# The Workplace Analysis Scheme for Proficiency

(WASP)

Information For Participants

## Preamble

This guide provides participants with information concerning the WASP PT scheme. A condition of joining the scheme is that participants abide by the HSL terms and conditions, abide by the scheme rules and fulfil their responsibilities within the scheme.

The guide should therefore be read in conjunction with the HSL standard terms and conditions and vice versa.

## Issue status

| Issue | Issue Date | Amendments | Authorised by |
|---|---|---|---|
| 12 | 26/05/2011 | Update on confidentially clause and data summary for Defra<br>Text errors found in Issue 11 corrected | O. Butler |

**Note:** Latest issue supersedes all previous issues.

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# WORKPLACE ANALYSIS SCHEME FOR PROFICIENCY (WASP)

## 1 Background

Proficiency testing (PT) is defined in ISO/IEC 17043[1] as the evaluation of participant performance against pre-established criteria by means of interlaboratory comparison.

The origins of the Workplace Analysis Scheme for Proficiency (WASP) lie in a small internal comparison that was set up to serve, at that time, the eight Health and Safety Executive (HSE) regional laboratories carrying out occupational hygiene analysis. It was decided to then expand the scheme and the first round of WASP samples was issued to external laboratories in September 1988. Interested participants can find more about the origins of the scheme in a paper by Jackson and West [2].

## 2 Scope and Purpose

WASP is designed to provide external quality assurance for laboratories carrying out chemical analysis of air samples taken in the workplace environment and the wider ambient atmosphere.

In the United Kingdom, the Control of Substances Hazardous to Health (COSHH) Regulations [3] requires that where hazardous materials are used a risk assessment be carried out to ensure that personal exposure is minimised. This may include measurement to assess exposures and test the effectiveness of containment or ventilation. The results of these tests are often used to make decisions that have significant implications for the operation of a particular workplace. Similarly occupational hygiene measurements are carried out elsewhere in the world for similar purposes.

It is therefore vital that the measurement results have sufficient integrity. Many factors contribute to a meaningful test, such as choice of where and when to sample, performance of sampling equipment and the analysis subsequently carried out back in the laboratory. Control of all these factors is important and the WASP scheme provides a means of assessing the quality and performance of the analytical steps carried out in a laboratory.

More specifically the scheme is designed to help laboratories meet the criteria in European Standard EN 482 [4] for occupational hygiene assessment which states that contribution of the overall errors for both sampling and analysis should not be greater than ± 30 % around the exposure limit value and ± 50 % at less than half the limit value.

In the WASP scheme the EN 482 criteria has been interpreted in the following way; the contribution of the errors in analysis can be expressed mathematically as:

$$\sigma_{Total} = \sqrt{\sigma_A + \sigma_S}$$

where

$\sigma_A$ is the analytical contribution and

$\sigma_S$ is the contribution from sampling

If it is assumed the sampling uncertainty is large and constant, there will be a point above which any further improvements in analytical uncertainty will not significantly improve the total uncertainty. Mathematically this is about a quarter of the overall uncertainty. For an overall uncertainty of ± 30 %, this level is about 8%. Most performance limits (satisfactory performance) in WASP are therefore set at this level if it is analytically achievable.

It is important to realise that the scheme alone cannot monitor day-to-day quality; each laboratory needs to devise its own system for achieving this according to its own work pattern. WASP will, however, provide an externally verified indication of performance that analysts can use to satisfy themselves, their organisation, and their clients that the quality of their analyses are fit for purpose. It is also a requirement of accreditation to ISO/IEC 17025 [5] that laboratories take part in a suitable PT scheme where available.

**Note:** Participation in the WASP PT scheme does not constitute recognition or approval of a laboratory by the Health and Safety Executive (HSE) or the Health and Safety Laboratory (HSL). Likewise participation in the scheme does not confer accreditation upon a laboratory.

# 3 Organisation of the WASP PT scheme

## 3.1 Management of the WASP scheme

Responsibility for the day-to-day running of the scheme rests with the Health and Safety Laboratory (HSL), in particular, the proficiency testing team, which undertakes the recruitment of new laboratories; preparation and dispatch of test samples; data processing of results; reporting laboratory performance and general liaison with participants.

The scheme employs the use of a scheme administrator and a scheme technical manager. The administrator role is to act as a conduit between HSL and participants and to co-ordinate all administrative issues associated with participation. The scheme technical manager coordinates the production and the validation of test samples; prepares the proficiency test reports and deals with any technical issues or queries from participants.

To ensure confidentiality, each laboratory is identified by a laboratory code known only to HSL staff directly involved in the administration of the scheme.

**Note:** Historically WASP was promoted by HSE's Committee on Analytical Requirements (CAR), and was guided by a Steering Committee, which was a sub-committee of CAR. The Steering Committee had an HSL chairman and representatives from the following interested organisations:

**HSE** (Health & Safety Executive)
**BOHS** (British Occupational Hygiene Society)
**IOH** (Institute of Occupational Hygienists)
**RSC** (Royal Society of Chemistry)

The demise of CAR and changing demographic makeup of WASP participations, wherein most participants now reside outside the UK, necessitates that a new approach be implemented. HSL is currently reviewing potential options on the reconstitution of a suitable steering committee.

## 3.2 Scheme Quality

HSL operates to the ISO 9001 standard [6] with a medium term aspiration of operating the WASP scheme to the ISO/IEC 17043 standard [1].

All test samples, except the WASP $NO_2$, are prepared and validated in-house by experienced chemists using analytical procedures using published standard methods. Currently, the analysis of the WASP VOC test samples by thermal desorption is carried out using a GC method accredited to the ISO/IEC 17025 standard [3]. Further details regarding the preparation and validation of test samples can be found in Appendix 3.

Participants requesting further information regarding HSL and its quality system are directed in the first instance to the HSL website.

**Note:** HSL is implementing a new WASP PT scheme software system in 2011 which meets key requirements set out in ISO 13528 [7] and by default to certain requirements set out in ISO 17043 [1].
**Note:** HSL Quality Information page can be accessed here at http://www.hsl.gov.uk/about-hsl/quality.aspx

## 3.3 Confidentiality

All paper and computer records are securely maintained by the HSL proficiency testing team. Access is strictly limited only to those HSL staff members directly involved in the delivery of the schemes.

Results are submitted to the WASP scheme in confidence and are not revealed to any third party. However some exceptions currently exist

- HSL is an agency of the Health and Safety Executive (HSE), the UK regulator for health and safety, and may be asked to provide pertinent information if requested as part of a criminal prosecution.

**Note:** A scenario where this may occur is if HSE were to be involved in a criminal prosecution against a company wherein a laboratory, internally or contracted to this company, being a WASP participant, was used to provide occupational hygiene measurement data. In such a scenario, HSL, through the

proficiency testing team, may be asked to provide, if available, any information regarding the quality of this laboratory performing measurements, which may form a part of the investigation.

- Round data from AIHA accredited laboratories that participate in the WASP scheme is provided to the AIHA PAT proficiency testing management team on a biannual basis. AIHA PAT recommends participation in the WASP PT scheme for samples/measurands not offered within their own PT scheme. As such, participation in the WASP scheme can be considered as an extension to the mandatory participation in the AIHA PT scheme for such laboratories.
- HSL has an arrangement with Defra wherein PT performance data from UK based WASP laboratories that subscribe to the $NO_2$ sample is supplied to them. Such laboratories may undertake local authority air quality monitoring measurements, data from which can be collated in air quality reports, which are in turn are supplied to and used by Defra. In turn local authorities, air quality experts and other stakeholders need to have confidence in the analytical quality of such laboratories. To assist this process, summary laboratory performance in WASP $NO_2$ is therefore published on the Defra Local Air Quality Management (AQM) webpage.

