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HEALTH & SAFETY LABORATORY

Removal of chrysotile containing textured decorative finishes: additional work report 1 – Site R.

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EXECUTIVE SUMMARY

Objectives

HSE is currently consulting as to whether textured decorative coatings (TDC) should continue to be regarded as one of a special category of licensed materials, which pose a much higher risk to workers than other asbestos containing materials (ACMs). To assist in this process HSE has asked HSL's Inorganics and Fibres Section (IFS) to investigate the effects of modifying the conditions under which such removals take place. In particular HSE wanted an assessment of:

1) the change in the personal airborne asbestos fibre concentrations inside the enclosed area if no air extraction is used to keep a reduced pressure inside the enclosure:

2) the effectiveness of the clearance based on a visual assessment alone:

The regulatory phase contrast microscopy (PCM) counting rules for fibres are to be amended (2006) and HSE has requested further assessment of the effects of these changes (from the current European reference method (ERM) to the World Health Organisation (WHO) fibre counting rules). They have also requested a further assessment of the filter treatment method used to remove soluble calcium sulphate fibres as permitted under the WHO counting method. Sites were to be selected, if possible, so that a wider range of substrates and removal methods could be sampled.

Main Findings – Site R

At this site, licensed removal of TDC from a ceiling using scrapers was being carried out. HSE granted a waiver so that removal conditions could be varied and the extracted air (often referred to as the negative pressure units - NPUs) could be switched off. Where the TDC was in poor condition and relatively easy to remove it was stripped by dry scraping. During a separate monitoring period the more firmly attached material was softened using a steam plate prior to scraping.

Personal monitoring of the airborne asbestos fibre concentrations was carried out during removals (dry scraping) of similar amounts of material with the NPU on and repeated with the NPU off. It was also carried out during a partial clean up (dry) and during scraping following the softening of the finish with a steam plate, both activities being carried out with the NPU off. A major failure of the electricity supply to the building prevented further sampling during the visit.

Compared to previous sites the amount of dust release during the removal was low allowing samples taken over the duration of the whole activity to be analysed. This meant it was not necessary to analyse the short-term (10-minute) samples, which would have increased the limits of quantification. The approximate duration of sampling for each type of removal was 45 – 62 minutes. The dry cleaning and removal of contaminated items took about 20 minutes.

Monitoring of dry scraping gave personal airborne fibre concentrations (PCM/WHO) of 0.125 f/ml (range 0.08 – 0.17 f/ml). Treating the filters to dissolve calcium sulphate particles and fibre reduced it to 0.048 f/ml (range 0.03 – 0.06 f/ml), 38% of the previous all fibre values.

The difference in the personal exposure measurements during dry scraping with the extract filter units on and with them off was not significant (in terms of the 95% confidence interval). However, when the NPU was switched off there was an apparent increase of about a third for using both the ERM (129%) and WHO (135%) counting rules.

WHO counting rules gave fibre counts about one third higher than ERM counting rules (130% for the untreated filters and 135% for the treated filters). However, this increase was more than offset by the discrimination of fibre types. Treatment of the membrane filters to dissolve calcium sulphate fibres reduced the PCM count of non-soluble fibres to about one third (34.7% untreated and 33.3% treated) of the untreated count. Identification of the fibre types using analytical transmission electron microscopy (TEM) with electron diffraction and energy dispersive x-ray analysis showed that only 14% of the PCM equivalent (PCME) sized fibres were asbestos. All the PCME asbestos fibres seen were chrysotile asbestos.

The net effect of the WHO rules, when discrimination was carried out, was to lower the measured concentration of fibre exposure. This is in line with previous measurements.

The measured TEM PCME asbestos concentrations for dry scraping were low and gave an average of 0.038 f/ml. Three of the four samples analysed were at or below the limit of quantification (0-3 asbestos fibres) but the other sample gave a much higher result (0.115 f/ml). The precision of the individual analyses with such low numbers of fibres is poor so the average is the most reliable result to use.

The TEM result for PCME asbestos fibres during dry removal (with the NPU both on and off) of 0.038 f/ml was slightly lower than the result, 0.048 f/ml, for the treated PCM count for non-soluble WHO fibres.

The use of a steam to loosen the TDC did not produce a substantial difference to the dry scraping airborne fibre levels, (~0.06 f/ml) when compared to the PCM/WHO counts with the NPU off. This suggests that much of the plaster and TDC being removed was still dry. However, the TEM results showed that the actual concentration of chrysotile fibres was much lower (0.01 f/ml). It is not clear why there should be these differences between the PCM and TEM results for steam removal. Again the small number of fibres encountered meant that the precision of the analysis was poor and the differences may be less than indicated by these measurements.

The dry sweeping and removal of the carpet underlay covered with dust and debris was a much more dusty process than the removal of the TDC with scrapers, and increased dust, fibre and asbestos fibre concentrations were recorded. Uncontrolled dry sweeping and disturbance of the debris gave average PCM counts for non-soluble fibres of 0.1 f/ml (with no extraction). The average TEM concentrations of PCME chrysotile fibres, 0.16 f/ml, were somewhat higher, but not significantly different (within the 95% confidence interval) to the treated WHO values.

