This paper describes workplace dermal exposure measurements that were carried out by the Health and Safety Laboratory as part of the EU RISKOFDERM project to measure dust contamination. Exposure to dry powder spray paints was measured at five sites on 12 subjects. Twenty-two samples were obtained, of which eight contained triglycidyl isocyanurate (TGIC) and 14 did not. All subjects wore Tyvek® whole body oversuits and some wore sampling gloves. These were either analysed in their entirety to extract the TGIC or surface scanned over representative areas using a portable X-ray fluorescence spectrometer (PXRF) to detect barium or titanium in the fillers of the paints. The method of Dirichlet tessellation was used to map the scans and the technique was developed further for these studies to extend measurements to gloves and to take limits of detection into consideration. The PXRF allowed dusts to be measured in situ that would otherwise be difficult to extract from the material and analyse by other means. The geometric mean surface loading rate of the 22 oversuits was 43 $\mu$g/cm$^2$/h (GSD = 6.0) and of the 23 pairs of sampling gloves was 970 $\mu$g/cm$^2$/h (GSD = 8.6). Exposure patterns could be attributed to the arrangements of the subjects, spray booths and the workpieces. Similar exposures were found for TGIC and titanium fillers in factories with similar methods of ventilation.

**Keywords:** dermal exposure; Dirichlet tessellation; powder; PXRF; spray painting; X-ray fluorescence

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**INTRODUCTION**

This paper describes a set of workplace dermal exposure measurements that were carried out by the Health and Safety Laboratory (HSL) as part of the EU RISKOFDERM project. The project was an opportunity to study dermal exposure in a generic manner, i.e. to measure in terms of a formulation, rather than to a hazardous substance of particular concern as an ingredient. This generic approach allows exposure to be subsequently inferred for a range of hazardous ingredients that might be encountered during similar tasks but using different substances (Rajan-Sithamparanadarajah et al., 2004). It was also an opportunity to gather data for substances where little work has been done before. One of the least studied areas of dermal exposure is for exposure to dusts. Part of the reason for this lack of knowledge has been the lack of analytical methods to determine dusts on surfaces, as many dusts are insoluble, unreactive and difficult to recover from fabrics. HSL has a portable X-ray fluorescence spectrometer (PXRF) that can detect many metals directly on the surfaces of materials, allowing us to quickly analyse certain compounds such as insoluble dusts previously difficult or impossible to detect by traditional methods that recover from the surfaces. Our aim was to target industries wherever possible that generated suitable dry dusty powders, to improve the knowledge base in this general area. We chose to study dry powder paint spraying.

**Spray dispersion for coating**

Some polyester dry powder polymer paints contain 1–5% triglycidyl isocyanurate (TGIC) as a cross-linking agent in the oven curing process of the paint. TGIC is a skin sensitizer (risk phrase R43) and a mutagen (R46). It has a maximum exposure limit in air of 0.1 mg/m$^3$ in the UK (HSE, 2002). It has been estimated that there are 5000–10000 users of coating
powders in the UK (Stear and Cooke, 1999). The Health and Safety Executive (HSE) carried out surveys of inhalable dust in 1994 that showed high exposures to TGIC (>3 mg/m³) (Stear and Cooke, 1999). It has issued guidance to firms on the control of coating powders (HSE, 2000a,b). In recent years, alternative curing systems have been developed that do not contain TGIC. The inert fillers of the paints (both TGIC and non-TGIC) contain heavy metals such as titanium dioxide, barium sulphate and calcium sulphate, although they are regarded as low toxicity dusts. Cullen et al. (1999) studied long-term lung effects of different dusts and showed that the larger surface area associated with the smaller particle size of titanium dioxide caused more inflammation in rat lungs than did barium sulphate at high inhalation levels (>20 mg/m³).

In this study dermal exposure to dry powder paint spraying was measured at five locations. Most of these were small enterprises carrying out spraying for coating on a contract basis, but even the largest enterprise often had only one person carrying out the spraying on a particular day. The products being sprayed were different from day to day and depended on the orders that had just come in. Examples included metal furniture frames, metal shelves and shelf supports, coat-hangers, window frames (1 m square), short brackets (30 cm) sprayed in groups of five, long brackets (1.5 m hung vertically), ventilator grilles (0.5 m square) and large flat panels (3 × 1 m).