**Note:** Defra AQM webpage can be found here at http://laqm.defra.gov.uk/diffusion-tubes/qa-qc-framework.html

## 3.4 Scheme Overview

### Sample types

The current range of test samples types offered as part of the proficiency test service include

- Metals on filters
- Metals in (bulk) welding fume*
- VOC on charcoal and tenax sorbents
- Respirable silica on filters
- Nitrogen dioxide (as nitrite) on passive Palmes-type diffusion samplers
- Formaldehyde (as DNPH-adduct) on filters
- Gravimetric (using sodium borate as a surrogate mass) on filters.

This range represents a good cross section of sample types typically measured in an occupational hygiene setting and also reflects a good cross section of analytical techniques and methods typically used in laboratories undertaking such analysis.

Further details regarding these sample types, measurands, indicative loading ranges and preparation details can be found in Appendix 4.

***Note:** welding fume sample is currently free to subscribers of the metal on filters sample type.

## Scheme frequency and timescales

Sample distribution (rounds) for the above sample types are sent approximately every 3 months to subscribing laboratories in the scheme. Hence laboratories that subscribe for the full period of 12 months will receive four sample distributions.

**Note:** The gravimetric sample and welding fume sample types are currently distributed biannually on a two round distribution.
**Note:** From April 2011, the welding fume sample type will be distributed one a one round per period basis
**Note:** Distribution schedules are made available in advance on the HSL WASP Proficiency Testing webpage.
**Note:** For a variety of reasons, distribution schedules can change and participants affected are informed of such changes by email.

## Sample distribution

HSL currently use Royal Mail Parcel Force to distribute test samples to participants. Subscription fee includes relevant distribution costs.

From April 2011, Parcel Force will be used to distribute test samples to participants in the UK and EU member states. A specialised courier will be used to distribute test samples to participants in other countries.

**Note:** Indicative Parcel Force transit times are as follows

- United Kingdom participants 2- 4 working days
- European participants 4 – 6 working days

**Note:** Indicative courier transit times are as follows

- Australia, Japan, New Zealand, South Africa, US: 2 – 5working days
- Other countries upon request

**Note:** Transit times in working days pending customs
**Note:** Participants should ensure that any required paperwork/permit application is in place, if requested by HSL or its nominated courier, to allow samples through national boundaries/customs. Failure to do so may result in delays in sample shipment.

## Sample composition within a round

In each distribution (round) participants receive four test specimens of each sample type that they have subscribed to. Each test specimen will contain one or more measurands (analytes) prepared at different test loadings (spike levels), and an appropriate number of blank media.

Further details regarding these sample types, measurands, indicative loading ranges and preparation details can be found in Appendix 4.

**Note:** The welding fume test sample is distributed on a two-sample basis for a number of measurands.

**Scheme operation**

Each PT round consists of the following steps:

- Preparation of test materials (see Appendix 4)
- Dispatch of test materials
- Participants analyse test materials for selected measurands and report results back to HSL by a given date using reporting templates supplied by HSL. The schedule is such that laboratories have at least 20 working days upon receipt to analyse the samples and to report their results.
- Results are processed by HSL (see Appendices 1 and 2)
- Distribution of test reports to all participants. Generally reports are issued within a month of the PT round closing date. For a variety of reasons, test reports can sometimes be delayed and participants affected are informed of such changes by email.

# 4 Participation in the WASP PT scheme

WASP is open to any laboratory involved in the chemical analysis of air samples. The membership fee covers one-year subscription (April – March). New participants joining the scheme part way through this period pay on a pro-rata basis for the remainder of the particular subscription period.

Included in the subscription fee is

- Provision of test samples for analysis including dispatch fees per distribution
- Provision of a participant performance report per distribution

**Note:** With the gravimetric test sample, participants have to send back per weighed filters to HSL for spiking at their own expense.
**Note:** Replacement test samples send to participants replacing original samples damaged, lost or contaminated in a participant's laboratory will be sent by courier and will incur additional fees.

Participants upon joining agree to abide by the rules and regulations of the scheme and the associated HSL terms and conditions. Details can be found in Appendix 4.

Participants can subscribe to sample type/measurands that meet their particular needs. Participants are free to use whatever methods of analysis they wish but it is preferable to use methods commonly used on routine samples within the laboratory.

# 5 Performance assessment and reporting

The statistical protocols used in the WASP PT are summarised in Appendix 2 and in more detail in Appendix 3.

**Participant report**

Following data analysis, participants will received a report containing

- Round cover letter
- Round summary information report
- Individualised performance information report

Details are presented in Appendix 1.

# 6 Queries and feedback

Administrative queries should be directed to the scheme administrator by email, phone or letter. Email is the preferred option.

Queries of a technical issue, including participants seeking measurement advice, should also be directed to the scheme administration. Once logged, the query is passed onto the scheme technical manager to progress.

**Note:** Technical queries by their nature may be complex. Hence the scheme technical manager may need to confer with other measurement experts from within HSL, which may add to the turnaround time in responding.
**Note:** The scheme welcomes feedback and suggestions regarding possible developments of new sample types, improvements in current sample types etc.

# 7 Complaint procedure

Participants can raise complaints encountered when participating in the scheme. Complaints should be addressed to the scheme technical manager, in writing, via the scheme administrator. The technical manager will attempt to resolve any issues arising to the satisfaction of the participant. If the response is unsatisfactory, participants can request to appeal and raise a formal complaint through the HSL formal complaints procedure as detailed in HSL's quality system.

**Note.** This complaint procedure will be revised if and when the WASP scheme re-establishes a WASP steering committee.

# 8 Advertising and endorsement

It is recommended that any publicity and advertising material should describe the laboratory as '***a WASP PT participant***' and state the sample type / measurands for which they participate. Participants may wish to describe their level performance as '***WASP participant with good or satisfactory performance***' if they achieve these categories, but may only do so for the period of participation in which their laboratory achieved this status.

**Note.** Participation in the WASP PT scheme does not constitute recognition or approval of the laboratory by the Health and Safety Executive (HSE) or the Health and Safety Laboratory (HSL). Likewise participation in the scheme does not confer accreditation upon a laboratory.
**Note.** Any misrepresentation could result in the removal of a participant from the scheme.

# 9 Advice and training

The WASP PT scheme is a performance based scheme and does not specify a particular analytical method to be used. A laboratory should use the same analytical procedures when analysing the WASP samples that it would use when analysing routine air samples.

Advice on method selection can be obtained from the scheme technical manager via the scheme administrator.

**Note:** Technical queries by their nature may be complex. Hence the scheme technical manager may need to confer with other measurement experts from within HSL, which may add to the turnaround time in responding**.**

Training samples, surplus samples from previous WASP rounds, are also available for laboratories wishing to take corrective action and/or training of new staff. Please contact the scheme for further details.

From time to time HSL publish scientific peer reviewed papers on various aspects of the WASP scheme. A listing of these papers will be made available on the HSL WASP website.

# 10 Scheme contact details

For all enquiries, including applications to join and changes in sample requirements, please contact:

WASP Scheme Administrator
Proficiency Testing Team
The Health & Safety Laboratory
Harpur Hill
Buxton
Derbyshire
SK17 9JN
United Kingdom

Telephone: +44 (0)1298 218553 (answer phone backup)

Facsimile number: +44 (0)1298 218572

Email:- proficiency.testing@hsl.gov.uk

Web:- http://www.hsl.gov.uk/centres-of-excellence/proficiency-testing-schemes/wasp.aspx

# APPENDIX 1

## Summary statistical protocols and customer reports

## Introduction

The treatment of returned results is considered at two levels: the first for those participants whose concern is for a straightforward assessment of their performance and the second for participants with a greater knowledge of statistics and an interest in gaining the maximum information from the data. An explanation of the WASP statistical treatment is given below. For those with knowledge of statistical techniques, a more formal and expanded statistical protocol is also presented in Appendix 2.