Overall, although dry removal was being carried out, the concentration of asbestos fibres were only around 0.05 f/ml during the periods of peak activity regardless of whether the NPU was on or off. During dry sweeping and clean up of the debris and removal of contaminated carpet backing, the peak concentration rose to 0.25 f/ml for all PCM fibres but in terms of asbestos/ non-soluble fibres this gave concentrations of 0.09 – 0.18 f/ml with the NPU off. Again this is in line with previous measurements showing that uncontrolled peak disturbance activities can exceed 0.1 f/ml but if CAWR is adhered to and controlled removal is used, it is unlikely that either the 10-minute or 4-hour control limits for asbestos fibres will be exceeded.

Recommendations

This report gives detailed information about sampling at site R, one of five sites sampled as part of this study. Recommendations for the study as a whole are given in IF2006/07: “Summary Report On Additional Work Carried Out On The Monitoring Of Chrysotile Containing Textured Decorative Coatings”.

1 INTRODUCTION

HSE is currently consulting on whether decorative textured finishes (TDC) should continue to be regarded as one of a special category of licensed materials, which pose a much higher risk to workers than other asbestos containing materials (ACMs). To assist in this process HSE has asked HSL's Inorganics and Fibres Section (IFS) to investigate the effects of modifying the conditions under which such removals take place. The consultative document (CD 205) sets out in paragraphs 164 – 173 of annex C, the Draft approved code of practice (ACoP), the procedures to be followed.

In particular HSE wanted an assessment of:

1) changes in the personal airborne asbestos fibre concentrations inside the enclosed area when no air extraction is used to keep a reduced pressure inside the enclosure:

2) the effectiveness of the clearance based on a visual assessment alone:

The regulatory phase contrast microscopy (PCM) counting rules for fibres are to be amended (2006) and HSE has requested further assessment of the effects of these changes (from the current European reference method (ERM) to the World Health Organisation (WHO) fibre counting rules). They have also requested a further assessment of the filter treatment method to remove soluble calcium sulphate fibres as permitted under the WHO counting method. Sites were to be selected, if possible, so that a wider range of substrates and removal methods could be sampled.

This report details an investigation into the removal of TDC from the ceiling of a bar and recreational area of site R.

A recommended sampling and analysis strategy for the work (see Appendix 1) was produced. It was intended that this strategy would be modified to meet local circumstances.

2 SITE MONITORING

2.1 SITE DESCRIPTION

The sampling site was a rectangular ~ 20 foot (6 m) x 50 foot (15 m) room about 13 foot (4 m) high, at one end of a larger building complex. The main room was divided into two similar areas by an archway and along three quarters of one wall was a bar area. A false ceiling suspended about 3 foot (1 m) below the coated ceiling had been removed but wooden panels scheduled for removal were still in place (see figures 1 & 2 and appendix 2). Prior to the removal the carpet had been removed (and disposed of) but underlay, covering about two thirds of the floor was still in place.

