Recommendation no. 17

BPC Ad hoc Working Group on Human Exposure

Update to HEEG Opinion 15 on the paper by Links et al., 2007 on occupational exposure during application and removal of antifouling paints

(version 2 agreed at the Human Health Working Group I-2020 on 25 March 2020)

Document history		
Version	**Changes**	**Date**
1	First version	Agreed at WG-V-2019
2	Changes to the document: Tiered approach for assessment of hands exposure for professional brush/rollers	Agreed at WG-I-2020

1. Background

TM IV 2012 endorsed the HEEG Opinion no. 15 concerning the paper by Links et al., 2007 done by TNO in The Netherlands on occupational exposure during application and removal of antifouling paints. However, a preliminary analysis by the UK HSE of the TNO study raw data revealed that the data could not be used without further information on the density of the products and individual measurements.

Data on the density of the products and individual measurements from the TNO study have since been made available, which lead to the update of HEEG Opinion no. 15 into HEAdhoc Recommendation 17 agreed during the WG-V-2019 meeting.

Version 2 of HEAdhoc Recommendation 17 includes in Section 4 a tiered approach for the actual hands indicative value for professional brush/rollers exposure.

2. Aim of the recommendation

To update HEEG Opinion 15 on the paper by Links et al., 2007 on occupational exposure during application and removal of antifouling paints after the availability of data from the TNO report.

3. Discussion

Now that data on the density of the products and individual measurements from the TNO study have been made available, it allows combining the TNO data with the HSE and IOM data from BEAT (Bayesian Exposure Assessment Tool) model. Using the combined data and following the HEEG considerations, occupational exposure during application and removal of antifouling paint can be refined. Further, refined exposure values are compared to applicable lower tier exposure model values. A detailed discussion of the combined data and refined exposure values is presented for each of the relevant scenarios in Annex 7.1. Brief details of the statistical methods used are given on Section 6.

Antifouling paint densities are shown in the table below. Individual measurements from the TNO study are shown in Annex 7.2. Annex 7.3 shows plots of the individual exposure data. Both 75th and 95th percentiles have been presented in this paper for completeness. The 75th percentiles are considered to be appropriate for many situations with regard to

chronic exposure, with 95th percentiles being included for situations where a higher percentile is required, such as when considering acute toxic effects (Human Exposure To Biocidal Products [TNsG June 2002], User Guidance V1, Annex 4). The precedent established for active substance assessments such as medetomidine reflects this.

Antifouling paint densities (kg/L)

Data source	Application by Spraying	Application by brushing and rolling
HSE surveys	2.0	NA
Hughson and Aitken (IOM)	1.7 or 2.3	NA
Links et al. (TNO)	1.8	1.4

The BPR guidance on the selection of indicative exposure values provides advice when due to greater than usual uncertainty regarding the nature of the distribution of the data, as evidenced by the ratio of the confidence levels or a lack of fit to lognormal distribution, it may be appropriate to replace the 75th percentile with higher values. The data considered below generally meet the criteria for use of the 75th percentile. However, in a few instances the ratio between the 75th percentile lower and upper confidence levels is greater than two or the lognormal hypothesis is rejected. The level of increased uncertainty and the nature of apparent deviation from lognormality, as shown on normal quantile-quantile plots, were considered in every case. Overall given the observed slight increases in uncertainty and deviations from lognormality, which were mainly in the lower quantiles, use of the 75th percentiles was considered appropriate for the assessment of long term exposure.

4. Proposal for harmonisation

A summary of the combined data and refined exposure values proposed for harmonisation is presented for each of the relevant scenarios.

Professional Sprayer	**Combined data from HSE, IOM and TNO**
Potential Body (mg paint/min)	195.04 (75th percentile) 677.1 (95th percentile)
Potential Hands (mg paint/min)	80.17 (75th percentile) 128.78 (95th percentile)
Actual Hands (mg paint/min)	1.14 (75th percentile) 3.34 (95th percentile)
Inhalation (mg paint/m^3)	11.3 (75th percentile) 39.0 (95th percentile)
Professional Brush/Roller (includes mixing/loading and application tasks)	**TNO 2007 study**
Potential Body (mg paint/min)	70.30 (75th percentile) 90.44 (95th percentile)

Potential Hands (mg paint/min)	64.49 (75th percentile) 89.99 (95th percentile)
Actual Hands (mg paint/min)	[1]3.88E-03 (75th percentile) 1.43E-02 (95th percentile)
Inhalation (mg paint/m³)	0.13 (75th percentile) 0.29 (95th percentile)
Professional Potman (includes mixing & loading into reservoirs for airless spraying. Cleaning of spraying equipment is not included)	**HSE & IOM data**
Potential Body (mg paint/min)	114.01 (75th percentile) 389.32 (95th percentile)
Potential Hands (mg paint/min)	[2]874.85 (75th percentile) 1275.55 (95th percentile)
Actual Hands (mg paint/min)	1.26 (75th percentile) 3.05 (95th percentile)
Inhalation (mg paint/m³)	1.45 (75th percentile) 5.74 (95th percentile)
Professional Sand/Grit Blaster	**TNO data** **mg old paint[3]/min**
Potential Body (mg paint/min)	4.56 (75th percentile) 14 (95th percentile)
Actual Body (mg paint/min)	0.66 (75th percentile) 1.71 (95th percentile)
Potential Hands (mg paint/min)	10.43 (75th percentile) 20.63 (95th percentile)
Actual Hands (mg paint/min)	3.04 (75th percentile) 4.08 (95th percentile)
Inhalation (mg paint/m3)	11.84 (75th percentile) 16.08 (95th percentile)

[1] Large difference between the potential and actual hand exposure values (reduction factor of 16621). This could be due to the used dermal measurement method. Measurement method in TNO data for dermal hand exposure based on worker applying the paint wears one pair of cotton gloves under and one pair of cotton gloves over nitrile gloves.
[2] The high potential hand exposure values are only from the IOM study. The actual values are from HSE. Potential and actual values are not measured simultaneously. The data source is different. The data for potential and actual hand exposure should not be used to calculate a new default protection factor for gloves.
[3] Exposure values are for old paint, adjustments are required for a.s. concentration in exposure calculations

For the assessment of hands exposure for professional brush/rollers a tiered approach is proposed consisting of:

- Tier I: use of value of potential hand exposure for professional brush/roller
- Tier II: use of value of potential hand exposure for professional brush/roller with one pair of gloves (10% penetration)
- Tier III: use of value of actual hand exposure for professional brush/roller. Using this value would require as RMM the use of two pairs of gloves, one pair of cotton gloves beneath the chemically-resistant gloves.

The use of two pairs of gloves was considered as an acceptable risk mitigation measure as it is commonly used for comfort and other practical reasons by professional users.

GRIT FILLING

HEEG opinion 15 considered:
[…] the HEEG is of the opinion that since there is no other exposure information on grit fillers, the maximum exposure levels (inhalation exposure loading and dermal exposure loading) found for grit fillers in the Links study may be used as a first tier approach until any further data is presented on possible correlations.

Exposure values in a.s./h

Inhalation exposure loading:	3.87 mg a.s./m^3
Dermal exposure loading:	433 mg a.s./h (body, potential exposure) 497 mg a.s./h (hands, potential exposure) 6.49 mg a.s./h (hands, actual exposure)

If a higher tier for the dermal exposure is warranted, then the exposure assessor may use the sand blaster data, under the assumption that the exposure of the grit filler is not higher than for the sand blaster. A prerequisite for use of actual exposure values is that the grit filler is equally or better protected by PPEs than the sand blaster.
To estimate the exposure to an active ingredient in a specific antifouling paint, the same approach as given for the sand blaster should be used; i.e. converting the measured amount of a.s. to old paint equivalents and using the estimated remaining fraction of a.s. in old paint versus new paint in OECD ESD (see paint removal scenario).

To calculate the appropriate exposure values the measured exposure in the Links et al., 2007 study (expressed as a.s. per time duration or m^3) was converted to old paint equivalents using the measured average concentration of a.s. in collected old paint layers (10.8 % w/w, p. 214) as suggested by HEEG.

Exposure values in mg paint per min (to be used in ESD)

Inhalation exposure loading:	35.83 mg paint/m^3
Dermal exposure loading:	66.82 mg paint/min (body, potential exposure) 76.70 mg paint/min (hands, potential exposure) 1.00 mg paint/min (hands, actual exposure)

5. References

Health and Safety Executive, Exposure Assessment Document EH74/3, Dermal exposure to non-agricultural pesticides. HSE, UK (1999) ISBN 0717617181

Hughson G.W. and Aitken R.J. (2004). Determination of Dermal Exposures During Mixing, Spraying and Wiping Activities. Annals of Occupational Hygiene (48) 245-256.