Please note that the current statistical approaches used for WASP $NO_2$, gravimetric and bulk welding fume samples are different to the main WASP protocol. These are also presented in this appendix.

## Main WASP statistical protocol

### Processing Raw Data

For each loading of each measurand, a 'true' (assigned) result is calculated by taking the mean of all laboratories results after excluding outliers. Individual results are ratioed to this mean result to give standardised results, which should lie close to 1.00.

### Treatment of Outliers

To ensure that results widely different from the norm do not unduly influence the calculation of the mean, it is necessary to have a procedure to identify extreme results and exclude them from the calculation of this mean. This will be done by defining outliers as results outside of a range around the nominal (target) loading value. The nominal loading value for a particular measurand is determined from the mean value of test samples analysed at HSL as part of the sample homogeneity testing.

Participant results that are deemed to be outlying results will not be used in the process to calculate ‘true’ (assigned) result but will still be used to calculate performance indices for that participant as described in the next section.

## Calculation of Performance Index (PI) and Running Performance Index (RPI)

For each measurand reported by a participant, a Performance Index (PI) is calculated for that round. The basis of the performance index for a given laboratory, round and measurand is the calculation of the sum of the squared deviations from 1.00 of the standardised results, divided by 4. This is equivalent to the variance of the standardised results about 1.00.

To avoid using small numbers, this index is arbitrarily multiplied by 10,000 to give the reported PI, which is then rounded to the nearest integer. The lower the index, the better the performance. A ceiling value is placed on some very high PI values when plotted on the report charts (scaling effect), but the actual participant PI obtained will be reported.

In addition, a Running Performance Index (RPI) is calculated by averaging the performance indices for the best four from five rolling rounds of WASP. This allows a laboratory an ability to disregard a poor(er) round. Should a laboratory for any reason fail to report data for one round, the latest '4-rounds' results will be used to calculate an RPI. However, more than one round 'gap' in a 5-round rolling period will mean that no RPI can be calculated and hence reported.

The square root of this score is an estimate of standard uncertainty in terms of the percentage standard deviation (%RSD) over the analytical range for this measurand (see Appendix 3). Laboratories can use such values to calculate in-house uncertainty estimates.

## Performance categories and classification

Because the quantity of data going into the single round is small, only four measurand results, the uncertainties in using the PI as a measure of underlying performance are rather high. Therefore, only the RPI, with 16 results contributing (4 measurand results from the best 4 rounds available), is used to assign laboratories to a performance category for each measurand.

**Note:** This categorisation is on a measurand -by -measurand basis; no attempt is made to combine results from more than one measurand into a global classification.

For each measurand, a running performance index reference value (reference RPI) has been set, based initially on data available from historical performances of laboratories in similar proficiency testing schemes, other method intercomparisons or round robins or reference material certification studies.

**Note:** Reference RPI values are subject to periodic review by the WASP scheme.

The upper and lower 95% points of the theoretical distribution of RPI produced by a laboratory operating consistently at the reference RPI value are used to divide such RPIs into three categories designated:

- Category 1 (good performance),
- Category 2 (satisfactory performance) and
- Category 3 (not satisfactory performance).

A laboratory's performance is categorised according to where its calculated RPI falls relative to these boundaries.

| | | **Performance Limits** | | |
|---|---|---|---|---|
| **Sample/measurand** | **RPI Reference Value** | **"Good"**<br><br>**Category 1** | **"Satisfactory"**<br><br>**Category 2** | **"Not Satisfactory"**<br><br>**Category 3** |
| Metals on filters | 36 | < 16 | 16 - 65 | > 65 |
| Benzene, toluene, xylene on charcoal or Tenax TA at occupational levels | 36 | < 16 | 16 - 65 | > 65 |
| Ethyl benzene on charcoal or Tenax TA at occupational levels | 79 | < 34 | 34 - 142 | > 142 |
| Benzene, toluene, xylene and ethyl benzene on Tenax TA at environmental levels | 169 | < 73 | 73 – 310 | > 310 |
| 111 trichloroethane, trichloroethene, tetrachloroethene on charcoal | 36 | < 16 | 16 - 65 | > 65 |
| Quartz on filters | 120 | < 52 | 52 - 216 | > 216 |
| Formaldehyde 2,4 DNPH on filters | 183 | < 79 | 79 - 330 | > 330 |

These categories can be interpreted in layman's terms as

- **Good** – analytical performance is good
- **Satisfactory** – analytical performance is satisfactory but improvements could be made
- **Not satisfactory** – analytical performance is not satisfactory and effort is required to improve performance i.e. method change, method optimisation, and/or staff training etc.

**Further Statistical Information**

The percent co-efficient of variation, based upon the standard deviation of 16 results from the latest four rounds is provided as an additional statistic.

Additional parameters for the mean deviation and within round variance (DELTA and SSW) are provided on the report sheet to enable further statistical tests for bias, etc. to be made by participants if they so wish. These are explained in detail in Appendix 3.

## Participant reports

Following data analysis, customer will received a report containing

- Round cover letter
- Round summary information report
- Individualised performance information report

**Round cover letter**
A cover letter detailing some generic feedback on the progress of the round from the scheme technical manager

**Round summary information report**
The round summary information tabulates the following information

- the percentage of participating laboratories that can be classified as “1 - good” “2- satisfactory” or “3 - not satisfactory” based upon calculated PI scores for that particular round for a selected sample type/measurand combination.
- A similar percentage breakdown is also tabulated for those participants that have participated in sufficient rounds to obtain a RPI score.
- Measurand specific information including target (nominal loading) values; assigned values; an assigned/target ratio; variance of all participants results for a measurand; number of participating laboratories and a median and mean PI for each measurand from all laboratory data (excluding outlier laboratories).

**Individualised performance information report**
Participating laboratories are provided with an individualised report (see Figure 1), on a measurand by measurand basis, detailing:

- the results they have submitted, the assigned values, the percentage difference and the standardised values.
- a histogram of standardised results from all laboratories is provided to give a visual indication of the position of an individual laboratory's results within the overall distribution
- the laboratories PI and if available their RPI value and the resultant performance category achieved are tabulated. The category boundaries in relation to the reference RPI values are also tabulated.

- mean and median PI and RPI values from all participants (excluding data fom laboratories classified as outliers)
- a laboratory ranking against its peers (only for those participants that have sufficient round data for an RPI to be calculated)
- additional statistical information (see appendix 3)
- the laboratory's historical performance (RPI) over preceding rounds is also plotted. This rolling graph plots both PI and RPI values over a number of rounds and also plots a mean RPI value from all participating laboratories (excluding data from laboratories classified as outliers)

**Note:** It is important for participants to analyse and report results for measurands in all four-test specimens received during each distribution. The WASP statistical calculation relies on participants reporting four measurand results within each round.

**Note:** Participant results that are deemed to be outlying results will not be used in the process to calculate 'true' (assigned) result but will still be used to calculate the PI and hence RPI values for that participant. In the individualised reports to participants, the number of outliers results per measurand is tabulated.

**Note:** It is useful for participants to maintain continuity, to participate in each subscribed sample round and to participate from year to year. The RPI score for each measurand is calculated using results from the best 4 rounds from a rolling 5 round window. If one round of data is not available then the RPI score is calculated using the four rounds available within this rolling window. If two or more rounds of data are missing, i.e. there are less than four rounds of data available within this rolling window then an RPI value cannot be calculated.

**Note:** Scenarios can sometimes exist where calculating the "assigned value" in the prescribed way is not appropriate e.g. small data pools, non-normal distributions and/or multi-mode distributions. The WASP PT scheme can employ other options in calculating an "assigned value" for a particular measurand. In the individualised reports to participants, the reference value used can sometimes be the HSL nominal (target) value rather than a participant trimmed mean value. Any such changes are communicated to participants in the round summary cover letter.