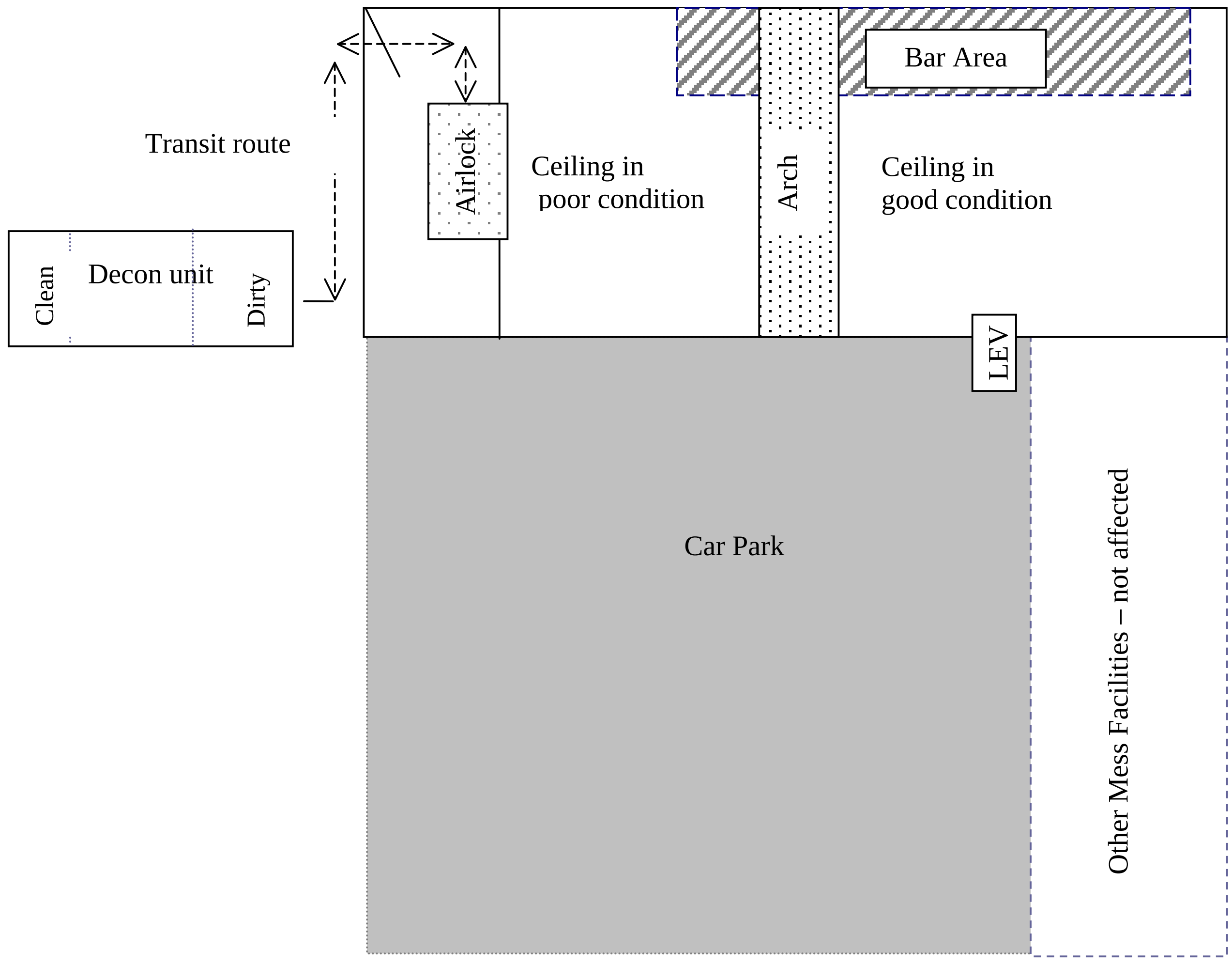

Figure 1: Schematic diagram of removal area and surrounds

The underlying tiled surface was exposed over the remainder of the area. Curtains had been removed and disposed of and fabric inserts (soft backs) from the bar furniture removed (to be cleaned and replaced). The bar was isolated with plastic sheeting but wooden furniture remained inside the enclosure. Access was through a three-stage airlock and negative pressure, inside the enclosure, was generated using a HEPA filtered air mover (also known as a negative pressure unit – NPU) through a window at the opposite end of the room (enclosure) to the airlock.

The job entailed the removal of a layer of TDC from the ceiling and sealing the ceiling before replacing the false ceiling. A small amount of TDC, which was inaccessible, without demolishing the bar, was to be left, sealed and marked as containing asbestos.

The TDC to one side of the central arch was in a poor state (see figure 2 and appendix 2) and debris on the floor in this area (prior to removal) included TDC from the ceiling. Analysis of samples of the TDC had confirmed that it contained chrysotile asbestos. At the other side of the arch the TDC appeared to be in good condition. [It was suspected that cold damp air admitted, via an air vent into the void above the false ceiling was responsible for the poor state of the TDC. The arch that divided the room presented a barrier preventing the damp air reaching the half of the void where the ceiling appeared undamaged]. The contractor's site plan indicated that the airlock and transit route would be through the bar area but this was amended so that access was via an airlock in the doorway visible (figure 2) at the end of the mess. This was a better and more practical option.

A plastic curtain hung from the arch to isolate the area with the undamaged TDC was pulled aside during the periods when the NPU was on. It was intended to use steam to soften and loosen the more firmly attached TDC. The purpose of this curtain was to reduce the room size (volume) during steaming.

2.2 REMOVAL METHOD

The contractor planned to remove the damaged TDC using scrapers. IFS requested that they stripped half of the damaged area using the current standard licensed procedures but removed the remaining damaged material with the local exhaust ventilation (NPU) switched off. A waiver from HSE, permitting this variation, was granted.

In the event, two of the asbestos removal workers cleared about half this area in approximately fifty minutes (NPU on). They made no attempt to wet the TDC and left several large patches (up to ~ 1 m^2), where the TDC was firmly attached. These were to be softened using a steam plate before scraping off. After a short break during which the workers left the enclosure, they resumed work on the other half of the area but now with the NPU off. Although the size and amount of material were roughly equivalent, they stripped this section in a slightly shorter time (than the first removal). This may have been because it was closer to the external air vent and possibly looser than the material further into the room. Again difficult patches were left to be softened using a steam plate.

Figure 2: The ceiling in the area where the TDC was in very poor condition. The end of the bar area can be seen on the right and thin metal wires from which the false ceiling hung are visible.

Before exiting the enclosure for lunch the removal workers brushed down (dry) window ledges and wooden furniture before rolling up the underlay (and debris) and sealing it in plastic. This activity, which took about twenty minutes, was monitored using cowl samplers only. The static total dust monitor (IOM head) continued to sample during this period and included airborne dust generated during removal and dust re-entrained during dry sweeping.

After lunch the removal workers returned to the enclosure with a large steam generator (a circular ~ 60 cm diameter by ~ 60 cm deep vat of water with a heating element). This was to be used to fill the half room with steam (the ½ with TDC in good condition). Whilst the vat was heating up a steam plate (type used for removing wallpaper) was used to soften the patches left during the morning session. After about 45 minutes with the NPU off, it was requested that it be switched on, with the intention for monitoring further removals during a similar period. Unfortunately at this point the electricity failed. Having ascertained that an electrician was needed (it wasn't a simple trip out that could be reset) work was abandoned for the day.