Links I., van der Jagt K. E., Christopher Y., Lurvink M., Schinkel J., Tielmans E., and van Hemmen J.J. (2007), Occupational Exposure During Application and Removal of Antifouling Paints. Annals of Occupational Hygiene (51) No 2, 207-218.

Technical Notes for Guidance (June 2002), Human Exposure to Biocidal Products. Guidance on Exposure Estimates. The Professional Airless Spraying Viscous solvent-based liquids at >100 bar pressure, Model 3, Part 2, pg 149.

Technical Notes for Guidance (June 2002), Human Exposure to Biocidal Products. Guidance on Exposure Estimates. The Consumer product painting Model 4, Part 2, pg 203.

Technical Notes for Guidance (June 2002), Human Exposure to Biocidal Products. Guidance on Exposure Estimates. Mixing & Loading Model 6, part 2, pg 140.

Guidance on the Biocidal Products Regulation Volume III Human Health - Assessment & Evaluation (Parts B+C) Version 4.0 December 2017.

6. Statistical methods

Percentiles: 75th and 95th percentiles were calculated using a linear interpolation between closest ranks method in Microsoft Excel using the function percentile.inc (data;percentile).

Lower and upper confidence limits for 75th and 95th percentiles were calculated according to Appendix 3-2: Confidence Intervals for Percentiles of Exposure Distributions, Guidance on the Biocidal Products Regulation Volume III Human Health - Assessment & Evaluation (Parts B+C) Version 4.0 December 2017.

The assumption that data were from lognormal distributions was tested by applying the Shapiro-Wilk test to natural log transformed data values. This was done in R (R Core Team, 2013, R A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria, http://www.R-project.org/.)

Annex 7.1. Detailed discussion of combined data and refined exposure values

APPLICATION OF ANTIFOULING PAINT BY SPRAYING

HEEG Opinion 15 considers:

[…] after a thorough evaluation of all available data, the HEEG recommends to pool the available data sets to get one larger set of measurements for spray painting of antifouling paint (the TNO 2007 study, the HSE surveys and the IOM study). A prerequisite for pooling all three data sets is that sufficient information on the individual measurements in the TNO study can be provided.

With the antifouling paint densities and individual measurements from the TNO study having been made available the prerequisite for pooling all three data sets is fulfilled. The pooled data on application of antifouling paint by professional spraying is shown in Annex 7.2. A summary of the data is presented in the table below. The 75th and 95th percentile values were calculated using a linear interpolation between closest ranks method and 90% confidence limits were calculated following BPR guidance. A Shapiro-Wilk test was used to test the assumption that the sample is from a lognormal distribution.

Table 1: Professional sprayer exposure (data from HSE, IOM and TNO studies)

	Sample size	Minimum (mg paint/ h)	Maximum (mg paint/ h)	Arithmetic mean (mg paint/h)	**P75 (mg paint /h)**	P75 LCL (mg paint/h)	P75 UCL (mg paint/ h)	P75 UCL: LCL
Potential body	57	63.7	62151.6	9269.9	**11702.4**	7994	17131	2
Potential hands	30	123.5	13188.7	3240.7	**4810.4**	3236	7150	2
Actual hands	29	1.2	237.6	51.6	**68.4**	37.4	125.3	3.4
Inhalation		Minimum (mg paint/m^3)	Maximum (mg paint/m^3)	Arithmetic mean (mg paint/m^3)	**P75 (mg paint/ m^3)**	P75 LCL (mg paint/ m^3)	P75 UCL (mg paint/ m^3)	P75 UCL: LCL
Inhalation	37	0.0	79.4	11.4	**11.3**	7.0	18.3	2.6

	P95 (mg paint/h)	P95 LCL (mg paint/h)	P95 UCL (mg paint/h)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Potential body	**40626**	23970	68856	2.9	0.254	Accept H_o
Potential hands	**7727**	4464	13377	3.0	0.037	Reject H_o
Actual hands	**200.6**	86.8	463.7	5.3	0.111	Accept H_o
	P95 (mg paint/m^3)	P95 LCL (mg paint/m^3)	P95 UCL (mg paint/m^3)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Inhalation	**39.0**	20.2	75.6	3.8	0.013	Reject H_o

P75 = 75th percentile; P95 = 95th percentile; UCL = Upper Confidence Limit; LCL = Lower Confidence Limit; S-W = Shapiro-Wilk; H_o = Null hypothesis

A comparison of the TNsG (2002) Spray Model 3 and more updated 75th and 95th percentile exposure values for the combined data from HSE, IOM and TNO studies are shown in the table below.

Table 2: TNsG Spray Model 3 vs. combined data from HSE, IOM and TNO professional sprayer exposure

Professional Sprayer	TNSG Spray Model 3	Combined data from HSE, IOM and TNO
Potential Body (mg paint/min)	250 (75th percentile) 745 (95th percentile)	195.04 (75th percentile) 677.1 (95th percentile)
Potential Hands (mg paint/min)	119 (worst case)	80.17 (75th percentile) 128.78 (95th percentile)
Actual Hands (mg paint/min)	2.04 (75th percentile) 3.95 (95th percentile)	1.14 (75th percentile) 3.34 (95th percentile)
Inhalation (mg paint/m^3)	17.3 (75th percentile) 64.6 (95th percentile)	11.3 (75th percentile) 39.0 (95th percentile)

HEEG Opinion 15 states that:
[*The somewhat different definition of potential exposure in the Links study compared to the one normally used should be given consideration, i.e. potential dermal exposure being defined as the combined exposure from both inner and outer dosimeters*].
Consequently, the TNO data could be considered more conservative than the IOM and HSE data which refer to the outer clothing contaminant layer.

APPLICATION BY BRUSHING AND ROLLING

HEEG Opinion 15 considers:
It was [provisionally] agreed by HEEG, as a conservative approach, to use the TNO study for assessment of exposure to professional roller painting only, but not for brush painting (neither application by professionals nor non-professionals) since only application by roller was measured in the study (HEEG opinion accepted at TM I 2012). Thus, for brush or combined brush/roller painting, use of the Consumer product painting model 4 was recommended.
However, after an evaluation of all data, including the provided raw data from the TNO study, the HEEG considers that the exposure data from the TNO study could be used for assessment of exposure during professional application of antifouling paint by roller as well as for the combined task of application of paint by brush and roller.
In the published report from Links et al. the AM, GM and 90th percentile exposure values are given as well as the range. Access to the raw data allows for calculating of 75th percentile exposure values, which are recommended as indicative exposure values for the specific data set. …]

Individual measurements for professional application by brush and roller application are shown in Annex 7.2. A summary of the data is shown in the table below. The 75th and 95th percentile values were calculated using a linear interpolation between closest ranks method and 90% confidence limits were calculated following BPR guidance. A Shapiro-Wilk test was used to test the assumption that the sample is from a lognormal distribution.

Table 3: Professional exposure during brushing and rolling (data TNO study)

	Sample size	Minimum (mg paint/h)	Maximum (mg paint/h)	Arithmetic mean (mg paint/h)	**P75 (mg paint/ h)**	P75 LCL (mg paint/h)	P75 UCL (mg paint/h)	P75 UCL: LCL
Potential body	15	338.26	6296.61	2881.55	**4217.85**	2990.72	5948.49	2.0
Potential hands	15	962.77	6471.79	2989.14	**3869.60**	2952.49	5071.60	1.7
Actual hands	15	0.06	0.90	0.26	**0.23**	0.15	0.36	2.4
	Sample size	Minimum (mg paint/m^3)	Maximum (mg paint/m^3)	Arithmetic mean (mg paint/ m^3)	**P75 (mg paint/m^3)**	P75 LCL (mg paint/ m^3)	P75 UCL (mg paint/ m^3)	P75 UCL: LCL
Inhalation	15	0.04	0.31	0.12	**0.13**	0.10	0.18	1.8

	P95 (mg paint/h)	P95 LCL (mg paint/ h)	P95 UCL (mg paint/ h)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Potential body	**5426.37**	3371.19	8734.45	2.6	0.1085	Accept H_o
Potential hands	**5399.33**	3712.72	7852.15	2.1	0.5493	Accept H_o
Actual hands	**0.86**	0.47	1.56	3.3	0.02232	Reject H_o
	P95 (mg paint/m^3)	P95 LCL (mg paint/m^3)	P95 UCL (mg paint/m^3)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Inhalation	**0.29**	0.19	0.44	2.3	0.06365	Accept H_o

A comparison of the TNsG (2002) Consumer Model 4, and 75th and 95th percentile exposure values based on TNO studies are shown in the table below.