Small items were suspended from hooks at chest height except at Factory C, where they were either hung or placed on a table. Larger items stretched from head height to knee height. The spray paint was applied with electrostatic spray guns inside various designs of ventilated open spray booths, all of which incorporated downward and rearward laminar airflow away from the operator’s breathing zone and some of which incorporated water recovery from the back wall. Two factories used conveyorized tunnel enclosures with windows to spray through, although one operator was observed to lean inside to spray, which is bad work practice. These types of booth are illustrated in HSG 203 and listed by Factory in Table 1. Sampling times ranged from 9 to 90 min, measured to the nearest minute. Sampling was limited to the spraying operation itself and was terminated upon changing paint or cleaning the spraygun. All subjects wore respirators during spraying, but no other protective clothing. They usually did not wear gloves because the electrostatic spray guns gave them electric shocks unless they used their bare hands to earth them, although the safety data sheets clearly specify that gloves should be worn. One worker at Factory Co used his hands to rotate the objects during spraying to ensure even coverage, but this is bad practice and is not necessary with electrostatic spraying. The information relevant to developing exposure models was recorded on a questionnaire developed for the RISKOFDERM project. This included categorical indicators for workpiece height (overhead, waist height or below waist height) and for spraying distance (greater than, at or less than arm’s length). A summary of the factories visited and the number of samples and questionnaires gathered at each is given in Table 1.

**SAMPLING METHODS**

Thin, lightweight, Tyvek® oversuits (Pro-Tech Classic) were issued to the subjects to wear over the top of any protective clothing that they normally used, to measure potential dermal exposure. It was noticed that the subjects frequently removed the hoods of their sampling oversuits during the work because they restricted head movement. The dust that gathered on the oversuits initially remained by electrostatic charge. It is usual to account for losses in transit by rinsing the storage bags to recover dislodged dust, which is added to that recovered from the sampling medium. However, this extra dust cannot be attributed to a specific area on the medium nor, if it is assessed gravimetrically rather than by chemical extraction, can it be explicitly attributed to the powder paint because it could also arise from other workplace dusts. For non-TGIC dusts analysis was to be location specific, so a method of reducing losses had to be devised. The suits were removed

<table>
<thead>
<tr>
<th>Factory code</th>
<th>No. of employees</th>
<th>Analyte</th>
<th>Types of booth</th>
<th>No. of subjects</th>
<th>No. of body samples</th>
<th>No. of hand samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>3</td>
<td>Barium</td>
<td>Open</td>
<td>2</td>
<td>0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>CS</td>
<td>10</td>
<td>TGIC</td>
<td>Open + tunnel</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Co</td>
<td>30</td>
<td>TGIC</td>
<td>Open</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>Titanium</td>
<td>Open</td>
<td>2</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8</td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>Barium</td>
<td>Tunnel</td>
<td>1</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td></td>
<td></td>
<td>22</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

TGIC, triglycidyl isocyanurate.

<sup>a</sup>Four body results and one hand result have been excluded because of a suspected fault in the PXRF instrument.
after the sampling period and laid out carefully to minimize initial losses, lightly sprayed with hairspray to fix the dusts in place, put onto coat-hangers and bagged immediately into ‘dry cleaning bags’, which were then sealed at the bottom and uniquely labelled. Blank oversuits were also placed in bags on site to act as field blanks. Silicon hairsprays were avoided in the factories because they interfere with the polymerization process. On receipt at the laboratory for analysis, the sealed bags were hung on clothes rails for storage and left undisturbed until analysis. After removing the oversuits, inspection of the insides of the bags showed very little dust on the plastic surfaces, with no accumulation at the bottom even for the most contaminated suits, indicating that the hairspray method had worked well.

Subjects were issued with white cotton gloves (Radiospares part no. 562-952) to wear on their bare hands whilst spraying. This can be classified as either potential or actual dermal exposure measurement. Some refused to wear them for the reasons described above. The gloves were all individually placed into Ziploc sealable bags and uniquely labelled after the sampling period. Fresh gloves were also placed in identical bags on site to act as field blanks.