The differences in the condition of the TDC, necessitating different removal techniques meant that comparisons either side of the arch would not be valid at this site. Therefore the draft sampling strategy based on the area be divided into separate halves, was not applicable at this site and the separation between methods had to be made by using a break in time rather than a physical barrier. The failure of electricity supply meant that no clearance sampling could take place that day but the difficulty in separating work areas at this site also meant that no useful clearance comparisons could be made.

2.3 SAMPLING

Airborne sampling for asbestos fibres was carried out in accordance with HSG248 "Asbestos: The analyst's guide for sampling, analysis and clearance procedures" and as far as practicable following the sampling strategy in appendix A. Both the removal workers, who worked in parallel carrying out identical tasks, wore two cowl samplers and a cyclone sampler on their lapels, throughout the period of sampling. The cyclone and one cowl sampler (operating at ~ 2 litre/minute) sampled continually throughout each phase of the removal but were changed when the conditions inside the enclosure were modified (NPU switched on/off). The other cowl samplers were replaced at approximately ten-minute intervals. This strategy was intended to maximise the probability that 'countable' samples were collected under the different conditions (NPU on / off). In addition to the personal samples a static, total dust sample (IOM head) was collected during each phase of the work.

3 ANALYSIS

Initial visual examination suggested that none of the cowl samples were overloaded. Consequently analysis was only carried out on the cowled samplers, which were run for the whole sampling period as these would have the best limit of quantification (LOQ).

Airborne fibre concentrations were determined by optical fibre counting (phase contrast microscopy – PCM) in accordance with HSG248 using both the current European Reference Method (ERM see MDHS 39/4) and the WHO counting rules. [WHO counting rules are scheduled to replace the ERM counting rules in 2006]. A quarter filter was prepared and counted in the normal way. A second quarter filter was also prepared by wet wicking the filter to remove any soluble particles. After wicking for approximately one hour and then leaving to dry, the filter was prepared and counted by PCM in the same way as the first quarter filter.

PCM fibre counts include all fibres meeting the counting criteria that are based on fibre dimensions and take no account of fibre type. Therefore additional analysis by analytical transmission electron microscopy (TEM), using electron diffraction and energy dispersive x-ray analysis to identify the individual fibres and the type of asbestos was carried out. A third quarter filter was prepared for the TEM counting, sizing and identification. Fibres of a size, which would have been visible and counted by the PCM (fibres >5 µm long, > 0.2 - 3 µm wide and with an aspect ratio >3:1), were analysed. This allowed the PCM equivalent (PCME) airborne asbestos fibre concentration to be calculated.

The total (IOM heads) and respirable (cyclone) dust concentrations were determined by weighing the filters in accordance with MDHS14. The cyclone samplers were fitted with membrane filters suitable for PCM analysis and these filters were also analysed by PCM fibre counting techniques.

4 RESULTS

4.1 PCM RESULTS

The results of PCM airborne fibre counting are shown in table 1. The table shows the results of fibre counting using the both the ERM counting rules and the WHO counting rules on both the untreated and treated filters.

Table 1: PCM results from airborne fibre monitoring.

Sample N^o	Untreated Filters					Treated Filters (wet wicked)						
	N^o fibre		F/ml			N^o fibre		F/ml			NPU	Activity
	ERM	WHO	ERM	WHO	WHO +95%	ERM	WHO	ERM	WHO	WHO +95%		
11641/05	33.5	38.5	0.07	0.08	0.14	15	15	0.03	0.03	0.06	On	R: dry scrape
11643/05	44.5	55	0.09	0.11	0.20	14	20	0.03*	0.04	0.08	On	M: dry scrape
11656/05	49	58	0.12	0.14	0.25	14.5	23	0.04*	0.06	0.11	Off	R: dry scrape
11661/05	51.5	68.5	0.13	0.17	0.29	13.5	22	0.03*	0.06	0.1	Off	M: dry scrape
11667/05	36.5	44.5	0.20	0.25	0.44	13	19.5	0.07*	0.11*	0.21	Off	M: cleaning
11668/05	33.5	40.5	0.20	0.24	0.42	8	14.5	0.05*	0.09*	0.17	Off	R: cleaning
11671/05	35.5	48	0.09	0.12	0.20	17	19	0.04*	0.06*	0.09	Off	R: steam scrape
11675/05	43	71.5	0.22	0.36	0.61	14	14.5	0.07*	0.07*	0.14	Off	M: steam scrape
Average	40.9	53.1	0.14	0.18	0.32	13.6	18.4	0.045	0.065	0.12		
	WHO:ERM = 130%					WHO:ERM = 135%						
WHO+95% = upper 95% confidence values for the WHO counts.						* these values would normally be reported as <LOQ						

4.1.1 Untreated PCM results for all fibre types

The average airborne fibre (all fibres) concentration (WHO) for the two workers during the period of uncontrolled dry removal was 0.095 f/ml with the NPU on and 0.125 f/ml when the NPU was switched off. These results were within the 95% fibre confidence interval for fibre counting; consequently the concentrations monitored with the NPU on and with the NPU off were not statistically significantly different.

The average airborne fibre (all fibres) concentration (WHO) for the two workers when cleaning (including dry sweeping and rolling up the underlay) with the NPU off was 0.245 f/ml. This was significantly greater than the dry scraping values recorded with the NPU either on or off.