Table 4: TNsG Non-Professional Brush and Roller Model 4 vs. TNO data Professional Brush & Roller exposure

Professional Brush/Roller	**TNsG Model 4**	**TNO 2007 study**
Potential Body (mg paint/min)	30.7 (75th percentile) 108 (worst case)	70.30 (75th percentile) 90.44 (95th percentile)
Potential Hands (mg paint/min)	76.6 (worst case)	64.49 (75th percentile) 89.99 (95th percentile)
Actual Hands (mg paint/min)	18.5 (worst case)	3.88E-03 (75th percentile) 1.43E-02 (95th percentile)
Inhalation (mg paint/m^3)	0.05 (75th percentile) 0.11 (worst case)	0.13 (75th percentile) 0.29 (95th percentile)

ASSISTANT WORKERS (ANCILLARY WORKERS AND POTMEN)

HEEG Opinion 15 considers:
As the assistant workers seemed to have the combined task of paint filling (pot man) and general assistance (ancillary worker), the TNO data cannot be easily used for assessment of the individual tasks of potmen or ancillary worker. Hence, exposure data included in the existing guidance documents (TNsG 2002/User guidance or BEAT) will have to be used. As for exposure to ancillary workers, working in the vicinity of the spray painter, the exposure is considered to be no higher than the exposure to the paint sprayer. Hence, an assumption could be made that the exposure is covered by the exposure data for the spray painter (a prerequisite for using actual exposure data being that the same PPE is assumed used).

For potmen the HSE and IOM exposure values are provided in Appendix 1 and a summary of the data in the table below. The 75th and 95th percentile values were calculated using a linear interpolation between closest ranks method and 90% confidence limits were calculated following BPR guidance. A Shapiro-Wilk test was used to test the assumption that the sample is from a lognormal distribution.

Table 5: Professional potmen exposure (data HSE and IOM studies)

	Sample size	Minimum (mg paint/h)	Maximum (mg paint/h)	Arithmetic mean (mg paint/h)	**P75 (mg paint/h)**	P75 LCL (mg paint/h)	P75 UCL (mg paint/h)	P75 UCL: LCL
Potential body	37	16.80	32925.42	6503.97	**6840.66**	4798.35	9752.24	2.0
Potential hands	16	183.60	78443.34	23405.16	**52491.06**	30251.81	91079.23	3.0
Actual hands	12	4.80	648.00	97.00	**75.30**	37.02	153.15	4.1
	Sample size	Minimum (mg paint/m^3)	Maximum (mg paint/m^3)	Arithmetic mean (mg paint/m^3)	**P75 (mg paint/m^3)**	P75 LCL (mg paint/m^3)	P75 UCL (mg paint/m^3)	P75 UCL: LCL
Inhalation	20	0.04	41.80	2.85	**1.45**	0.74	2.83	3.8

	P95 (mg paint/h)	P95 LCL (mg paint/h)	P95 UCL (mg paint/h)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Potential body	**23358.98**	14296.62	38165.80	2.7	0.0629	Accept H_o
Potential hands	**76532.96**	35685.55	164136.28	4.6	0.2186	Accept H_o
Actual hands	**378.72**	141.73	1012.00	7.1	0.9336	Accept H_o
	P95 (mg paint/m^3)	P95 (mg paint/m^3)	P95 UCL (mg paint/m^3)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Inhalation	**5.74**	2.28	14.47	6.4	0.02136	Reject H_o

A comparison of the TNsG (2002) Mixing and Loading Model 6, and 75th and 95th percentile exposure values based on combined HSE and IOM studies are shown in the table below.

Table 6: TNsG Mixing and Loading Model 6 vs. combined HSE and IOM data

Professional Potman	TNsG Mixing and Loading Model 6	HSE & IOM data
Potential Body (mg paint/min)	92 (75th percentile) 222 (95th percentile)	114.01 (75th percentile) 389.32 (95th percentile)
Potential Hands (mg paint/min)	30 (worst case)	874.85 (75th percentile) 1275.55 (95th percentile)
Actual Hands (mg paint/min)	8.2 (95th percentile)	1.26 (75th percentile) 3.05 (95th percentile)
Inhalation (mg paint/m^3)	1.9 (75th percentile) 17 (95th percentile)	1.45 (75th percentile) 5.74 (95th percentile)

PAINT REMOVAL (SAND BLASTING)

HEEG Opinion 15 considers:
The exposure data from the TNO study should be given preference to the spraying model 3 from TNsG for assessing exposure to paint removal by sand blasting.
In the publication, only AM/GM and the 90th percentile values are available. A 75th percentile value could be calculated assuming a log normal distribution of the data. (If further information on the individual measurements can be provided, the individual measurements should be used in establishing the 75th percentile value).
The average concentration of a.s. in collected old paint layers is recommended used for converting the exposure load into old paint equivalents (if access to individual records does not open up for a direct comparison of exposure load (expressed as amount of a.s.) and a specific concentration of a.s. in collected paint layers).

In absence of specific information on whether the exhausted outer layer was already removed by hydroblasting before sand blasting took place (leaving only the innermost layer to be removed), the removed paint layer is assumed to consists of only the innermost layer containing 90 % of the original concentration of a.s. as a worst case assumption. A refinement might be possible if further information is possible to retrieve from TNO.
It seems reasonable to assume the same time duration for the task of sand blasting as for paint spraying i.e.180 minutes.

To calculate the appropriate exposure values the measured exposure in the 2007 TNO study (expressed as a.s. per time duration or m^3) was converted to old paint equivalents using the measured average concentration of a.s. in collected old paint layers (10.8 % w/w, p. 214) as suggested by HEEG.

Based on the TNO raw data 75th and 95th percentiles were calculated for professional removal sand/grit blaster using a linear interpolation between closest ranks method and 90% confidence limits were calculated following BPR guidance. A Shapiro-Wilk test was used to test the assumption that the sample is from a lognormal distribution. The summarized values are shown below and used for occupational exposure assessment.

Table 7: Exposure during sandblasting (data TNO study)

	Sample size	Minimum (mg paint/h)	Maximum (mg paint/h)	Arithmetic mean (mg paint/h)	**P75 (mg paint/h)**	P75 LCL (mg paint/h)	P75 UCL (mg paint/h)	P75 UCL: LCL
Potential body	9	56.27	984.58	310.12	**273.36**	152.13	491.22	3.2
Actual body	12	12.84	132.13	39.11	**39.52**	27.12	57.58	2.1
Potential hands	9	123.22	1412.36	504.66	**625.98**	357.75	1095.33	3.1
Actual hands	12	15.59	277.78	102.86	**182.40**	107.86	308.46	2.9
Inhalation	Sample size	Minimum (mg paint/ m^3)	Maximum (mg paint/ m^3)	Arithmetic mean (mg paint/m^3)	**P75 (mg paint/m^3)**	P75 LCL (mg paint/m^3)	P75 UCL (mg paint/m^3)	P75 UCL: LCL
	12	0.39	17.11	7.64	**11.84**	6.00	24.12	4.0

	P95 (mg paint/h)	P95 LCL (mg paint/h)	P95 UCL (mg paint/h)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Potential body	**839.82**	373.06	1890.55	5.1	0.6646	Accept H_o
Actual body	**102.62**	60.94	172.81	2.8	0.3841	Accept H_o
Potential hands	**1237.66**	570.41	2685.42	4.7	0.3313	Accept H_o
Actual hands	**244.57**	118.16	506.18	4.3	0.434	Accept H_o
	P95 (mg paint/m^3)	P95 LCL (mg paint/m^3)	P95 UCL (mg paint/m^3)	P95 UCL:LCL	S-W test p value	Lognormal H_o
Inhalation	**16.08**	6.00	43.09	7.2	0.03019	Reject H_o

Annex 7.2 Antifouling paint application and removal occupational exposure values

APPLICATION OF ANTIFOULING PAINT BY SPRAYING

Based on combined data, from HSE surveys, IOM and TNO studies.