Samples were taken of each bulk paint powder and the proportion of analyte measured. This allowed all measurements of analytes to be used to calculate the total quantity of dust formulation retained on the glove and suit samplers.

**ANALYTICAL METHODS**

A summary of the analytical methods and their detection limits is given in Table 2. The detection limits are given in milligrams per oversuit analysed. They are independent of the surface area of the oversuit for TGIC, but the PXRF detection limits depended on garment size. They are reported in Table 2 for the combined readings for the XL size oversuit. The proportions of analyte in the various bulk formulations and the recovery efficiencies from the sampling media are given in Table 3. Recovery efficiency in Table 3 is the product of extraction efficiency and analytical detection efficiency for TGIC, but for PXRF it is the detection efficiency as calibrated against known quantities of the metal analyte.

In all, seven different paints of varying colours were used on the days of sampling, of which three contained TGIC.

**TGIC**

The oversuits were sealed in 2 l storage jars in their entirety with 1 l of tetrahydrofuran. Gloves were similarly treated as pairs in 200 ml. They were left overnight to dissolve the TGIC and then mixed in the jar for 1 h on a motorized roller. A sample was removed and analysed for TGIC using liquid chromatography with diode array detection (LC-DAD) according to an HSE standard method (HSE, 1997). This standard refers to air filter samples, but was modified to cope with the larger mass of material in gloves and patches. Calibration was from certified standard solutions of TGIC.

**Non-TGIC**

The four paints that contained no TGIC could not be analysed as described above. However, all of the paints contained large quantities of barium sulphate, calcium sulphate and titanium dioxide as bulk fillers. These metals could be detected simultaneously using the PXRF, and the method of Wheeler and Warren (2002) described below was adopted. The PXRF was not used if TGIC was present because the PXRF method required extensive manipulation of the samplers by hand, which would have caused unnecessary exposure risks to the analyst.

**Non-TGIC oversuits**

The oversuits were lightly sprayed with hairspray again upon removal from the storage bag to reduce resuspension. They were cut along the seams into seven sections, which were laid flat on a benchtop surface that was covered in clean Mylar film to prevent cross-contamination. A second Mylar film was laid on top and a plastic sheet template laid over the top of that, aligned with the corners of the suit section. The template contained a set of 25 mm diameter holes that located the exact positions for surface sampling using the PXRF. Each hole represented a small area of oversuit that was allocated according to the probability of the area being contaminated. These interlocking areas are referred to as Dirichlet tessellations or Voronoi tessellations (Stoyan et al., 1992; Moller, 1994). For example, holes were closer together around the knees and wrists but further apart on the back of the suit. There were 104 holes altogether, each of 4.9 cm² area (total 510 cm²). This area is less than the patch method described in the OECD guidelines (OECD, 1997), where 11 patches of 100 cm² area (total 1100 cm²) represent the body, but the greater number of points sampled using Dirichlet tessellations improves the representation.

The PXRF (Spectrace 9000) was used in thin film mode with the threshold set to off (to retain low value readings). The oversuit surface was exposed to three radioactive α and β sources in turn. The characteristic X-rays produced by metal atoms exposed to the sources were detected by the instrument and calculated as equivalent surface concentrations (µg/cm²). The PXRF was placed over each hole in turn in strict order and the surface concentrations of 24 metal elements were stored in memory. Results were calculated only for barium (Ba) and titanium (Ti). Calcium was later used as a consistency check. Unlike
Wheeler and Warren (2002), who did not need to consider limits of detection (LOD) or limits of quantification (LOQ) in their highly contaminated samples, data points of <LOD were not set to 0 individually. The tessellating surface areas represented by each reading were used to weight the results, which were then summed to represent the entire oversuit of ∼30000 cm² (Table 4). Six new oversuits were measured in their entirety to act as blanks and to calculate LOD and LOQ.

The first seven barium sample oversuits were from Factory A (Powder A) and were measured directly on the plastics laboratory bench, which unknowingly also contained barium as a filler. This raised the barium background to a high but very consistent level of 40 µg/cm² (1200 mg per oversuit) before blank correction (High Ba in Table 2). Subsequent gloves and oversuits were measured on a perspex platform raised above the bench, which reduced barium levels to ∼5 µg/cm² for an oversuit (∼150 mg) before blank correction (Low Ba in Table 2).