The airborne fibre (all fibres) concentrations (WHO) recorded when steaming and scraping (NPU off) were significantly different for the two workers (0.12 f/ml and 0.36 f/ml). [The ERM values 0.09 and 0.22 f/ml although different were not as markedly so]. The average (0.24 f/ml) was significantly greater than that for dry scraping with the NPU on.

On average the WHO counts for untreated filters were higher 129.3% (range 114.9 – 166.3%) than those using the current ERM counting rules.

4.1.2 Treated PCM results for in-soluble fibres

The average airborne fibre (insoluble fibres) concentration using the WHO counting rules for the two workers during the period of uncontrolled dry removal was 0.035 f/ml with the NPU on and 0.06 f/ml when the NPU was switched off. Again the results were within the 95% fibre confidence interval for the fibre counts and were not significantly different.

The average airborne fibre (all fibres) concentration (WHO) for the two workers when cleaning (including dry sweeping and rolling up the underlay) with the NPU off was 0.1 f/ml. This was significantly greater than the dry scraping values.

The average airborne fibre (all fibres) concentration (WHO) for the two workers when steaming and scraping (NPU off) were 0.065 f/ml and were not significantly different between the two workers or from the dry removal.

The average WHO airborne (insoluble) fibre concentration for eight treated samples was 0.07 f/ml.

4.1.3 Time weighted average

The four-hour time weighted averages for all PCM fibres (untreated samples) based on the WHO counting rules, for the two workers were 0.087 f/ml and 0.152 f/ml. These were for a working period of 166 minutes. The exposure during the remainder of the four-hour assessment period (74 minutes) was assumed to be minimal. For treated samples the TWAs were 0.025 f/ml and 0.044 f/ml.

4.1.4 Comparison between PCM counting rules

On average the WHO counts for untreated filters were 129.3% the ERM values (114.9 – 166.3%). For treated filters this rose to 151.2% (111.8 – 181.3%).

On average the WHO airborne (insoluble) fibre concentration for eight treated (water wicked) filters was about one third (average 35%, range 19% – 50%) that for untreated filters. The ratio (untreated / treated) for ERM counts (average 32%, range 23 – 44%) was not significantly different.

The ratio of treated (insoluble fibres) WHO counts to all fibres using ERM counts was 48% (range 32% – 67%). This suggests that the combined effect of WHO counting (increasing counts by 150%) but treating the filters to remove soluble fibres, results in a net reduction in measured airborne fibre concentrations of about 50%.

4.2 TEM RESULTS

Untreated quarter filters were analysed for asbestos and non-asbestos fibres using TEM techniques. All PCM equivalent fibres (PCME) were counted and the results included in table 2 with the corresponding PCM results (WHO counts) from treated filters.

Table 2: TEM PCME airborne fibre concentrations

Sample N°.	N°. of PCME fibres counted		PCME Fibre Concentration (f/ml)		PCM / WHO treated (f/ml)
	Asbestos	Non-asbestos	Asbestos	Non-asbestos	
11641/05	3	6	0.019	0.038	0.03
11643/05	0	28	0.000	0.244	0.04
11656/05	11	42	0.115	0.440	0.06
11661/05	2	46	0.019	0.429	0.06
11667/05	8	39	0.184	0.898	0.11
11668/05	5	20	0.124	0.494	0.09
11671/05	0	19	0.000	0.192	0.06
11675/05	2	26	0.019	0.250	0.07
Total / average	31	226	0.060	0.373	0.065

Highlighted values show samples where the TEM value was greater than the comparable treated WHO values

The TEM analysis of the PCME fibres showed that only some 14% of the fibres meeting the counting criteria were asbestos. All the PCME asbestos fibres were chrysotile fibres and many of these were attached to particles.

The average PCME asbestos concentration for the eight TEM samples was 0.06 f/ml (range 0 – 0.184 f/ml). The highest chrysotile concentrations were associated with the clean up where dry sweeping and underlay rolling took place. Both samples exceeded 0.1 f/ml over the 20 minutes that this activity took place.

Although some 5,600 fields of view were inspected for each TEM sample, only a few PCME asbestos fibres were found and the precision was poor. Normally the limit of quantification (LOQ) is based on reaching a count of 3 fibres and it can be seen that half of the analyses were below the LOQ. Overall the 31 PCME chrysotile fibres seen in the eight samples were only marginally above the minimum number (24) of fibres required in each sample to exceed the LOQ.

Overall the average values of the TEM count of asbestos fibres was in good agreement with the WHO counts on treated samples.

The four-hour time weighted averages, using the PCME fibres, for the two workers were 0.048 f/ml and 0.027 f/ml. As with the TWAs calculated using optical microscope data, the remainder of the assessment period (76 minutes) had zero exposure. These TEM PCME values were similar to, or slightly lower than the comparable TWAs for treated samples.

4.3 GRAVIMETRIC RESULTS

The results of the gravimetric analysis are given in table 3.

