

Biological Monitoring for Isocyanates

Employers – Guidance for Employers and Occupational Health Providers on the analysis of workers' urine to assess exposure to isocyanates

What is the problem with isocyanates?

'Isocyanates' occur in many 2-pack (2K) paints and other products. Breathing in isocyanates is the top cause of work-related asthma in Britain. If you get asthma from isocyanates, you won't be able to work with them again.

As an employer, you have a [duty](#) to control adequately your workers' exposure to isocyanate. For example, you may be providing ventilated spray booths, air-fed breathing apparatus and extracted gun cleaners. But how can you be confident that your employees are safe, particularly as sprayers are engulfed by invisible mist when spraying and you are relying on correct behaviour as well as equipment maintenance to prevent exposure? Your industry has [agreed](#) that the best and simplest way to do this is by analysing your worker's urine for traces of isocyanates ([biological monitoring](#)).

If you use isocyanate-based products, you normally need a health surveillance scheme. Your surveillance scheme provider can help you with biological monitoring although it is also possible for you to run the programme yourself – please refer to HSE [guidance](#) to ensure you set it up properly. There is a biological monitoring guidance value for isocyanate traces in urine. The value is "1 micro mol urinary di-amine per mol creatinine" for a urine sample collected at the end of the task. Most workplaces using good control can get below 1. The guidance value is about exposure control, and it has no direct meaning for health.

Why analyse urine?

The body breaks down any isocyanates that are breathed in and quickly eliminates them (as di-amines) in urine. The more isocyanate is breathed in, the more di-amine there is in urine. If controls are working correctly – e.g. the breathing apparatus is working and used properly - the workers will not breathe in any isocyanate, and we will not find any di-amines in urine.

Who needs monitoring?

You should monitor all workers who may breathe in isocyanates. In MVR bodyshops this normally means the sprayers.

Is it compulsory?

Employees may refuse to give a sample. Hopefully, if you explain why the sample is required and assure them that nothing else is checked for, their concerns will be addressed. Nevertheless, legally, they must cooperate with you so that you can fulfil your health and safety duties. If your COSHH risk assessment indicates that monitoring of exposure is

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necessary to ensure your controls measures are working (and for spraying isocyanates in a spray booth/room, it should) then you have a legal duty to monitor (unless you can demonstrate compliance by some other method of evaluation). We are not aware of any other procedure that can demonstrate this compliance. Consequently, monitoring requires their cooperation.

Will anything else be measured? No. The laboratory will only analyse your sample for isocyanate breakdown products and a substance called creatinine. Creatinine is in everyone's urine, and it is measured to check the sample is urine (and not water) and to adjust the result for hydration level (a balance between fluid intake versus losses due to physical effort, sweating etc.). The laboratory will not analyse your sample for drugs, alcohol, pregnancy, HIV or anything else.

If, after explaining all of this to the employee, they still refuse to cooperate you will need to decide whether you are prepared to place yourself in breach of the regulations or take further action. You may wish to discuss this with your local HSE inspector. Ultimately, you may decide to move the employee to a position where they are no longer potentially exposed to isocyanates.

Informed consent

It is important that your workers understand what is being done and why, so they can give informed consent; again, your health surveillance scheme provider can help you with this.

- You need to explain to workers that you are checking the controls to prevent exposure to isocyanates that could give them asthma. This will normally be done once a year unless the results show there is a problem.
- Ask them to provide a urine sample at the end of a typical spray session using isocyanate products.
- Tell them that only things related to isocyanates ('biomarkers') will be measured in the sample - not drugs, alcohol etc. (they have not given permission and you are not paying for it).
- Ask them if they will let you see their results because if there is a problem you will need to work together to resolve it.
- Tell them that the results will not say anything about their health or risk of ill-health, only their exposure.
- Tell them that if the results show controls are not working properly, you will both need to find out why, sort it, and then check with a further urine sample.

How to collect samples

- We provide 30ml plastic bottles containing a small amount of white powder (citric acid) as a preservative.

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- The worker should direct a sample of urine into the bottle at the end of a work session and close the bottle firmly. Instructions for workers can be found [here](#).
- Label the bottle with a unique identifier such as initials, employee number or a bespoke code. If sending multiple samples from the same individual, also add the date and time of collection.
- Complete the sample request form and tell us where to send the results.
- Put the bottle and form in our packaging, following the supplies instructions to prevent leaks.
- Send it to us by first class post. Further details on [collection](#) and [shipment](#) can be found on our website.