**Note:** Participants that have participated in sufficient rounds to obtain RPI values will also be ranked against their peers. This may lead to a mismatch in round reports between the total number of participants in a particular round and the total number of participants ranked in a particular round because some laboratories may not have as yet participated in the required number of rounds to receive an RPI value.

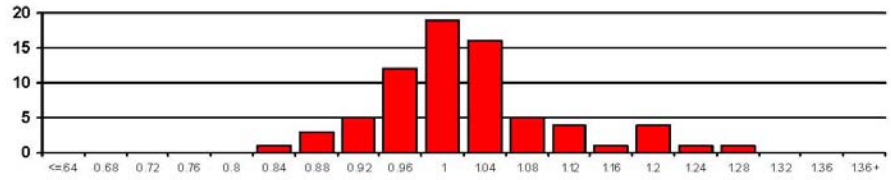
**Figure 1 – Representative individualised participant report**

# WASP Results

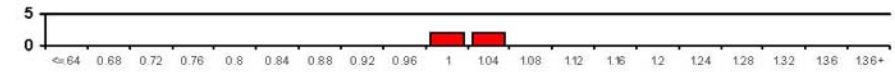
Round: 63 Laboratory: 645

## Isocyanate (MDI) on Glass Fibre Filter

**Frequency Count of Results for this Analyte**




**Results for this Laboratory**




**Summary of your results and their ratio to the mean**

| sample number | your result | 'true' result | standardised results |
|---|---|---|---|
| 1 | 325.80 | 337.40 | 0.966 |
| 2 | 278.80 | 276.18 | 1.009 |
| 3 | 758.30 | 773.69 | 0.980 |
| 4 | 443.80 | 443.59 | 1.000 |

**Reference Value Used:** No **mean:** 0.99

| RPI | performance category |
|---|---|
| < 79 | 1 |
| 79 to 330 | 2 |
| > 330 | 3 |

*RPI Reference Value: 183*

**Results for Your Laboratory:**

**Number of outliers:** 0
**Performance Index (PI):** 4
**RunningPerformanceIndex (RPI):** 64
**Performance Category:** 1

**Results for All Participants:**

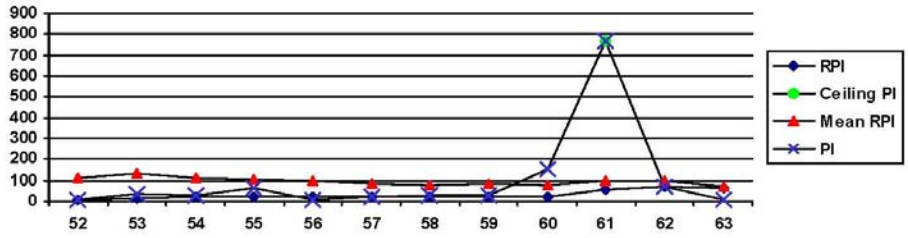
**Mean PI:** 71.89 **Median PI:** 31
**Mean RPI:** 76.63 **Median RPI:** 45

**Your laboratory is ranked** 9 **out of** 14 **labs.**

additional statistical data ( see the statistical protocol paragraphs 12 to 18)

analysis of variance: **Delta:** -0.011077 **SSW:** 0.001177 **Standard Uncertainty:** 8.27%

**RPI Plot for your Laboratory**

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**WASP statistical protocol for $NO_2$ and welding fume sample types**

**Processing Raw Data**

The WASP $NO_2$ and the welding fume sample types currently make use of the well-known Z-score statistic

$$Z_{score} = \frac{\left(x_{lab} - \bar{x}_{ref}\right)}{\sigma_{ref}}$$

where

$\chi_{lab}$ = participant result

$\chi_{ref}$ = reference (target) result

$\sigma_{ref}$ = reference standard deviation

| Sample type | $\chi_{ref}$ | $\sigma_{ref}$ |
|---|---|---|
| WASP $NO_2$ | Theoretical spike value from sample production[1] | Fixed at 7.5 % of $\chi_{ref}$ |
| Welding fume | Mean of a minimum of ten analysed replicates carried out at HSL as part of sample homogeneity testing[1] | Fixed at 10 % of $\chi_{ref}$ |

[1]see appendix 3 for details of test sample preparation

**Performance categories and classification**

The general classification of a $Z_{score}$ is

$Z_{score} < \pm 2$ – satisfactory result

$Z_{score} > \pm 2$ and $< \pm 3$ – questionable (warning) result

$Z_{score} > \pm 3$ – unsatisfactory result

## Participant report

A round report is issued for each of these two sample types. The report details sample production, summary validation data, supplied data and calculated Z-scores in tabular and/or graphic formats. Short discussion and conclusion sections provide feedback on round performance.

## WASP statistical protocol for gravimetric test sample

**Processing Raw Data**

Participant results are benchmarked against a consensus value derived from a trimmed mean using participants' data. This trimmed mean is calculated after removal of outlier data. For the purpose of this measurand, outlier data is defined as participant results outside ± 10% of the target value determined at HSL. The target value is the mean value determined during homogeneity testing of test samples. See Appendix 3 for further details regarding the preparation of test samples.

**Performance categories and classification**

For each filter sample, laboratories are awarded an A,B or C performance category based upon:

"**A**" within ± 10% of the consensus mean

"**B**" within ± 20% of the consensus mean

"**C**" greater than ± 20% of the consensus mean (participant trimmed mean)

Working towards an overall laboratory classification:

each "**A**" value is then allocated a score of 1 point,

each "**B**" value is then allocated a score of 2 points and

each "**C**" value is then allocated a score of 3 points.

Thus resulting in overall classification result of

"**A**" for a participant achieving a cumulative score of less than or equal to 5 points (i.e. minimum 3 A' s and a B) or

"**B**" for a participant achieving a cumulative score of less than or equal to 9 point or

"**C**" for a participant achieving a score in excess of 9 points.

## Participant reports

A round report is issued for this sample types. The report details sample production, summary validation data, supplied data and calculated Z-scores in tabular and/or graphic formats. Short discussion and conclusion sections provide feedback on round performance.

# APPENDIX 2

## Detailed statistical protocol

### Processing raw data

1. Data returned by the participating laboratories, in each round consisting of four measurand results are entered into the WASP software for processing.

### Calculation of mean result

2. For each measurand, a mean result ($x_o$) is calculated from the participating laboratories measurements after excluding outliers. The current outlier limits are set around the nominal (target) loading value of an individual sample. The nominal (target) loadings are those values determined at HSL during the production of the test samples and typically are the mean results from test samples analysed during sample homogeneity testing (see Appendix 3).

| Sample /Measurand | Current Outlier limits (ratio to nominal) | |
|---|---|---|
| | Lower | Upper |
| Metals on filters | 0.82 | 1.18 |
| VOCs on charcoal or Tenax TA | 0.82 | 1.18 |
| Quartz on membrane filters | 0.64 | 1.36 |
| Formaldehyde | 0.64 | 1.36 |

### Calculation of standardised results

3. Individual results (x) at each loading are ratioed to the this mean, to yield figures, which lie close to 1.00 and are referred to as standardised results (y).

$$y = H_1 : \frac{1}{2}\sigma_w^2$$

### Assessment of performance

4. The assessment of performance is based on a Performance Index (PI) and a Running Performance Index (RPI), which enable both short and long-term trends in performance to be monitored.

### Calculation of performance index

5. The performance index for a given laboratory, round and analyte is calculated from the sum of the squared deviations from 1.00 of the standardised results, divided by 4. This is equivalent to the variance of the standardised results about unity. To avoid small numbers, the basic performance index is arbitrarily multiplied by 10,000 to give a typical performance indices in the range 10 to 200; the lower the figure, the better the performance.

$$PI = \sum_{s=1}^{s=4} (y_{sr} - 1)^2 \times \frac{10000}{4}$$

Where $y_{sr}$ is the standardised result for the sample s on round r.