All the gravimetric samples, both total dust and respirable dust were low. One total dust sample (4.23 mg m^{-3}) was considerably higher than the other samples but this sample included airborne dust generated both during dry scraping and cleaning (including dry brushing of surfaces) with the NPU off). These measurements confirmed, what was apparent during the airborne fibre sampling, that only a limited amount of dust was being released during the scraping. This was in contrast to some other sites (see MF/2005/03) where the substrate was also removed, releasing much larger amounts of airborne dust, which rapidly overloaded filters making sampling for asbestos fibres extremely difficult.

Table 3: Results off Gravimetric Sampling

Sample No.	Activity:	Sample type	Time (mins)	Vol. (litre)	Wt. Dust (mg)	Conc. mg m^{-3}	WHO F/ml#
11654/05	Dry scraping NPU on	IOM Head	62	130	0.17	1.28	
11659/05	Dry scraping NPU off + clean up	IOM Head	62	124	0.53	4.23	
11676/05	Steaming, scraping NPU off	IOM Head	58	116	0.14	1.21	
11644/05	R, dry scraping NPU on	Cyclone	54	119	0.03	0.24	0.04*
11645/05	M, dry scraping NPU on	Cyclone	54	119	0.04	0.36	0.08
11657/05	R, dry scraping NPU off	Cyclone	45	99	0.05	0.45	0.05*
11658/05	M, dry scraping NPU off	Cyclone	45	99	0.05	0.45	0.05
11672/05	R, steaming, scraping NPU off	Cyclone	47	103	0.08	0.79	0.03*
11673/05	M, steaming, scraping NPU off	Cyclone	47	103	0.04	0.41	0.02*

IOM heads operating at ~ 2 litre $minute^{-1}$ were used to collect static total dust samples
Cyclones operating at 2.2 litre $minute^{-1}$ were used to collect respirable samples. These samples were collected on MEC filters, allowing the filters to be mounted and counted, so that airborne respirable fibre concentrations could be determined in addition to the respirable dust concentrations.
Treated (wet wicking) samples
* Result would normally be reported as <LOQ

4.4 RESULTS OF THE PCM COUNTS ON THE CYCLONE FILTERS

The cyclone samples were collected on 25-mm diameter, 1.2 µm pore size, MEC filters allowing both gravimetric (respirable dust) and airborne respirable fibre concentrations to be determined. Quarter sections of the cyclone filters were samples were treated (water wicked) and then mounted and counted in the normal way (HSG248). The airborne fibre (non-soluble) concentrations are included in table 3. The average for the six-cyclone filter PCM counts was 0.045 f/ml slightly lower than the 0.053 f/ml by the conventional counting method. As most of the cyclone samples were below the LOQ these results are not significantly different, but they may represent a reduced fibre count from the cyclone as the larger particles with attached fibres may have been removed.

5 DISCUSSION AND CONCLUSIONS

This site provided an opportunity to measure the airborne asbestos concentrations released during the dry scraping of the TDC from the underlying surface. The ceiling with the asbestos removal worker positioned underneath the ceiling area being scraped ensured that they would be exposed to the airborne releases generated.

Sampling airborne asbestos fibre releases during the removal of TDC can be difficult. It is often a question of getting a balance between overloading the filters with non-fibrous debris and / or non-asbestos fibres (e.g. calcium sulphate fibres from plaster), making analysis (counting fibres) impossible, or under sampling to the extent the limit of quantification (LOQ) is so high that interpretation of the results is difficult. Compared to previous sites the amount of dust release during the removal at this site was low and the samples taken over the whole duration of the activity could be analysed.

Dry scraping gave personal sampling levels of PCM/WHO fibres of all types of 0.125 f/ml (range 0.08 – 0.17 f/ml) during the duration of the activity. When the filters were treated so that calcium sulphate particles and fibre were dissolved, this reduced the concentrations to 38% of the previous value for all fibres 0.048 f/ml (range 0.03 – 0.06 f/ml).

Although the difference in the personal exposure measurements during dry scraping was not significant (in terms of the 95% confidence interval) between when the extract filter units were on and off, an increase was apparent in the raw data with the counts increasing by about a third for both the ERM (129%) and WHO (135%) counting rules when the NPU was switched off.

The WHO counting rules gave fibre counts that were about one third higher than if the ERM counting rules were used (130% for the untreated filters and 135% for the treated filters). However, this increase was more than offset by the discrimination of the fibre types. Treatment of the membrane filters to dissolve calcium sulphate fibres reduced the PCM count of non-soluble fibres to about one third (34.7% untreated and 33.3% treated) of the count. Identification of the fibre types using analytical transmission electron microscopy (TEM) with electron diffraction and energy dispersive x-ray analysis showed that only 14% of the PCME sized fibres were asbestos. All of the PCME fibres were chrysotile asbestos.

The net effect of the WHO rules, if discrimination is carried out, is to lower the measured level of fibre exposure. This is in line with previous measurements.

The measured TEM PCME asbestos concentrations for dry scraping were low and gave an average of 0.038 f/ml. Three of the four samples were at or below the limit of quantification (0-3 asbestos fibres) but one sample gave a much higher result (0.115 f/ml). The precision of the individual analyses with such low numbers of fibres is poor so the average is the most reliable result to use.

The TEM result for PCME asbestos fibres during dry removal (with the NPU both on and off) of 0.038 f/ml was slightly lower than the result for the treated PCM count for non-soluble WHO fibres 0.048 f/ml.