Scenario	Detailed scenario	Gloves	SG (kg/l)	Potential Body Exposure (mg paint per hour)	Potential Hand Exposure (mg paint per hour)	Actual Hand Exposure (mg paint per hour)	Inhalation Exposure (mg paint per m^3)
Spraying	Antifoulant paint spraying (IOM)	No	2.30	1468.32			2.28
Spraying	Antifoulant paint spraying (IOM)	No	2.30	5822.22			2.74
Spraying	Antifoulant paint spraying (IOM)	No	1.70	3284.40	4783.80		8.04
Spraying	Antifoulant paint spraying (IOM)	No	2.30	16579.32	509.22		12.03
Spraying	Antifoulant paint spraying (IOM)	No	2.30	1962.36	138.00		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	2762.76	1580.10		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	9731.76	1675.32		
Spraying	Antifoulant paint spraying (IOM)	No	1.70	2505.12	1319.88		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	22888.68	2278.38		
Spraying	Antifoulant paint spraying (IOM)	No	1.70	15147.00	4433.94		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	4693.38	6290.04		
Spraying	Antifoulant paint spraying (IOM)	No	1.70	11265.90	6039.42		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	17327.28	8205.48		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	3881.94	13188.66		
Spraying	Antifoulant paint spraying (IOM)	No	2.30	1270.98			
Spraying	Antifoulant paint spraying (IOM)	No	2.30	2123.82			
Spraying	Antifoulant paint spraying (IOM)	No	2.30	5831.88			
Spraying	Antifoulant paint spraying (IOM)	No	2.30	6902.76			
Spraying	Antifoulant spraying (HSE)	Yes	2.00	17013.60		97.20	0.04
Spraying	Antifoulant spraying (HSE)	Yes	2.00	96.00		1.20	0.10
Spraying	Antifoulant spraying (HSE)	Yes	2.00	1616.40		4.80	0.20
Spraying	Antifoulant spraying (HSE)	Yes	2.00	1084.80		7.20	1.26
Spraying	Antifoulant spraying (HSE)	Yes	2.00	3060.00		87.60	1.92
Spraying	Antifoulant spraying (HSE)	Yes	2.00	7042.80		15.60	2.20
Spraying	Antifoulant spraying (HSE)	Yes	2.00	3525.60		163.20	2.60
Spraying	Antifoulant spraying (HSE)	Yes	2.00	6172.80		60.00	3.12
Spraying	Antifoulant spraying (HSE)	Yes	2.00	6103.20		52.80	3.40

Spraying	Antifoulant spraying (HSE)	Yes	2.00	14706.00		34.80	3.68
Spraying	Antifoulant spraying (HSE)	Yes	2.00	16386.00		237.60	5.68
Spraying	Antifoulant spraying (HSE)	Yes	2.00	693.60		12.00	7.56
Spraying	Antifoulant spraying (HSE)	Yes	2.00	8026.80		130.80	7.60
Spraying	Antifoulant spraying (HSE)	Yes	2.00	11702.40		22.80	10.40
Spraying	Antifoulant spraying (HSE)	Yes	2.00	62151.60		68.40	11.34
Spraying	Antifoulant spraying (HSE)	Yes	2.00	1364.40			15.66
Spraying	Antifoulant spraying (HSE)	Yes	2.00	17307.60		120.00	22.40
Spraying	Antifoulant spraying (HSE)	Yes	2.00	43196.40		225.60	22.80
Spraying	Antifoulant spraying (HSE)	Yes	2.00	2876.40			32.60
Spraying	Antifoulant spraying (HSE)	Yes	2.00	39984.00		56.40	64.80
Spraying	Antifoulant spraying (HSE)	Yes	2.00	8520.00			79.40
Spraying	Antifoulant spraying (HSE)	No	2.00	4809.60	1299.60		
Spraying	Antifoulant spraying (HSE)	No	2.00	36680.40	2529.60		
Spraying	Antifoulant spraying (HSE)	No	2.00	45765.60	4248.00		
Spraying	Antifoulant spraying (HSE)	No	2.00	7256.40	4819.20		
Spraying	Antifoulant spraying (HSE)	No	2.00	13528.80	5542.80		
Spraying	Antifoulant spraying (HSE)	No	2.00	3240.00	7142.40		
Spraying	Spraying (TNO)	Yes	1.80	118.78	1912.82	3.32	0.65
Spraying	Spraying (TNO)	Yes	1.80	63.72	212.82	2.31	2.24
Spraying	Spraying (TNO)	Yes	1.80	488.04	5806.62	14.25	2.39
Spraying	Spraying (TNO)	Yes	1.80	421.09	1254.95	2.25	3.74
Spraying	Spraying (TNO)	Yes	1.80	548.39	381.78	3.13	5.47
Spraying	Spraying (TNO)	Yes	1.80	517.49	2821.22	1.43	6.74
Spraying	Spraying (TNO)	Yes	1.80	541.85	123.46	1.86	7.07
Spraying	Spraying (TNO)	Yes	1.80	567.57	1683.04	23.68	10.62
Spraying	Spraying (TNO)	Yes	1.80	651.30	378.59		10.91
Spraying	Spraying (TNO)	Yes	1.80	1647.89	3164.01	33.09	11.18
Spraying	Spraying (TNO)	Yes	1.80	697.44	1687.36	3.09	14.56
Spraying	Spraying (TNO)	Yes	1.80	2760.37	1770.08	9.41	23.83

Measurement method in TNO data for dermal hand exposure based on worker applying the paint wears one pair of cotton gloves under (actual) and one pair of cotton gloves over (potential) nitrile gloves.
Measurement method in HSE data for dermal hand exposure based on worker wearing white cotton gloves over the protective gloves provided for the task to demonstrate potential dermal exposure. Sampling gloves worn beneath protective gloves was used to demonstrate actual dermal exposure (EH74/3, 3.5 Gloves, general comment on sampling). As for the IOM study (Hughson and Aitken, 2004, page 247), white cotton fourchette gloves were worn on the outside of the protective gloves usually provided for the task to monitor potential exposure to hands.

APPLICATION BY BRUSHING AND ROLLING

Based on TNO data.

Scenario	Detailed scenario	Gloves	SG (kg/l)	Potential Body Exposure (mg paint / hour)	Potential Hand Exposure (mg paint / hour)	Actual Hand Exposure (mg paint / hour)	Inhalation Exposure (mg paint / m^3)
Rolling	Rolling (TNO)	Yes	1.40	338.26	1153.70	0.68	0.05
Rolling	Rolling (TNO)	Yes	1.40	1187.62	2725.24	0.24	0.06
Rolling	Rolling (TNO)	Yes	1.40	1619.59	4257.72	0.11	0.130
Rolling	Rolling (TNO)	Yes	1.40	1755.83	2384.92	0.13	0.09
Rolling	Rolling (TNO)	Yes	1.40	1770.04	2952.09	0.22	0.31
Rolling	Rolling (TNO)	Yes	1.40	1861.63	1840.25	0.14	0.09
Rolling	Rolling (TNO)	Yes	1.40	1903.90	1633.21	0.10	0.07
Rolling	Rolling (TNO)	Yes	1.40	2550.56	3644.60	0.90	0.06
Rolling	Rolling (TNO)	Yes	1.40	2583.57	962.77	0.06	0.06
Rolling	Rolling (TNO)	Yes	1.40	3011.72	1135.50	0.07	0.06
Rolling	Rolling (TNO)	Yes	1.40	3942.63	6471.79	0.06	0.08
Rolling	Rolling (TNO)	Yes	1.40	4493.06	3513.53	0.09	0.25
Rolling	Rolling (TNO)	Yes	1.40	4854.80	4094.61	0.14	0.04
Rolling	Rolling (TNO)	Yes	1.40	5053.40	3127.42	0.10	0.133
Rolling	Rolling (TNO)	Yes	1.40	6296.61	4939.71	0.84	0.28

Measurement method in TNO data for dermal hand exposure based on worker applying the paint wears one pair of cotton gloves under (actual) and one pair of cotton gloves over (potential) nitrile gloves.

POTMEN

Based on existing BEAT model data, i.e HSE and IOM data.