Will anything else be measured?

No. The laboratory will only analyse the sample for isocyanate breakdown products and creatinine to check the sample is urine (and not water) and to adjust the result for hydration level. The laboratory will not analyse the sample for drugs, alcohol, pregnancy, HIV or anything else.

How often should we monitor?

It depends. Take several samples, until you are confident about your controls.

- With results that fall at or below the guidance value, sample once a year unless work practices change or you employ new workers.
- With results that are above the guidance value, investigate, make changes, and take more samples. Sample until you have confidence in the control measures.

You should normally consider your biological monitoring programme to be a continuous cycle of testing, evaluating and (if necessary) making appropriate improvements.

Occasionally exceeding the guidance value is unlikely to result in significant health impacts, but it may indicate that exposure control can be improved.

For most workplaces, with adequate exposure control, annual testing should be sufficient. It is important to collect samples for biological monitoring on a day when the individual has been using isocyanates. The sample will reflect only that day's exposure, so we want the sample to represent 'typical' exposure.

Most elevated biological monitoring results are due to failure of exposure control measures or training but occasionally, a result can reflect non-workplace exposure or co-exposure to other chemicals that may be present in industrial or DIY products (e.g. diamines). If initial investigations do not find an exposure control issue, then it can be useful to check product data sheets or discuss other potential exposure sources with the individual (only the day or two prior to sample collection would be relevant). Your analytical laboratory or occupational health advisor may be able to offer advice.

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You should only request analysis for isocyanates that are actually being used on the day of sampling.

The laboratory will report your results something like this:

| Worker reference | TDI μmol/mol creatinine | HDI μmol/mol creatinine | IPDI μmol/mol creatinine | MDI μmol/mol creatinine |
|------------------|----------------------------|----------------------------|-----------------------------|----------------------------|
| AB82 | ND | ND | ND | ND |
| CD79 | ND | 0.5 | ND | ND |
| EF96 | ND | 2 | ND | ND |
| Guidance value | 1 | 1 | 1 | 1 |

The columns show the breakdown products of different types of isocyanates.

- Toluenediisocyanate (TDI) breaks down to toluenediamine (TDA)
- Hexamethylenediisocyanate (HDI) breaks down to 1,6 hexamethyldiamine (HDA)
- Isophoronediiisocyanate (IPDI) breaks down to isophoronediamine (IPDA)
- Methylenediphenyl diisocyanate (MDI) breaks down to methylenedianiline (MDA)
- All the common isocyanates are shown here for illustrative purposes, but you should only monitor for the ones that you use.

The levels of the diamines are reported as “μmol/mol creatinine” (micro mol/mol creatinine). Creatinine is found in everyone’s urine and is used to adjust the level of diamines to compensate for dilute or concentrated urine.

If the results are ‘**ND**’ (like AB82 above), or are at, or below, the guidance value of 1 micromol urinary diamine per mol creatinine (like CD79 above), your controls in place on the day of the sample are adequate. Keep an eye on the controls, and your workers’ use of breathing apparatus. Send new samples in a year’s time. If something changes, or you have new workers send in samples before the annual check.

If the results are above the guidance value of 1 (like EF96 above), your controls may be inadequate or else not used properly. Check that everything is working. Consider:

- Carrying out a new clearance time test with smoke, which will also reveal if the booth/room is leaking.
- Is the air-line breathing apparatus being maintained and are workers using it properly?
- Has the breathing air quality and quantity been tested recently?

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- Are sprayers lifting their visors or take off their breathing apparatus before the spray booth or room has cleared?
- Could exposure be occurring some other way e.g. during gun cleaning?

Repair anything that needs it and/or advise workers on using the controls and breathing apparatus then collect fresh samples. It is a [requirement](#) that you train your workers to use isocyanates safely.

If the result is the first from a worker, then it is sensible to ask for another sample for confirmation. It should be noted that because the guidance value is based on the value found in 9 out of 10 samples in places with good control it is likely that 1 in 10 values will be above the guidance value even in places with good control.

A result above 1 does not mean your worker will get asthma, but it may mean that controls are not working properly and should be reviewed.

Further information

INDG388 (2014) Safety in isocyanate paint spraying (<https://www.hse.gov.uk/pubns/indg388.PDF>)

Guidance on working with 2-pack isocyanate paints
(<https://www.hse.gov.uk/construction/healthrisks/hazardous-substances/isocyanates.htm>)