The use of a steam to loosen the TDC did not produce a substantial difference between dry scraping, when comparing the PCM/WHO counts with the NPU off (~0.06 f/ml). This suggests that in the main dry plaster was being removed. However the TEM results showed that the actual concentration of chrysotile was much lower (0.01 f/ml). It is not clear why the differences between the PCM and TEM results for steam removal should be greater than for dry removal. Again the small number of fibres encountered meant that the precision of the analysis was poor and the differences may be less than is apparent from small number of measurements.

The dry sweeping and removal of the carpet underlay which was covered with dust and debris was a much more dusty process than the removal of the TDC with scrapers, and increased dust, fibre and asbestos fibre concentrations were recorded. Uncontrolled dry sweeping and disturbance of the debris gave average PCM counts of non-soluble fibres of 0.1 f/ml (with no extraction). The average TEM concentrations of PCME chrysotile fibres was somewhat higher at 0.16 f/ml but was not significantly different and was within the 95% confidence interval.

Overall, although dry removal was being carried out the concentration of asbestos fibres were around 0.05 f/ml during the periods of peak activity sampled regardless of whether the NPU was on or off. During dry sweeping and clean up of the debris and removal of contaminated carpet backing, the peak level rose to levels of 0.25 f/ml for all PCM fibres but in terms of asbestos/ non-soluble fibres levels of 0.09 – 0.18 f/ml with the NPU off. Again this is in line with previous measurement that uncontrolled peak disturbance activities can exceed 0.1 f/ml but if CAWR is adhered to and controlled removal is used, it is unlikely that either the 10-minute or 4-hour control limits for asbestos fibres will be exceed.

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7 APPENDIX 1 – Strategy For Proposed Project To Monitor Personal Fibre Levels Of Workers Involved In The Removal And Renovation Of Textured Decorative Finishes Phase 2.

7.1 AIM

The aim of this work is to collect data on fibre emission from work with asbestos containing textured decorative finishes removed under licensed and unlicensed conditions. It is intended to build on the experience of phase 1.

7.2 PURPOSE

The results will be used to inform further the consultation by HSE on whether decorative coatings should continue to be a licensed asbestos material.

7.3 INTRODUCTION

The work in phase 1 showed that very high dust concentrations were produced by licensed removal contractors during the removal of chrysotile containing textured decorative finishes. A number of sampling and analytical strategies were developed for and during phase 1 to try to get countable samples, which were not overloaded. This however, meant that very short sampling times and low volumes of air had to be collected, that often reduced the limit of quantification to above the proposed control limit of 0.1 f/ml. This required pooling of several samples to characterise the fibre concentration. Also in the later samples using much lower flow rates 0.2 – 0.5 L/min it was decided to monitor for longer periods

The release of calcium sulphate particles and fibres from the underlying plaster was also a problem.. This caused the PCM fibre count to include calcium sulphate fibres and to overestimate the asbestos content. A procedure was developed to remove the calcium sulphate before the PCM analysis and was shown to be effective in removing some of the particulate matter. This made some overloaded filters countable, reduced fibre undercounting due to obscuration and/or the touching particle rule and reduced the count of non-asbestos fibres.

The same principles are to be extended to this further work and a generic project design has been produced below. As sites will be different it is expected that variations will have to be made to accommodate the types of work taking place and local conditions.

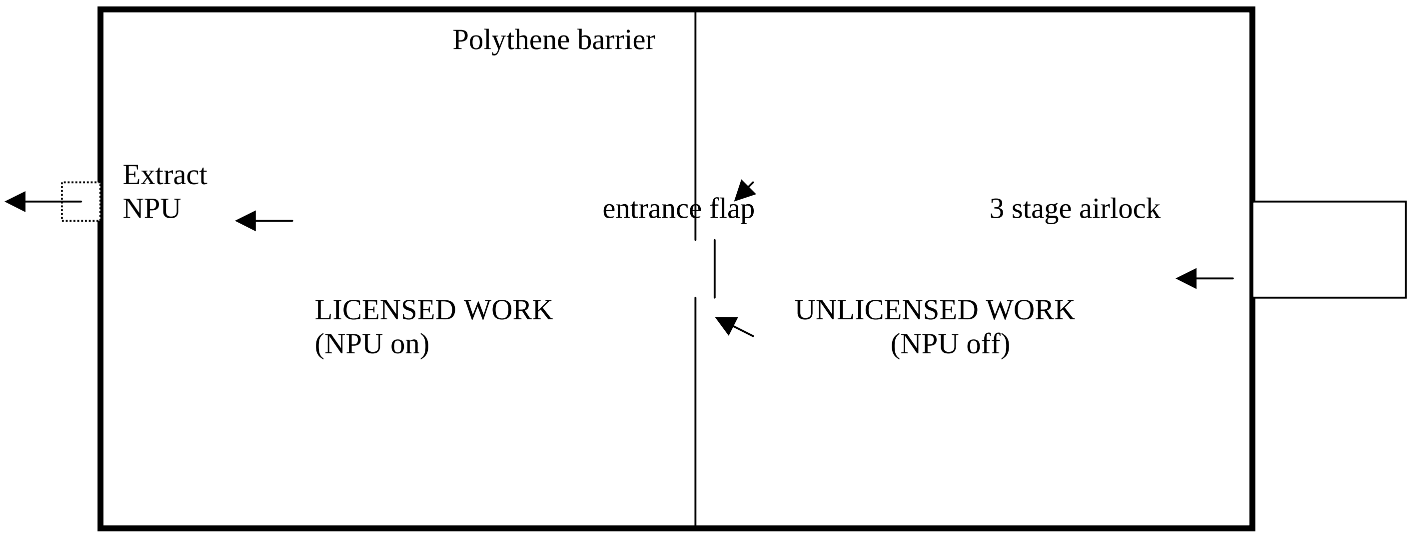
7.4 PROJECT DESIGN

The proposed project is designed to:

- Collect personnel exposure data (fibre and mass concentration) during the repair, renovation or removal of damaged ceilings or walls coated with asbestos containing textured decorative finishes;
- Compare the personal exposures from licensed and simulated unlicensed work with appropriate controls as required by CAWR and the proposed ACoP;
- Compare the clearance levels from licensed and unlicensed removal;

To achieve this, where possible, the full enclosure built for licensed removal will be divided into two halves (one for licensed removal and the other for unlicensed type removal) with a temporary plastic barrier in between with a doorway entrance flap cut to allow persons and air to pass through but can be sealed up later to limit the dust spread (see below). The licensed removal type work will be carried out first, in the half with the NPU) with the NPU unit on and dust suppression techniques used as normal. Both the removal and clean up should be completed so the Contractor is happy with the area passing a visual assessment.

Then turn off the NPU and tape up the entrance to the middle barrier to seal the area and carry out removal and clean up in the unlicensed area. This will mean no extraction or ventilation in most cases but the <u>use of water sprays, gel removers and steam units etc. should be used</u> as we would expect these control measures to be used by anybody who removes asbestos under CAWR.



7.5 SAMPLING STRATEGY DURING WORK

Use up to 3 samplers per person 1 for mass concentration and 2 for fibre concentration (depends on number of workers). The sampling personnel will have to apply a judgement on what sampling rate and time of sampling to use, based on the expected amount of airborne dust.

Sample the two main work phases (removal and clean-up) separately by:

- Use a cowled sampler head with 0.8 µm pore size filter sampling set at between 0.2 – 2.0 litres/minute for entire period of removal and then change head for entire period of clean up.

- Use a cowled sampler with 0.8 um pore size filter sampling at 1-2 litres/minute and change cowl every 10 minutes during dusty periods, or if lower concentration leave for longer. (The sampling person will have to judge this as best they can).

- Measure respirable dust on at least 1 person using a cyclone sampler at the appropriate rate (e.g. 2.2 L/min) for removal period and then change over for the clean-up. (The cyclone can be fitted with a 1.2 µm pore size membrane filter to allow for PCM counting after reweighing).

- Measure total dust on 1 person using IOM inhalable sampler operating at 2 L/min for removal period and then change over for the clean-up period.

7.6 SAMPLING STRATEGY DURING CLEARANCE

The Contractor should thoroughly clean the area after the work as required by CAWR and carry out their own visual clearance. Once this has been done and the Contractor is satisfied, HSL personnel will carry out stage 2 and 3 of the four-stage clearance test as documented in HSG 248 in each part of the enclosure (licensed and unlicensed) individually.

For each separate part:

- The stage 2 visual clearance will note whether dust and debris are visible inside the work area. The Contractor will not be asked to carry out further clean-up if not found to be adequately cleaned, in either section but a detailed note and photographs) will be made of the amount and location of the debris seen.

- The stage 3 disturbance sampling (using a new broom) will be carried out separately (as detailed in HSG 248) in each half of the enclosure when dry to collect 480 litres of air onto static membrane filter samplers.

- The licensed area should be cleared first (with NPU off).

The full 4 stage procedure for a certificate of reoccupation will be carried as usual by another laboratory, after the HSL clearance. Results to be forwarded to HSL.

7.7 ANALYSIS

Quarter filter should be mounted for PCM analysis and counted by WHO rules (200 fovs examined).

Quarter filters should be carefully wicked in water to remove calcium sulphate particles and when dry (left overnight) mounted for PCM analysis and counted by WHO rules (200 fovs examined).

Quarter filters should be prepared for TEM analysis and counted by ISO method for PCME fibres (asbestos and non-asbestos fibres identified). If lots of calcium sulphate present, grids can be placed in a water washer for 60 minutes to dissolve fibres , (see appendix H ISO 10312:95) or if practical determine the non-asbestos content without water washing.

A quarter filter should be retained and stored.

Mass concentration filters should be weighed before and after sampling with 3 control blank filters.

7.8 **REPORTING**

Individual site reports detailing the work and results will be produced by HSL.

8 APPENDIX 2: PHOTOGRAPHS

A2:1 View of bar area after removal of false ceiling. All the movable items were removed prior to stripping the ceiling. The blue inserts were removed from the seats and the carpet and curtains disposed of. An airlock was built in the doorway at the end of the room and the bar area sealed off using plastic sheet.

A2:2 Photograph of large pieces of the TDC. These had fallen from the ceiling during the dismantling of he false ceiling.

A2:3 Photograph showing high concentrations of contamination much of which was TDC from the ceiling.