Scenario	Detailed scenario	Gloves	SG (kg/l)	Potential Body Exposure (mg paint per hour)	Potential Hand Exposure (mg paint per hour)	Actual Hand Exposure (mg paint per hour)	Inhalation Exposure (mg paint per m^3)
Potman	Antifoulant potman (HSE)	Yes	2.00	129.60		4.80	0.20
Potman	Antifoulant potman (HSE)	Yes	2.00	840.00		7.20	0.10
Potman	Antifoulant potman (HSE)	Yes	2.00	3656.40		15.60	0.20
Potman	Antifoulant potman (HSE)	Yes	2.00	6298.80		19.20	0.20
Potman	Antifoulant potman (HSE)	Yes	2.00	3993.60		26.40	0.20
Potman	Antifoulant potman (HSE)	Yes	2.00	844.80		31.20	0.84
Potman	Antifoulant potman (HSE)	Yes	2.00	3300.00		34.80	0.04
Potman	Antifoulant potman (HSE)	Yes	2.00	1089.60		42.00	0.80
Potman	Antifoulant potman (HSE)	Yes	2.00	15526.80		62.40	0.16
Potman	Antifoulant potman (HSE)	Yes	2.00			114.00	0.18
Potman	Antifoulant potman (HSE)	Yes	2.00	1210.80		158.40	1.40
Potman	Antifoulant potman (HSE)	Yes	2.00	2565.60		648.00	1.60
Potman	Antifoulant potman (HSE)	No	2.00	790.80	403.20		0.10
Potman	Antifoulant potman (HSE)	No	2.00	537.60	183.60		0.20
Potman	Antifoulant potman (HSE)	No	2.00	396.00			0.20
Potman	Antifoulant potman (HSE)	Yes	2.00	16.80			0.22
Potman	Antifoulant potman (HSE)	No	2.00	9410.40	5554.80		2.00
Potman	Antifoulant potman (HSE)	Yes	2.00	5833.20			2.80
Potman	Antifoulant potman (HSE)	Yes	2.00	5390.40			3.84
Potman	Antifoulant potman (HSE)	Yes	2.00	346.80			41.80
Potman	Antifoulant potman (HSE)	No	2.00	6510.00	456.00		
Potman	Antifoulant potman (HSE)	No	2.00	14019.60	1370.40		
Potman	Antifoulant potman (HSE)	No	2.00	3988.80	1680.00		
Potman	Antifoulant potman (HSE)	No	2.00	940.80	1791.60		
Potman	Antifoulant potman (IOM)	No	2.30	6840.66	4338.72		
Potman	Antifoulant potman (IOM)	No	2.30	32925.42	5728.38		
Potman	Antifoulant potman (IOM)	No	1.70	910.86	11199.60		
Potman	Antifoulant potman (IOM)	No	2.30	416.76	15287.64		
Potman	Antifoulant potman (IOM)	No	2.30	2213.52	51233.88		
Potman	Antifoulant potman (IOM)	No	2.30	6528.78	56262.60		
Potman	Antifoulant potman (IOM)	No	2.30	21939.24	78443.34		
Potman	Antifoulant potman (IOM)	No	1.70	9036.18	64652.70		
Potman	Antifoulant potman (IOM)	No	1.70	5155.08	75896.16		
Potman	Antifoulant potman (IOM)	No	2.30	2795.88			
Potman	Antifoulant potman (IOM)	No	2.30	4789.98			
Potman	Antifoulant potman (IOM)	No	2.30	10940.64			
Potman	Antifoulant potman (IOM)	No	2.30	19478.70			
Potman	Antifoulant potman (IOM)	No	2.30	29037.96			

Potman	Paintfilling (TNO)*	Yes	1.80	888.40	4254.23	0.66	2.04
Potman	Paintfilling (TNO)*	Yes	1.80	3661.55	7077.79	1.12	0.30
Potman	Paintfilling (TNO)*	Yes	1.80	702.49	3924.72	1.43	4.14
Potman	Paintfilling (TNO)*	Yes	1.80	297.60	692.43	1.93	1.31
Potman	Paintfilling (TNO)*	Yes	1.80	213.63	3560.18	2.78	0.85
Potman	Paintfilling (TNO)*	Yes	1.80	3616.83	2941.17	3.53	4.15
Potman	Paintfilling (TNO)*	Yes	1.80	466.81	566.07	7.70	6.44
Potman	Paintfilling (TNO)*	Yes	1.80	4733.82	5345.50	8.63	0.59
Potman	Paintfilling (TNO)*	Yes	1.80	1407.49	7833.28		1.21
Potman	Paintfilling (TNO)*	Yes	1.80	918.91	30507.49		7.93

*According to HEEG Opinion these values should be excluded as the assistant workers seemed to have the combined task of paint filling (pot man) and general assistance (ancillary worker), thus the data cannot be easily used for assessment of the individual tasks of potmen or ancillary worker. The assistant workers are located on the floor, in the vicinity of the paint sprayer and are not as exposed to the paint (since they're responsible for general assistance e.g. by keeping paint lines free and manoeuvring the platform) compared to potmen who prepare the paint and ensure the continuous supply of paint to the high pressure pump, with the major contribution to exposure arising from contact with contaminated surfaces for which the mixing station might be remote from the area being painted.

Measurement method in TNO data for dermal hand exposure based on worker applying the paint wears one pair of cotton gloves under (actual) and one pair of cotton gloves over (potential) nitrile gloves.
Measurement method in HSE data for dermal hand exposure based on worker wearing white cotton gloves over the protective gloves provided for the task to demonstrate potential dermal exposure. Sampling gloves worn beneath protective gloves was used to demonstrate actual dermal exposure (EH74/3, 3.5 Gloves, general comment on sampling). As for the IOM study (Hughson and Aitken, 2004, page 247), white cotton fourchette gloves were worn on the outside of the protective gloves usually provided for the task to monitor potential exposure to hands.

PAINT REMOVAL (SAND BLASTING)

Based on TNO data.

Sand-blasting	Detailed scenario	Air conc a.s. (mg / m^3)	Air conc (mg paint / m^3)*	Pot. dermal body (mg a.s. / hour)	Pot. dermal body (mg paint / hour)*	Act. dermal body (mg a.s. / hour)	Act. dermal body (mg paint / hour)*	Pot.derm hands (mg a.s. / hour)	Pot. derm. hands (mg paint / hour)*	Act. Derm hands (mg a.s. / hour)	Act. derm. hands (mg paint / hour)*
Sand-blasting	Sand-blasting (TNO)	0.10	0.89	7.43	68.75	1.39	12.84	16.69	154.56	1.69	15.67
Sand-blasting	Sand-blasting (TNO)	0.22	2.04	6.08	56.27	1.39	12.897	13.32	123.30	1.68	15.59
Sand-blasting	Sand-blasting (TNO)	0.98	9.07	29.07	269.18	1.49	13.83	64.50	597.19	7.94	73.54
Sand-blasting	Sand-blasting (TNO)	0.17	1.62	29.52	273.36	2.12	19.67	35.66	330.22	5.87	54.39
Sand-blasting	Sand-blasting (TNO)	0.09	0.83	9.63	89.19	2.64	24.44	13.31	123.22	3.46	32.05
Sand-blasting	Sand-blasting (TNO)	1.28	11.84	20.08	185.92	2.75	25.51	67.61	625.98	19.44	179.97
Sand-blasting	Sandblasting (TNO)	1.04	9.67			3.37	31.196			10.55	97.68
Sand-blasting	Sand-blasting (TNO)	1.65	15.25	67.25	622.68	4.13	38.21	105.37	975.61	20.49	189.70
Sand-blasting	Sandblasting (TNO)	1.20	11.12			4.21	38.95			30.00	277.78
Sand-blasting	Sand-blasting (TNO)	0.04	0.39	26.05	241.20	4.45	41.20	21.55	199.54	4.05	37.50
Sand-blasting	Sand-blasting (TNO)	1.28	11.84	106.34	984.58	8.48	78.48	152.54	1412.36	4.65	43.04
Sand-blasting	Sand-blasting (TNO)	1.85	17.11			14.27	132.13			23.48	217.39

*HEEG Opinion: The measured exposure in the Links et al., 2007 study (expressed as a.s. per time duration or m^3) was converted to old paint equivalents using the measured average concentration of a.s. in collected old paint layers of 10.8 % w/w (page 214 of Links et al., 2007 paper).

Measurement method in TNO data for dermal hand exposure based on worker applying the paint wears one pair of cotton monitoring gloves only, under newly provided strong protective gloves. As a measure for potential hand exposure loading, the protective gloves were analysed.