**Calculation of Running Performance Index**

6. The running performance index is calculated by averaging the performance index over the best four rounds from a participant's last five round of WASP (four from four if one is missing, no RPI value calculated if more than one round missing). The square root of this score is an estimate of uncertainty in terms of per cent relative standard deviation (%RSD) over the analytical range used if it is assumed this estimate includes the bias component. It is recommended that participants compare this with their own estimates of uncertainty.

$$\frac{(\sum_{r=1}^{r=5} PI) - PI_{\max}}{4}$$

7. Laboratories are also ranked in order of RPI starting with the lowest (best) as 1. These rankings will be reported to the laboratories to enable them to assess their position in the overall distribution of running performance values and to encourage competition between them. This function is only available for laboratories that have completed sufficient rounds to obtain an RPI value.

**Performance Criteria**

8. For each measurand, a running performance index reference value (reference RPI) is set, based initially on data available from historical performances of laboratories in similar proficiency testing schemes, other method intercomparisons or round robins or reference material certification studies. Such reference values can be subject to periodic review by the WASP scheme.

9. The upper and lower 95% points of the theoretical distribution of running performance indices produced by a laboratory operating at the reference value are used to categorise performance. Laboratories with a running performance indices less than the lower 95% point will be rated category 1, and those with indices greater than the upper 95% point will be rated a category 3. Laboratories performing within these limits will be rated category 2 performing laboratories. There is only a one in forty chance that a laboratory operating at the running performance reference level will be awarded a category 1. There is an equal chance that it would be given a category 3. The RPI reference values and category limits to be used are given below.

| | | **Performance Limits** | | |
|---|---|---|---|---|
| **Sample/measurand** | **RPI Reference Value** | **"Good"**<br><br>**Category 1** | **"Satisfactory"**<br><br>**Category 2** | **"Not Satisfactory"**<br><br>**Category 3** |
| Metals on filters | 36 | < 16 | 16 - 65 | > 65 |
| Benzene, toluene, xylene on charcoal or Tenax TA at occupational levels | 36 | < 16 | 16 - 65 | > 65 |
| Ethyl benzene on charcoal or Tenax TA at occupational levels | 79 | < 34 | 34 - 142 | > 142 |
| Benzene, toluene, xylene and ethyl benzene on Tenax TA at environmental levels | 169 | < 73 | 73 – 310 | > 310 |
| 111 trichloroethane, trichloroethene, tetrachloroethene on charcoal | 36 | < 16 | 16 - 65 | > 65 |
| Quartz on filters | 120 | < 52 | 52 - 216 | > 216 |
| Formaldehyde 2,4 DNPH on filters | 183 | < 79 | 79 - 330 | > 330 |

10. The limits are calculated on the assumption that the standardised results have a normal distribution with a known mean 1.00 and variance $\sigma^2$ . The variance of the RPI will then have a $\sigma^2\chi^2_n$ distribution with n degrees of freedom. If $\sigma^2_o$ is the running performance index reference value, then the upper and lower 95% points are given by:

lower: $\sigma_0^2 \frac{\chi^2}{16}(n=16, p=0.025)$ (=0.432 $\sigma^2_o$)

upper: $\sigma_0^2 \frac{\chi^2}{16}(n=16, p=0.975)$ (=1.800$\sigma^2_0$)

11 In most cases, simple inspection and informal interpretation of the descriptive statistics presented so far will extract all the useful information from the data. Participants may find the following analysis of variance approach useful.

**Analysis of variance**

12 The appropriate model is a one-way component of variance (type II) model

$$Y_{rs} = 1 + \beta + x_r + \varepsilon$$

where $Y_{rs}$ is the standardised result of sample s on round r, $\beta$ is the bias, and $x_r$ and $\varepsilon$ are independent random variables with zero means and variances $\sigma_r^2$ and $\sigma_w^2$ representing the between-round and within-round contributions to the overall variance.

This can be re-written:

$$\delta_{rs} = Y_{rs} - 1 = \beta + x_r + \varepsilon$$

where $\delta_{rs}$ is the deviation from 1.00 of the standardised result ( $Y_{rs}$ ). The analysis of variance table covering the results from (n) rounds is shown in Table 2, where $\bar{\delta}_r$ (DELTA$_r$) is the mean deviation on round, and $\bar{\delta}$ is the mean deviation over all (n) rounds. All the quantities in the table can be simply calculated from the data provided in the WASP results output for each round, namely SSW, DELTA and PI. Using the table, tests for 'consistent' bias ($\beta = 0$ ) and for 'erratic' bias ($\sigma_r^2 \neq 0$) can be performed by taking the appropriate F ratios. The tests may be conducted over any chosen series of WASP rounds; the worked example below covers four rounds.

**Worked example**

13 The following are data that may have been generated for a participant over four rounds of WASP.

| Standardised Results | Round | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Sample 1 | 1.09 | 1.04 | 0.92 | 0.91 |
| Sample 2 | 1.08 | 1.03 | 0.95 | 0.93 |
| Sample 3 | 1.12 | 1.07 | 0.86 | 1.16 |
| Sample 4 | 1.01 | 0.96 | 1.08 | 1.09 |
| $PI_r$ | 72.5 | 22.5 | 87.25 | 116.75 |
| $DELTA_r$ | 0.075 | 0.025 | -0.0475 | 0.0225 |
| $SSW_r$ | 0.0065 | 0.0065 | 0.025875 | 0.044675 |

Using these data, the analysis of variance table can be established.

| Source | Sum of squares | | Degrees of freedom | Mean square |
|---|---|---|---|---|
| Within round | $\sum_1^n SSW_r$ | 0.08355 | 12 | 0.006963 |
| Between round | (by subtraction) | 0.03043 | 3 | 0.01014 |
| Pooled | | 0.11398 | 15 | 0.0076 |
| Bias | $\frac{4}{N}\left[\sum_1^N DELTA_r\right]^2$ | 0.005625 | 1 | 0.005625 |
| Total | $\frac{4}{10000}\sum_1^N PI_r$ | 0.1196 | 16 | |

In the discussion which follows, the within round, between round, pooled and bias mean squares are denoted by MSW, MSR, MSP and MSB respectively.

**'Erratic' bias**

14 To test for 'erratic' bias ( $\sigma_r^2 \neq 0$ ) the F-ratio MSR/MSW is calculated. In the example above the ratio is 1.46, which is less than the critical figure of 3.49 (5% level). If the ratio had been above 3.49, this would have indicated significant round to round variation. Put differently, this means that the individual round means are more scattered than would be predicted by the variability shown within each round. This pattern would be seen, for example, if two different analysts were involved, both highly consistent but one with a tendency to high results and the other to low results. If such round-specific effects can be identified and eliminated, overall laboratory performance will be improved. However, it should be appreciated that the statistical

power of this analysis is not high since there are not many observations. For this particular test over four rounds, it would probably be sensible to consider any F-ratio greater than 2 as an indicator of real round-to-round variation. This corresponds to a significance level of about 17% and power of 60% against $H_1 : \sigma_r^2 = \sigma_w^2$ and 70% against $\beta \neq 0$

.

**'Consistent' bias**

15 If the MSR/MSW F-ratio is raised (say > 2) then it is unlikely that any 'consistent' bias ($\beta \neq 0$ ) will also be detectable, but formally this can be tested by forming the ratio MSB/MSR. The value of the F-ratio in this example is 0.55 well below the level indicating significant consistent bias, which is 10.1 at the 5% level of significance.