A histogram of the 104 readings from a high barium blank and from one of the six high barium-contaminated oversuits is shown in Fig. 1. A few very high results are seen as ‘hot-spots’ of contamination, which were on the sleeves. A difference between the distributions is clear in Fig. 1, but a large proportion of the contaminated oversuit is still within the region of random noise of the instrument, and the distributions overlap. There was insufficient difference to raise the mean of the distribution in Fig. 1 above the LOQ, which is based on all six blank oversuits.

Non-TGIC gloves

Barium compounds are characterized in the PXRF by β-particles of high penetration. The two sides of each glove were separated into front and back pieces by cutting along the side seams and each side was...
measured flat on the perspex sheet at six places: the middle of each digit and the centre of the palm. The measurements were weighted by surface area, as determined from blank gloves. Titanium is characterized by α-particles of low penetration. These gloves were not cut, but an aluminium strip was inserted along each finger to shield the reverse side of the glove.

The PXRF readings were calibrated directly against known surface loadings of the four bulk powders, deposited onto pre-weighed 25 mm glass fibre filters and verified gravimetrically before and after PXRF measurement. The dust calibrations were used to directly convert PXRF readings into equivalent dust formulation. The PXRF readings were also calibrated against known surface loadings of metal atoms by pipetting known volumes of certified standard solutions of titanium chloride or barium nitrate atoms evenly over pieces of material. The detection ‘efficiency’ was constant over the full range and was 36% for Ti and 120% for Ba, showing that the PXRF may over- or under-read on different elements. These figures were used to convert PXRF readings into ‘true’ results in terms of the analyte metal. The lower figure of 36% for Ti may reflect lower depth penetration of α-particles than of β-particles, however, limited penetration of thicker coatings would be expected to show as a ‘knee’ in the calibration. In fact, calibrations were linear for both dusts and dried salt solutions at concentrations well in excess of those found on the samples. Calibration of the PXRF was directly against known dust masses, so detection efficiency was automatically taken into account.

**PXRF problems**

The PXRF developed a fault before measurements of the non-TGIC spraying oversuits were completed. It manifested itself as increasingly negative results for some of the elements whilst other elements were unaffected. Comparison of the ratios of titanium and calcium present on the gloves and oversuits showed that four suits had been affected and these results were withdrawn, there being no time to completely remeasure them. Gloves that had been measured just before repair were re-measured, which exonerated all glove measurements before repair, identified the moment that the fault occurred and acted as a reproducibility check on the handling, analytical and tessellation method.

The rest of the gloves were all re-analysed again, which confirmed positive (>LOQ) glove results previously obtained using powders at factories A and S. Results were generally slightly lower the second time (80–100%), which may have been caused by occasional loss of powder from the gloves through extra handling. Gloves were not treated with hairspray as the oversuits were, which in retrospect was a mistake. However, the need for the hairspray can be gauged from this exercise, as it would have reduced losses from the 0–20% found here. The original set of glove results are quoted in this paper.

**Limits of detection and quantification using Dirichlet tessellations**

The Dirichlet tessellation method relies upon 104 individual measurements over the surface of a single oversuit. To calculate the LOD and LOQ six blank oversuits were measured for all elements simultaneously. Each measurement had its own error, which could be quite large relative to the single reading, but 104 repeat readings over a blank oversuit reduced the standard error of the mean by a factor of 10 compared with an individual reading. The between-suit standard deviations were calculated from the six blank suit means and the LOD and LOQ levels were calculated.

LOQs were calculated as 10 times the standard deviation (SD) of the blanks or as the lowest calibration point when all blanks were less than the instrument detection limit. LODs were calculated as 3 times the SD of the blanks. Where the results were <LOD they were assigned values of ½ LOD (Table 4). By convention, the value of ½ LOQ, which is equal to 5 times the blank SD, is often assigned to results <LOQ, but there was no reason not to report our best estimates here that were between 3 and 10 times the blank SD. Therefore, where the results were >LOD but <LOQ, the measured value was retained. The results are presented for whole-body oversuits measured as one piece. Gloves were treated in a similar