Annex 7.3 PLOTS OF INDIVIDUAL EXPOSURE DATA FOR APPLICATION AND REMOVAL OF ANTIFOULING PAINTS

Application of antifouling paint by spraying

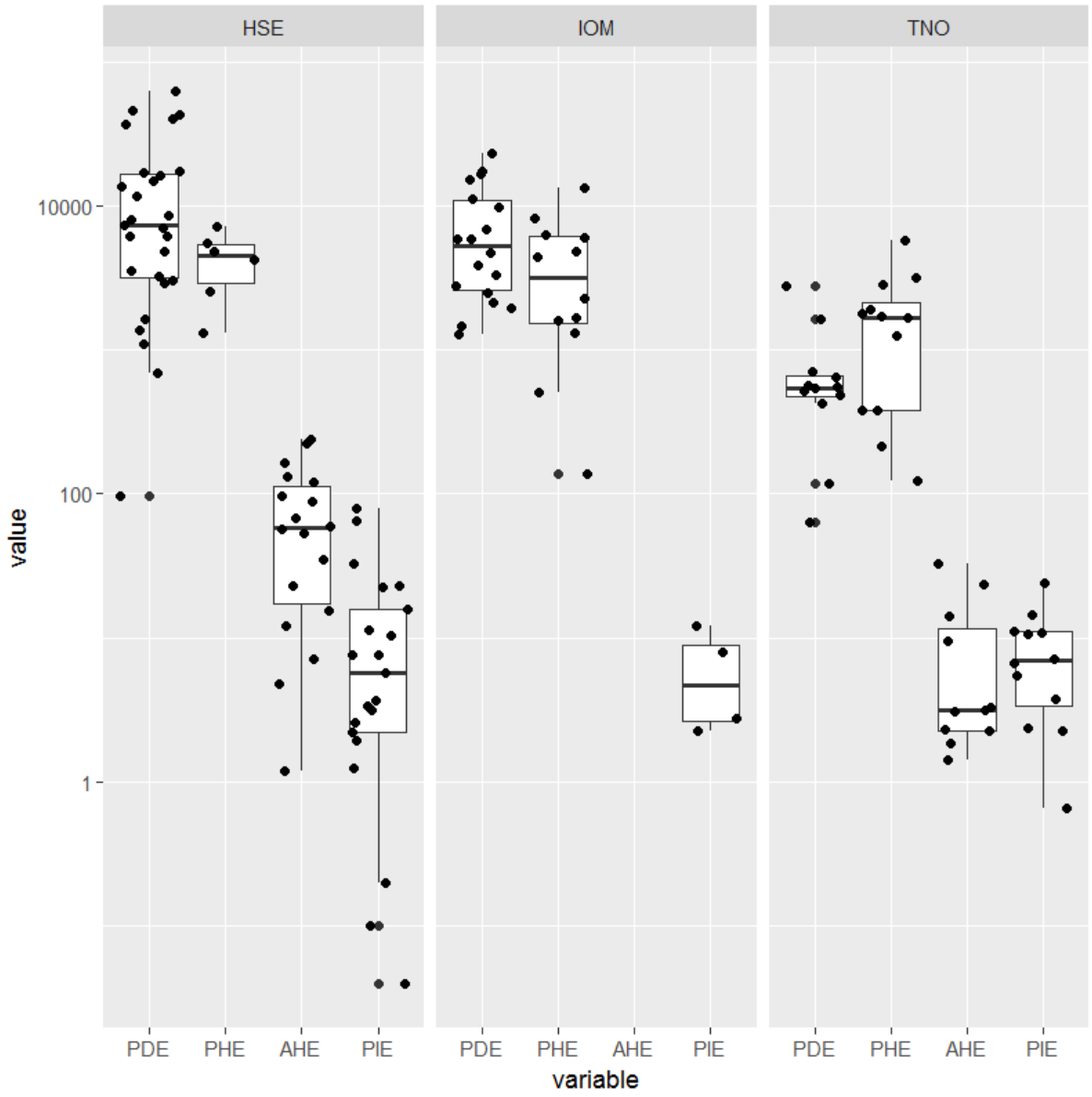

Figure 1 Plots of individual data points for Potential Body Exposures (PDE), Potential Hand Exposures (PHE), Actual Hand Exposures (AHE), and Potential Inhalation Exposures (PIE) from HSE, IOM, and TNO studies. Exposure units are mg paint/hour for dermal exposures and mg paint/m^3 for inhalation exposures. The individual data are grouped by study, and are imposed on summary box plots which show median (bar), 25th and 75th percentile (lower and upper hinges) values, the whiskers extend from the hinges to 1.5 times the interquartile range unless limited by the minimum or maximum observed.

The assumption that exposure distributions are lognormal was formally assessed by applying a Shapiro-Wilk normality test to log transformed data. Results are reported in the tables summarising the data in the main text and below. In addition, quantile plots were made, as shown below.

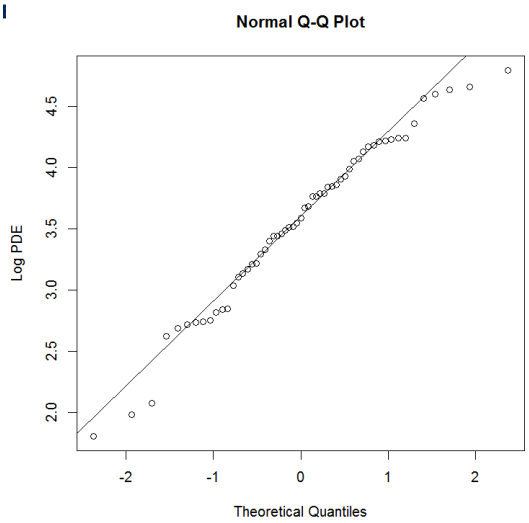

Figure 2 Normal quantile-quantile plot for professional spraying combined data for Log Potential Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.25, accept H_o data are from lognormal distribution.

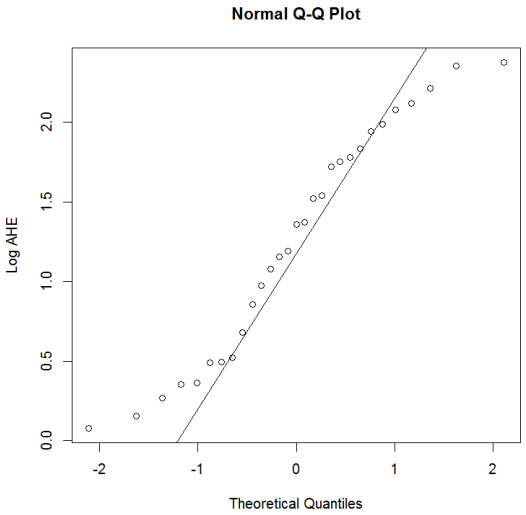

Figure 4 Normal quantile-quantile plot for professional spraying combined data for Log Actual Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.11, accept Ho data are from lognormal distribution.

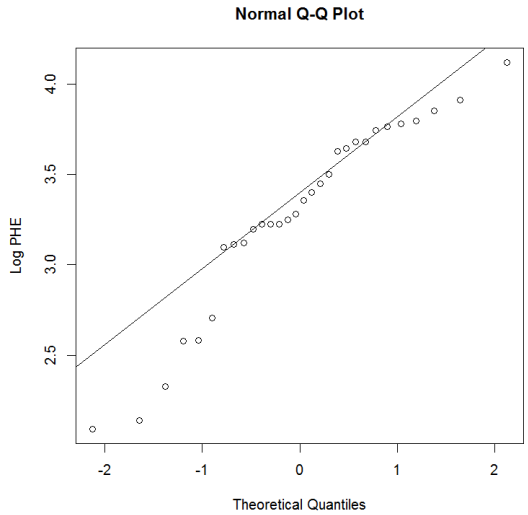

Figure 3 Normal quantile-quantile plot for professional spraying combined data for Log Potential Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.037, reject Ho data are from lognormal distribution.

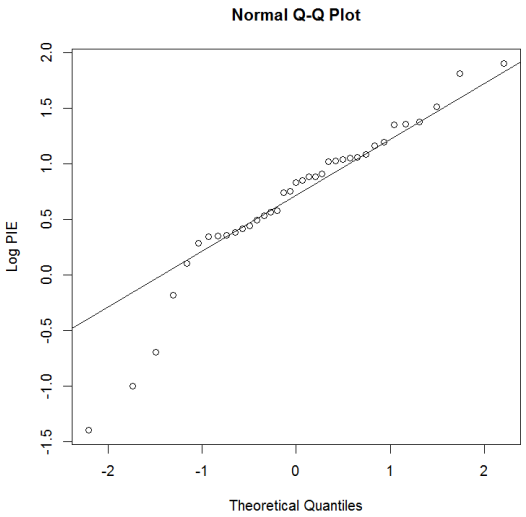

Figure 5 Normal quantile-quantile plot for professional spraying combined data for Log Potential Inhalation Exposure (mg paint/m3)

Shapiro-Wilk normality test p value = 0.013, reject Ho data are from lognormal distribution.