16 Should the MSR/MSW F-ratio be < 2 then a more powerful test for consistent bias can be performed by 'pooling' MSW and MSR to form MSP which is calculated by adding together the within round and between round sums of squares and dividing by 4n-1. The F test for bias is then MSB/MSP, and again in this example the F-ratio of 0.74 is not significant at the 5% level (critical value is 4.54).

17 It must be clearly understood that getting non-significant results from these various F-tests does not say anything about the goodness or otherwise of a laboratory's performance. This is because the tests are all done using the laboratory's own underlying error distribution. If there are large errors within each round none of the tests will reach significance. The performance of a laboratory is measured in absolute terms by its performance index and categorised accordingly. The F-tests described above may, particularly in the case of the better performing laboratories, give useful diagnostic pointers to sources of error.

| Source | Sum of Squares | Calculation | Degrees of Freedom | Mean Square | Expectation |
|---|---|---|---|---|---|
| Within Round | $\Sigma_{r=1}^{N}\Sigma_{s=1}^{4}\left(\delta_{rs}-\bar{\delta}_r\right)^2$ | $\Sigma_{r=1}^{N} SSW_r$ | 3N | $\frac{1}{3N}[\Sigma_1^N SSW_r$ | $\sigma_w^2$ |
| Between Rounds | $4\Sigma Nr = 1\left(\bar{\delta}r-\bar{\delta}\right)^2$ | By Subtraction | N-1 | $\frac{4}{N-1}\left[\Sigma N1\left(\bar{\delta}r-\bar{\delta}\right)^2\right.$ | $\sigma_w^2+4\sigma_r^2$ |
| Bias | $4N\bar{\delta}^2$ | $\frac{4}{N}[\Sigma_1^N DELTA_r]^2$ | 1 | $\frac{4}{N}[\Sigma_1^N DELTA_r]^2$ | $\sigma_w^2+4\sigma_r^2+4N\beta^2$ |
| Total | $\Sigma_{r=1}^{N}\Sigma_{s=1}^{4}\delta_{rs}^2$ | $\frac{4}{10000}[\Sigma_1^N PI_r$ | 4N | | |

$\Sigma_{s=1}^{4}\left(\delta_{rs}-\bar{\delta}_r\right) = SSW_r$

$\bar{\delta}_r = DELTA_r$

# APPENDIX 3

## Test samples within the WASP scheme

**WASP Inorganic Test Samples Overview**

| Sample type/Measurand combination | Medium | Indicative Analyte Loading Range µg/sample (unless stated) |
|---|---|---|
| **Metals spiked onto filters** | | |
| Cadmium | 25-mm diameter membrane filters (mixed cellulose ester) | 5 - 50 |
| Chromium | | 50 - 500 |
| Cobalt | | 50 - 250 |
| Copper | | 50 - 250 |
| Iron | | 50 - 250 |
| Manganese | | 50 - 250 |
| Nickel | | 50 - 250 |
| Lead | | 15 - 150 |
| Zinc | | 50 - 250 |
| | | |
| **Metals spiked onto filters** | | |
| Cadmium | 25-mm diameter glass fibre filters (GFA) | 5 - 50 |
| Chromium | | 50 - 500 |
| Cobalt | | 50 - 250 |
| Copper | | 50 - 250 |
| Iron | | 50 - 250 |
| Manganese | | 50 - 250 |
| Nickel | | 50 - 250 |
| Lead | | 15 - 150 |
| Zinc | | 50 - 250 |
| | | |
| **Welding fume in bulk sample** | | |
| Chromium | Typically ~ 10 mg sample sample | 0.1 – 30 % (m/m) |
| Iron | | Balance |
| Manganese | | 0.1 – 30 % (m/m) |
| Nickel | | 0.1 – 30 % (m/m) |
| Other elements (from distribution to distribution) | | 0.1 – 30 % (m/m) |
| | | |
| **Quartz sampled onto filters** | 25mm diameter PVC filters (GLA5000) | 60 to 460 |
| | | |
| **$NO_2$ (as nitrite) spiked into diffusion tube** | Palmes-type diffusion tubes | 0.4 - 3 |
| | | |
| **Gravimetric PT scheme (sodium borate salt as mass surrogate spiked onto filter)** | 25-mm or 37-mm diameter glass fibre filters (GFA) | 0.2 – 2.0 mg |

## WASP Organic Test Samples Overview

| Sample Type/ Measurand combination | Medium | Indicative Analyte Loading Range<br><br>µg/sample unless stated |
|---|---|---|
| **Solvent vapour dynamically loaded onto tubes** | | |
| | | |
| **Analysis involving solvent extraction** | | |
| Benzene | Glass sorbent tube with charcoal | 10 to 400 |
| Toluene | | 50 to 2500 |
| Xylene (all isomers) | | 50 to 5000 |
| Ethyl benzene | | 20 to 400 |
| | | |
| 111 trichloroethane | Glass sorbent tube with charcoal | 250 to 12000 |
| Trichloroethene | | 80 to 7000 |
| Tetrachloroethene | | 100 to 4000 |
| | | |
| **Analysis involving thermal desorption (occupational workplace levels)** | | |
| Benzene | Perkin Elmer type thermal desorption tube with Tenax TA sorbent | 0.5 to 15 |
| Toluene | | 2 to 200 |
| Xylene (all isomers) | | 2 to 200 |
| Ethyl benzene | | 0.5 to 50 |
| | | |
| **Analysis involving thermal desorption (environment air levels)** | | |
| Benzene | Perkin Elmer type thermal desorption tube with Tenax TA sorbent | 15 to 300 ng |
| Toluene | | 15 to 300 ng |
| Xylene (all isomers) | | 15 to 300 ng |
| Ethyl benzene | | 15 to 300 ng |
| | | |
| **Spiked Derivatives** | | |
| Formaldehyde derivative 2,4,DNPH spiked onto filter | 25-mm diameter Glass fibre filters | 1.5 to 30 |

# Overview of the preparation of the WASP PT test samples

All test samples are prepared in-house at HSL except where noted.

## Metals spiked onto membrane or glass fibre filters

Metals are spiked, using calibrated motorised repeater pipettes, onto individual filters by spotting with aliquots of a custom-made stock multi-element solution(s). These stock solutions are prepared in-house from suitable metal powders or metal salts and are cross-checked by ICP-AES analysis, following dilution, against NIST traceable multielement calibration solutions. Filter media used are either 25-mm cellulose nitrate or glass fibre filters, all obtained from the same manufacturer's lot to ensure matrix consistency.

For homogeneity checking, ten filters, taken at random, from each sample loading are analysed. Filters are subjected to analysis by ICP-AES, to procedures set out in ISO 15202 part 3, after leaching the filters in dilute nitric acid, to procedures set out in ISO 15202 part 2, Annex B.

Spiked filters are individually packaged in labelled 50 mm Petri-dishes. Blank (unspiked) filters are also supplied.

## Metals in bulk welding fume

Welding fume collected from workplaces and/or generated under simulated workshop conditions is used as a basis for this sample type. Fume is initially sieved and subsequently mixed using a roller mixer. The default sample aliquot size used for the WASP scheme is 10 mg. At this default sample size, sample-to-sample homogeneity can is guaranteed. It is a sufficient sample aliquot to ensure that laboratories can adequately weigh out. The nominal size is a sufficient sample aliquot size for analysis down to ~ 0.1 % (m/m) concentration by typical atomic spectrometric techniques.

For homogeneity assessment, 10 separate sample aliquots (10 mg nominal) are taken at random following sample mixing, dried and analysed for the required elements. Analysis is carried out using ICP-AES, to procedures set out in ISO 15202 part 3, after digesting test aliquots in an aqua regia/HF acid mixture using a closed vessel microwave assisted digestion procedure, to procedures set out in ISO 15202 part 2, Annex H.

