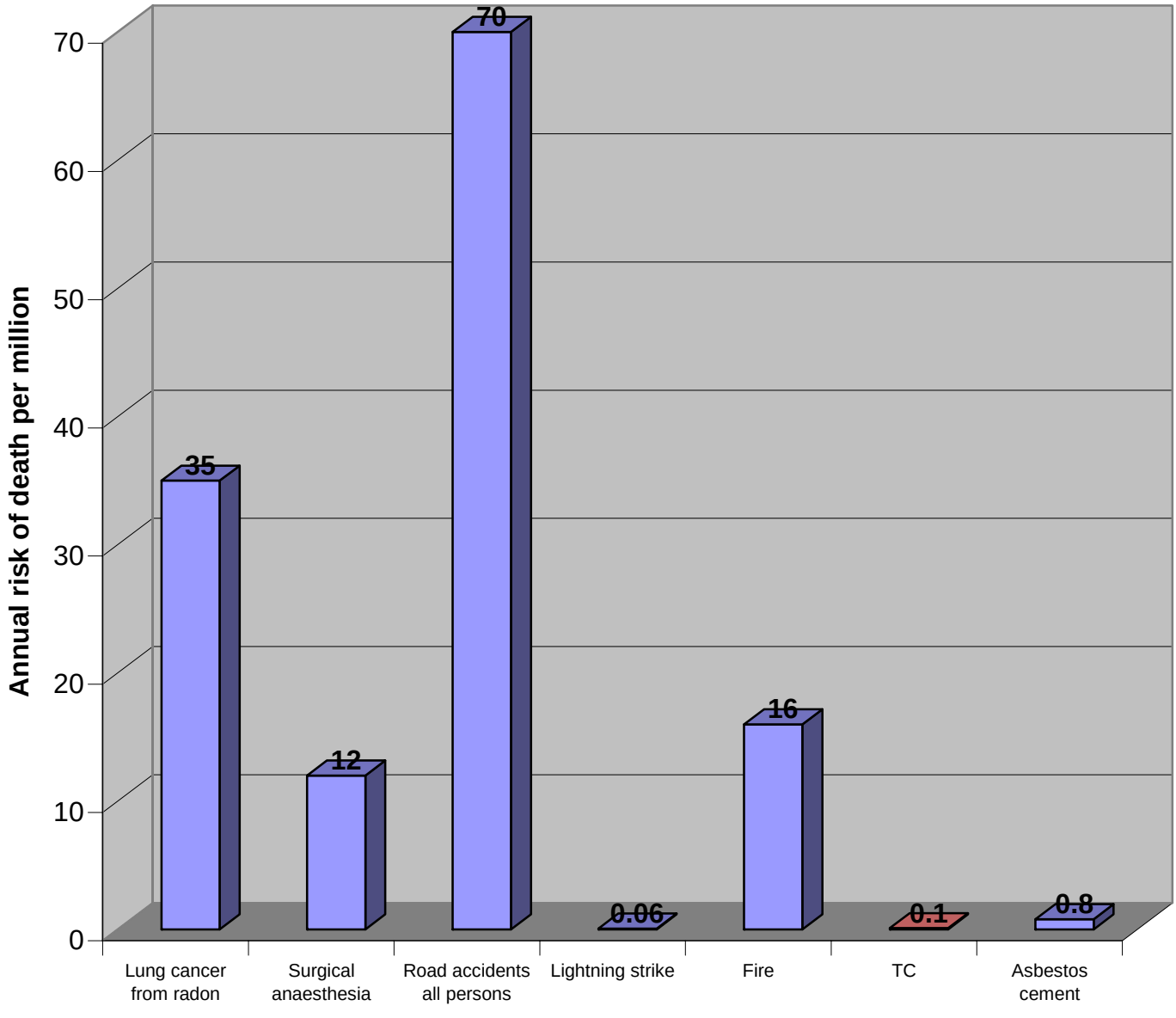


Figure 10: Comparisons of textured coating and asbest cement product group annual risk of death per million to other public risks. (asbestos risk based on 10% of time actively removing ACMs from age 20 for 40 years with limited controls and no RPE)



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