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**Table 4. Summary of surface loading rates in µg/cm²/h for all scenarios assigning results <LOD as ½ LOD and including results <LOQ**

<table>
<thead>
<tr>
<th>n</th>
<th>No. &lt;LOD</th>
<th>No. &lt;LOQ</th>
<th>Median</th>
<th>AM</th>
<th>SD</th>
<th>GM</th>
<th>GSD</th>
<th>Range 75th percentile</th>
<th>95th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling time</td>
<td>25</td>
<td>28</td>
<td>38</td>
<td>29</td>
<td>29</td>
<td>2.1</td>
<td>9–90</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>Body potential</td>
<td>22</td>
<td>1</td>
<td>3</td>
<td>48</td>
<td>150</td>
<td>230</td>
<td>43</td>
<td>6.0</td>
<td>1.3–750</td>
</tr>
<tr>
<td>Hands potential</td>
<td>23</td>
<td>2</td>
<td>4</td>
<td>400</td>
<td>7100</td>
<td>13 500</td>
<td>970</td>
<td>8.6</td>
<td>67–52 000</td>
</tr>
</tbody>
</table>

Results <LOQ are assigned their measured value as a best estimate. Sampling time is in minutes. Hand area was taken to be 820 cm². The oversuit areas ranged from 26 700 cm² for a size L to 34 000 cm² for a size XXL. Surface loading rate is taken to be the mass measured on the entire oversuit divided by its area, divided by the sampling time.
fashion, but as there were only 12 readings per glove, the LOD and LOQ are relatively high.

RESULTS AND DISCUSSION

Results were all corrected for analytical recovery efficiency. OECD guidelines state that correction must be made outside the 80–120% region, but do not forbid it inside. The results are shown for individuals in Fig. 2a for oversuits and Fig. 2b for gloves, with the relevant analyte marked for each sample. They are shown by analyte and factory in Fig. 2c for oversuits and Fig. 2d for gloves and summarized in Table 4. The results are calculated in terms of dust formulation only from those analytes. Results in all cases were better described by log normal than by normal statistics, so Table 4 also shows geometric means and geometric SD values. All results are shown as surface loading rates in terms of the formulation used in order to allow comparison of different sampling times and different analytes. This makes the assumption that loading occurred in a linear fashion over the sampling time.

The total body results for barium were significantly higher \( (P = 0.001) \) than for TGIC and titanium (Fig. 2). Figure 3a shows the distribution of barium contamination over oversuit A7. There is heavy barium contamination only on the insides of the sleeves at the cuffs. This was characteristic of one subject because the sleeves were held inside the window of the conveyorized tunnel enclosure. The other two subjects used titanium at Factory C in open booths, and consistently showed less total contamination than at Factory A, although it was spread over the body. One of these two (C1) had leg but no sleeve contamination (Fig. 3b), which was characteristic of all four of his repeat samples. He sprayed various objects that were all sat on a table at waist height. The other subject (C2) was contaminated mainly on the legs, but dust was also present on the sleeves (Fig. 3c). He sprayed a number of coat-hangers on a hook at chest level.

Subject Co6, who rotated the workpiece with his hand whilst spraying, was the only one classed as spraying at less than arms length, but in fact had the lowest measured body and hand contaminations.

Glove surface loading rates were ~10 times higher than the body (oversuit) rates for TGIC and titanium and 40 times higher for barium (at Factory A). Body and hand measurements correlated well using Pearson’s correlation \( (r = 0.67) \), as shown in Fig. 4, especially for the subject at Factory A where body contamination was mostly on the sleeves (Fig. 3a). The results for TGIC and titanium covered similar ranges for both hands and gloves where the types of booths were similar. It is reasonable to assume that the range of surface loadings were also similar, even if their distributions over the body may have been
Fig. 3. Distributions of dust on spraying oversuits. (a) Subject A (barium) in terms of dry powder paint formulation. Result >LOQ. Hands and sleeves were held inside a conveyorized tunnel enclosure. (b) Subject C1 (titanium) in terms of dry powder paint formulation. Result >LOQ. Open booth. Spraying objects at waist level on a table. (c) Subject C2 (titanium) in terms of dry powder paint formulation. Result >LOQ. Open booth. Spraying coat-hangers at face level on a hook.
different. If that is the case, the range of likely surface loadings of TGIC itself may be inferred from the individual PXRF titanium dust measurements on the seven titanium workers oversuits. The median and 95th percentile surface loading rates for the 728 individual titanium workers oversuits. The median and 95th percentile body surface loadings of TGIC content, over an 8 h shift, this is equivalent to median and 95th percentile body surface loadings of −0.7 and 6.5 µg TGIC/cm² on the skin and clothing of the worker. Hand loadings were 10 times higher than that. These are high levels for a known skin sensitizer and measures should be taken to reduce the exposure.