Samples are packaged into labelled small glass vials.

## Quartz on filters

Respirable sized quartz powder, Sikron F600 (HSE standard quartz A9950) is re-aerosolised in a test chamber and sampled onto 25-mm diameter PVC filters (GLA5000) mounted in Higgins-Dewell respirable cyclonic samplers. Using a multiport sampler, with matched flow rates, 40 filters are concurrently sampled.

For batch homogeneity purposes, all 40 charged filters are unloaded from the samplers and are screened using an FTIR measurement approach detailed in HSE MDHS 101.

Charged filters are packaged individually in labelled petri dishes.

**Note:** The filters are suitable for participants using either FTIR or XRD measurements approaches as exemplified in HSE MDHS 101. Participants using FTIR also received spectrum matched blank PVC filters.

**Note:** Please note that the geometry of the quartz deposited on the sample filters is characterised by the use of the specific Higgins – Dewell respirable sampler design employed for sampling. Participants are therefore requested to note this fact as (their) calibration filters generated using alternative sampler designs may generate a different dust deposition geometry that could potentially generate a bias in test results when using a "direct on filter" analytical procedure. Further technical advice can be obtained from HSL.

## $NO_2$ (as nitrite) in diffusion tube

Samples are prepared and dispatched by a sub-contractor. An aliquot of a sodium nitrite solution is spiked onto sampling grids mounted in Palmes type diffusive samplers using a calibrated pipette. The spike value(s) are calculated based upon gravimetric and volumetric considerations following a titrimetric determination of the nitrite concentration in the prepared stock spiking solution. The pipette used for sample spiking is routinely checked at intervals during sample production using this gravimetric approach. As a cross check and also to assess sample homogeneity, ten spiked tubes, taken at random from each sample loading, are analysed for nitrite by ion chromatography following leaching of samples in water. This addition check is carried out at a separate third party laboratory, which is accredited to ISO/IEC 17025 for this assay.

## Gravimetric samples

Glass fibre filters (25-mm or 37-mm glass fibre filters) are sent to participants to pre-weigh in individually labelled transport Petri dishes. Following weighing the filters are returned HSL. Upon return, filters are spiked with a sodium borate solution prepared in-house. The concentration of this solution is checked, following dilution, by ICP-AES. Filters are then subsequently dried in a HEPA filtered drying cabinet and dispatched for re-weighing by participants. In a similar fashion, for homogeneity checking, six filters, at each sample loading level, are weighed at HSL, spiked, dried and reweighed. Weighing procedures outlined in HSE MDHS 14/3 are followed.

**Note:** Return of filters to HSL for spiking is at the expense of the participant.

## Solvent samples

The organic solvent samples are prepared by sampling vapour onto sorbent tubes (charcoal or Tenax) from a dynamically generated vapour atmosphere. An atmosphere is generated by vapourising a solvent mixture into a heated chamber, using an automated syringe to continually inject at a controlled rate. The resultant vapour cloud is then mixed and diluted in a dilution chamber to provide the required standard atmosphere. This approach is described in HSE MDHS 3 and ISO 6145 part 4**.**

With the current sample-loading rig, twenty-nine sorbent tubes can be loaded simultaneously and all gas flows are metered using mass flow controllers. An on-line FID detector with adaptive feedback control is used to monitor the vapour concentration within the dilution chamber thus ensuring that batches of tubes can be loaded, sequentially, with a very high degree of precision.

For homogeneity assessment, ten sorbent tubes from each loading batch are taken at random for analysis. As a minimum, one sorbent tube must be taken from each loading batch. Analysis is carried out using GC procedures described in HSE MDHS 72 (analysis following thermal desorption) or HSE MDHS 96 (analysis following solvent extraction).

**Note:** Analysis carried out using in-house analytical procedure based upon HSE MDHS 72 is an accredited method to ISO/IEC 17025.

## Formaldehyde samples

Formaldehyde samples are prepared by spiking individual glass fibre filters with formaldehyde - 2,4-dinitrophenylhydrazine derivate solution using a calibrated pipette.

For homogeneity assessment, 10 spiked filters are randomly taken from each sample loading for analysis. The analysis is carried out by desorbing the filters in solvent and analyzing by a HPLC method described in HSE MDHS 102.

## Test Sample Homogeneity Requirements

A crucial factor in the operation of the WASP PT scheme, like any other PT scheme, is that, for any sample type, all participants should receive samples as near identical as possible. In essence, the variability of the replicate samples must be considerably less than the typical analytical variability so that a participants results and hence performance is not unduly influenced by minor variations from sample to sample.

Guidance in ISO 13528 suggests that test samples can be considered sufficiently homogeneous if the sample production precision is < 0.3 times the anticipated (likely) participant (group) analytical precision. HSL has interpreted this guidance in the following manner

| Test Sample | Target sample production precision | Typical sample production precision Obtained[1] | Analytical precision requirement for satisfactory performance |
|---|---|---|---|
| Metals spiked on filters | < 2.5 % | < 1.5 % | 8 % |
| VOC on charcoal tubes | < 2.5 % | < 1.5 % | 8 % |
| VOC on tenax tubes | < 2.5 % | < 1.5 % | 8 % |
| Ethyl benzene on on charcoal or tenax tubes | < 2.5 % | 1.5 % | 12 % |
| $NO_2$ spiked into diffusion tubes | < 2.5 % | < 1.5 % | 15 % |
| Quartz on filters | < 2.5 % | < 1.5 % | 15 % |
| VOC on tenax tubes at environmental levels | < 2.5 % | < 1.5 % | 18 % |
| Formaldehyde derivative 2,4,DNPH spiked onto filter | < 2.5 % | < 2 % | 18 % |
| Gravimetric PT scheme | < 2.5 % | < 2 % | 20 % |
| Welding fume on filters | < 3 % | 1.5 - 3 % | 20 % |

[1]As the sample production precision is determined by the analysis of typically 10 randomly selected samples, such values will include both test sample preparation and analytical measurement variability, hence the actual test sample precision should be actually lower than the typical values tabulated above.

## Packaging of Test Samples prior to dispatch

In each round, the four samples of each sample type are placed in plastic ziplock bags, placed in foam lined cardboard box and finally placed within a padded (Jiffy) envelope.

Participants receiving the environmental Tenax samples will note that the plastic ziplock bag may contain a segment of a carbon filled cloth material. The aim of this material is to mop up any VOC that may potentially ingress into the sample packaging during sample transport i.e. aviation fuel vapour

Participants will note that the Tenax tube test samples are supplied in a foam lined plastic transport box.

**Note**. It is a mandatory requirement that Tenax tubes and associated plastic transport boxes are returned to HSL after every completed round. See Appendix 4.

# APPENDIX 4

# Responsibilities and terms and conditions

## Summary

HSL will operate the WASP PT scheme in accordance with its obligations set out below. In turn, a condition of joining the WASP scheme, upon signing the subscription order form, is that participants abide by the rules and responsibilities of the scheme as set out in this handbook and in particular detailed below. Likewise participants comply with the HSL's standard conditions of business, which are available upon request.

## Obligations of HSL

HSL will operate the WASP PT scheme in accordance with procedures and conditions set out in this handbook in particular offering the particular sample test types set out in Appendix 3; operating the statistical protocols as set out in Appendix 1 and 2 and applying any relevant actions detailed as notes below.

HSL undertakes to correct any mistakes attributable to errors on its part as quickly as possible. HSL also undertakes to follow up any technical queries relating to test samples and associated scores.

## Participant Responsibilities

### Payment responsibilities

- The Client will pay the invoice in full, including any amount shown in respect of VAT, within 30 days of the date of the invoice.
- An invoice shall not be regarded as paid until funds (GBP) are received into a UK sterling bank account operated by HSL or by the Health and Safety Executive.
- Within a subscription period, HSL reserves the right to withhold PT reports until full payment is made.
- HSL reserves the right not to accept repeat subscriptions from participants who have unpaid invoices from a previous subscription period.