Application of antifouling paint by brushing and rolling

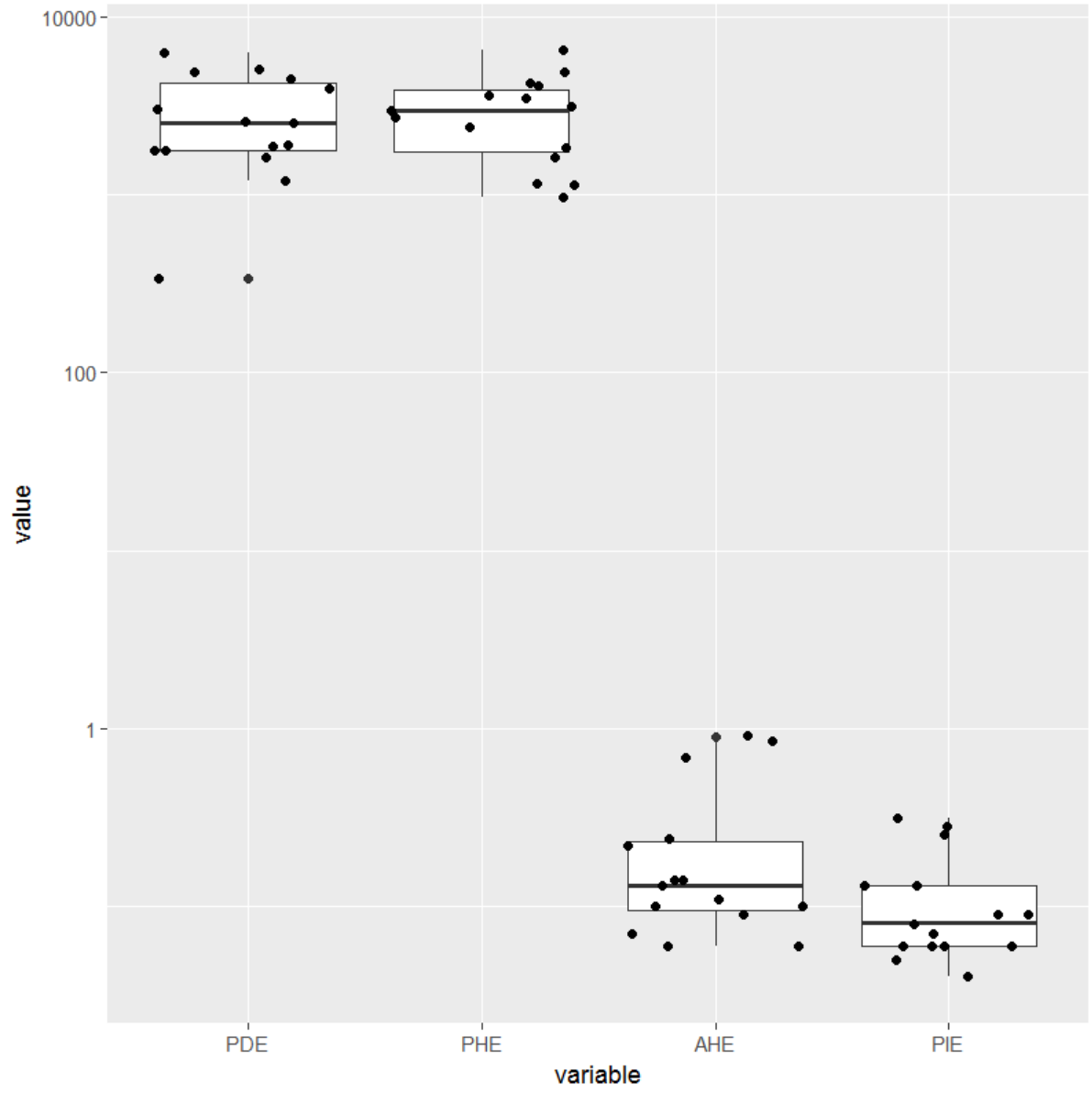

Figure 6 Plots of individual data points for Potential Body Exposures (PDE), Potential Hand Exposures (PHE), Actual Hand Exposures (AHE), and Potential Inhalation Exposures (PIE) from TNO study. Exposure units are mg paint/hour for dermal exposures and mg paint/m3 for inhalation exposures. The individual data are grouped by study, and are imposed on summary box plots which show median (bar), 25th and 75th percentile (lower and upper hinges) values, the whiskers extend from the hinges to 1.5 times the interquartile range unless limited by the minimum or maximum observed.

The assumption that exposure distributions are lognormal was formally assessed by applying a Shapiro-Wilk normality test to log transformed data. Results are reported in the tables summarising the data in the main text and below. In addition, quantile plots were made, as shown below.

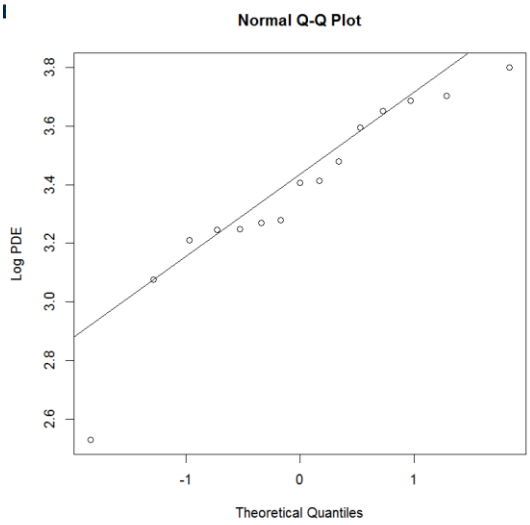

Figure 7 Normal quantile-quantile plot for professional rolling TNO data for Log Potential Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.11, accept H_o data are from lognormal distribution.

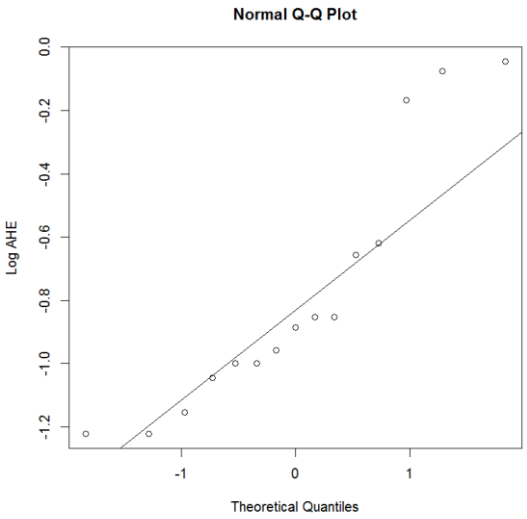

Figure 9 Normal quantile-quantile plot for professional rolling TNO data for Log Actual Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.022, reject H_o data are from lognormal distribution.

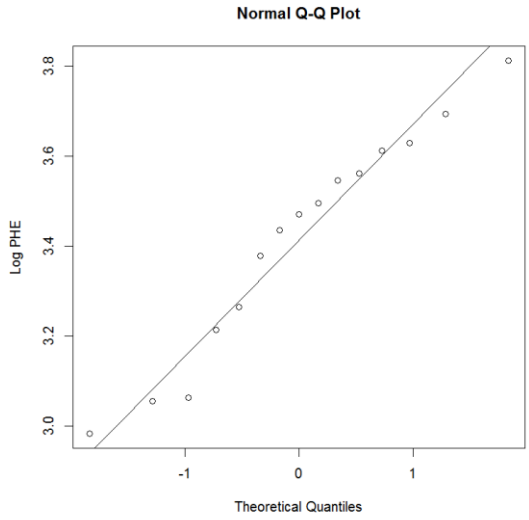

Figure 8 Normal quantile-quantile plot for professional rolling TNO data for Log Potential Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.55, accept H_o data are from lognormal distribution.