Air samples

Personal inhalable air samples were taken at Factory C for the whole duration of the visit using IOM samplers with GFA filters and assessed gravimetrically according to a standard method (MDHS 14/3). General workplace dust was also sampled, not just paint dust. Air concentrations of total dust were low in all cases, ranging from 2.8 to 3.6 mg/m³. The results cannot be attributed solely to the spraying task, because they also covered the time involved in loading and cleaning the spraygun and changing the workpieces.

Limits of detection for PXRF

LOD is defined as 3 times the SD of n blank readings, where n is six or more. There is 99% confidence that a result equal to the LOD truly exceeds the background (Keith et al., 1983). In the 11 patch method, LOD and LOQ are applied to each individual sampler and scaled up to a standard body area, so each subject’s summed result may consist of a mixture of <LOD, <LOQ and ≥LOQ results, which causes problems in interpretation of whether a subject is, overall, >LOD or not. In this study a single measure of LOD or LOQ was obtained from statistical treatment of 104 results (12 for gloves). Although there is a clear, single value, mappings of results <LOD (not shown) still clearly identify local areas of contamination above the background.

A whole oversuit may scale down to standard body size, but it is not possible to scale each body part from parts of the whole oversuit. With the PXRF, the statistical distribution of blanks is well characterized. A result greater than 3 times the SD of n sets of m blank readings (as used here) gives a 99% chance that a single set of m results truly exceeds 0. There is an opportunity to minimize the LOD by investigating the relationship between n and m in future. Here, the LOD was reduced by measuring 104 samples on each oversuit, but not by the factor of 10 that might be expected because daily variations in the instrument added a small contribution to the SD of n blanks. For smaller glove areas with only 12 measurements the LOD was higher.

CONCLUSIONS

The measured values were high for a known skin sensitizer and measures should be taken to reduce the exposure to TGIC. It should not be difficult, for example, to develop an electrically conductive glove suitable for use with electrostatic sprayers that would eliminate static shocks and thus increase worker acceptance of gloves. Behaviour was observed such as leaning inside an enclosed booth that is expressly described as bad practice in guidance, although this was exceptional. A more worrying observation, at one factory only, was that the operatives sometimes did not know whether they were using a paint that contained TGIC or not.

The Dirichlet tesselation method has been considerably developed here for field use in conjunction with the PXRF. LODs have been considered and the method extended to gloves. The 104 sampling points offer better representation of the body surface than the 11 points of the OECD patch method. One of its benefits is the range of substances detected simultaneously. One of its drawbacks is its lack of sensitivity relative to wet chemical extraction methods.

In retrospect, we should have adopted a handwashing method when gloves were refused, but no methodology was available on site at the time. Gloves were accepted in the pilot visit before the main study took place, so the need for a handwashing method was not apparent. Both methods would have provided suitable potential and actual dermal exposure measurements, but if both had been adopted interchangeably, the mixture of sampling efficiencies and retention characteristics that would have ensued would have been difficult to compare. Any dermal exposure measurements using surrogate skin sampling media such as patches, oversuits or gloves raises the question of sampling efficiency and retention relative to the skin. The different media used by partners in

![Fig. 4. Pearson correlation between hands and body (r = 0.67).](Image)
Dermal exposure to dry powder spray paints

the RISKOFDERM project to sample dermal exposure may have measured in a similar fashion to each other, but none of the samplers necessarily resembled the skin, particularly for dusts, where little is known about the relative differences in retention characteristics of skin and materials (Roff and Griffiths, 2002). The retention of dust on the oversuits was enhanced by the use of hairspray, but this still leaves the comparison with the skin unresolved.

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