### Communication responsibilities

- Laboratory number must be quoted in all correspondence.
- All queries should be directed in the first instance to the proficiency testing team. Contact details are detailed in section 10. Email communication is preferred.

- To ensure we can keep you updated with important information it is the participant's responsibility to inform the scheme of any changes to contact details.
- Technical queries relating to test samples and associated scores must be forwarded to HSL within the timescale as noted below.

**Note:** Failure to provide up to date contact details may result in additional expense and delays in sample shipment. Delays may also result in a laboratory missing participating in a selected round and/or missing result reporting deadlines.
**Note:** Participants are advised to check the WASP PT webpage on a frequent basis for latest information regarding round schedules.
**Note:** Participants are requested to bring technical enquires to the attention of the scheme within a reasonable timescale. WASP defines a reasonable timescale as the current five round rolling window (Appendix 1) i.e. current round and four previous rounds (test rounds within the last 15 months).

## Test sample transportation responsibilities

- Participants should ensure that any required paperwork/permit application is in place, if requested by HSL, to allow samples through national boundaries/customs.

**Note:** Failure to do so may results in a participant incurring additional courier costs arising from HSL attempting to deliver said samples or replacements. Delays may also result in a laboratory missing participating in a selected round and/or missing result reporting deadlines.

## Responsibilities regarding lost, delayed, damaged or suspect samples

Participants are requested to contact HSL if

- Samples are not received as scheduled or if samples appear to be have damaged in transit (indicative transit times below). The participant shall inform HSL within 15 working days of the advertised dispatch date.
- Samples are 'lost' during sample workup and/or during the analysis.

From April 2011, Parcel Force will be used to distribute test samples to participants in the UK and EU member states. A specialised courier will be used to distribute test samples to participants in other countries. Hence non-EU participants will be subject to an additional courier fee noted on their subscription forms.

Subscription fee includes relevant distribution costs except where noted below.

**Note:** Indicative Parcel Force transit times are as follows
- United Kingdom participants 2- 4 working days
- European participants 4 – 6 working days

**Note:** Indicative courier transit times are as follows
- Australia, Japan, New Zealand, South Africa, US: 2 – 5 working days
- Other countries upon request

**Note:** Transit times in working days pending customs
**Note:** Participants should ensure that any required paperwork/permit application is in place, if requested by HSL or its nominated courier, to allow samples through national boundaries/customs. Failure to do so may result in delays in sample shipment and hence participation.
**Note:** For samples lost or damaged in transit, HSL will attempt to supply replacement of test samples, at HSL's expense, on a best endeavours basis provided replacement test samples are available and

provided adequate notification is given, as outlined above. HSL cannot guarantee shipment of replacement test samples if notification is received after this stated time period.
**Note:** If transport issues persist with a certain address/location, HSL reserve the right to dispatch future test samples by alternative means and where additional courier costs may therefore apply.
**Note:** For test samples suspected of being damaged in transit, HSL request that, in the first instance, photographic evidence be provided, if requested. HSL reserve the right to inspect said shipments. Therefore the participant should not dispose of any said test samples and associated packaging until confirmation is received from HSL. The participant shall, if requested, send them back to HSL for examination. HSL will reimburse the associated courier costs.
**Note:** In the eventuality of non delivery of test samples by HSL to a participant, the participant may elect for a refund of the fees paid for the PT round in question for said test samples or a credit note to the equivalent of one round for said test samples to apply in the next available subscription period.
**Note:** For test samples damaged and lost in the care of the participant, HSL will attempt to supply replacement of test samples on a best endeavours basis provided replacement test samples are available using an express courier service. This is provided adequate notification is given and within the constraints of the round schedule. HSL however cannot guarantee replacements if such notification is received within 5 working days from round result deadline. The participant will bear any additional express courier costs.

## Test sample handling responsibilities

- VOC samples on sorbent tubes should be stored away from other potential solvent sources in the laboratory.
- WASP samples should be stored, prior to analysis, in the transport cassette provided to minimise potential from contamination.

## Test sample reporting responsibilities

- It is the participant's responsibility to ensure that scheme round results are submitted by the defined deadlines
- Participants are requested to report results on the reporting forms/format provided and have access to certain mandatory IT facilities such as Microsoft Word and Excel; an email account and a web access facility.
- Results should be reported as clearly as possible if a handwritten format is provided/required. Thousands should be separated by a comma not a full stop.
- All results should be reported to a minimum of 3 significant figures unless otherwise requested.

**Note:** Generally results received after a round deadline will not be processed. The one exception is if a laboratory notifies HSL in advance of the round deadline of a particular issue e.g. instrument failure, delays in sample transit, sample loss or damage (see above). At the discretion of the WASP PT technical manager, a short time extension may be granted.
**Note:** HSL reserves the right to refuse results submitted on reporting forms/format alternative to those provided.
**Note:** Transcription errors and/or errors in reporting results in the correct units by participants is considered by HSL to be part of the proficiency testing assessment process. As such HSL will not amend or correct any submitted results if requested. Participants can however, report revised results, if such errors are noted, provided that they are received at HSL before the round reporting deadline.

## Test sample and associated packaging returns responsibilities

- Participants subscribing to the VOC test samples on Tenax TD sorbent tubes **must** return said tubes and associated transportation box(es) to HSL within 4 weeks of the round results reporting deadline.
- Non-UK participants must follow the guidance in the supplementary note below.

**Note:** When returning the transportation boxes (including the sorbent tubes) please mark the parcels as **"Returned sample tubes for Proficiency Testing scheme, with no commercial value".** If a mandatory value is required for the package then a statement such as "**declared nominal value of 1 Euro/Dollar"** should be added. Please ensure that these statements are clearly detailed on the outside packaging and any associated shipment documentation if requested by a courier.

**Note:** Failure to do this can result in HSL incurring custom and excise importation charges. Any such fees will be passed onto the participant.

**Note:** HSL reserve the right to charge the full replacement costs for TD sorbent tubes and transport boxes not returned by the required deadline.

## Renewal of membership

A renewal order form is sent to participants at the beginning of each year. Each laboratory must return a signed copy of this order form if it wishes to continue to participate.

**Note:** This signed order form constitutes the membership agreement between HSL and the participating laboratory. By signing the order form the participant agrees to their responsibilities set out in this handbook and agree to abide by the HSL's standard conditions of business.

## Closure of membership

Notification of a laboratory's intent to withdraw from the scheme must be sent in writing to the Proficiency Testing Team. HSL will refund unused subscriptions after deducting a £50 administration fee. Closed participant data is then archived under the laboratory ID number that is subsequently retired.

## Change of ownership and laboratory mergers

Participants are requested to contact the scheme in the first instance.

## Collusion and falsification of results by participants

The responsibility rests with each participant to behave in a professional scientific manner. Whilst maintaining confidentially (see section 3.3 in the main handbook), HSL has in the past and will in future provide generic scientific feedback on likely achievable analytical performance to accreditation bodies and regulators where requested.

# APPENDIX 5

# References

[1] ISO/IEC 17043:2010 Conformity assessment – General requirements for proficiency test

[2] West and Jackson *Initial experience with the workplace analysis scheme for proficiency (WASP),* Annuals of Occupational Hygiene, 1992, 36, 2 545-561.

[3] COSHH http://www.hse.gov.uk/coshh/

[4] EN482: 2006 Workplace exposure - General requirements for the performance of procedures for the measurement of chemical agents

[5] ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories

[6] ISO 9001:2008 Quality Management Systems – Requirements

[7] ISO 13528:2005 Statistical methods for use in proficiency testing by interlaboratory comparisons