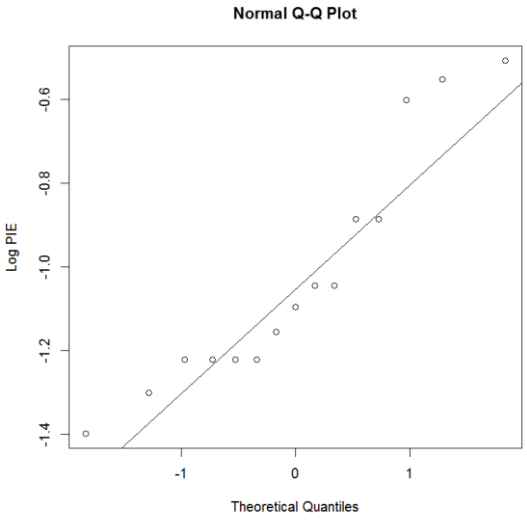

Figure 10 Normal quantile-quantile plot for professional rolling TNO data for Log Potential Inhalation Exposure (mg paint/m3)

Shapiro-Wilk normality test p value = 0.064, accept H_o data are from lognormal distribution.

Assistant workers (ancillary workers and potmen)

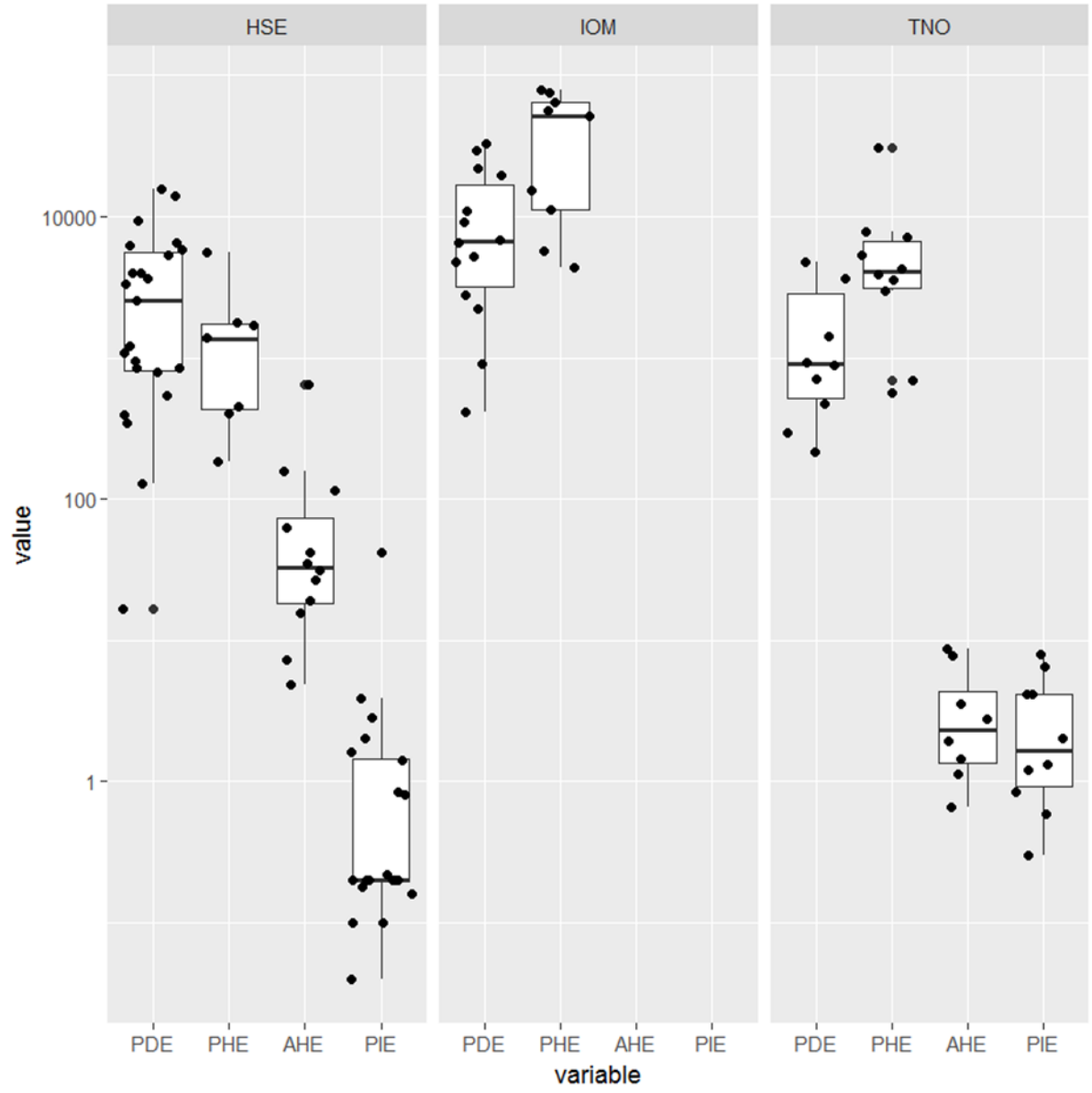

Figure 11 Plots of individual data points for Potential Body Exposures (PDE), Potential Hand Exposures (PHE), Actual Hand Exposures (AHE), and Potential Inhalation Exposures (PIE) for potmen from HSE, IOM, and TNO studies. Exposure units are mg paint/hour for dermal exposures and mg paint/m3 for inhalation exposures. Data are grouped by study, and box plots show median (bar), 25th and 75th percentile (lower and upper hinges) values, the whiskers extend from the hinges to 1.5 times the interquartile range unless limited by the minimum or maximum observed.

The assumption that exposure distributions are lognormal was formally assessed by applying a Shapiro-Wilk normality test to log transformed data. Results are reported in the tables summarising the data in the main text and below. In addition, quantile plots were made, as shown below. This was done separately for the HSE and IOM data only together, and for the combined data from all three sources.

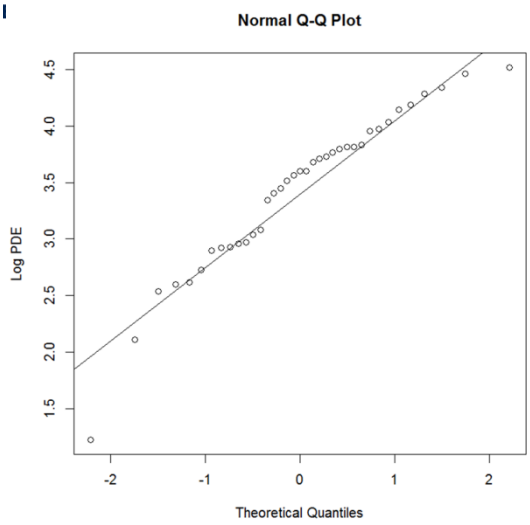

Figure 12 Normal quantile-quantile plot for potmen from HSE and IOM data for Log Potential Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.061, accept H_o data are from lognormal distribution.

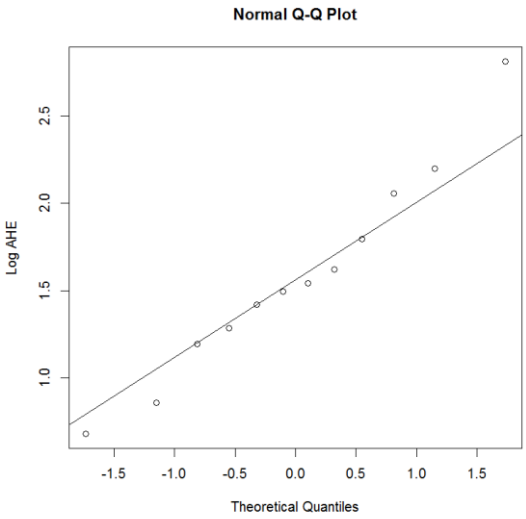

Figure 14 Normal quantile-quantile plot for potmen from HSE and IOM data for Log Actual Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.93, accept H_o data are from lognormal distribution.

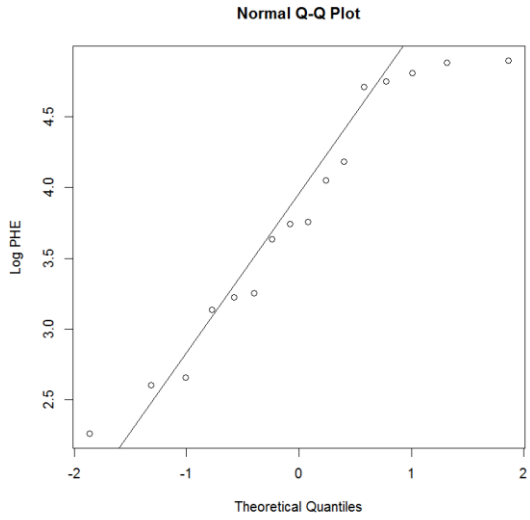

Figure 13 Normal quantile-quantile plot for potmen for HSE and IOM data for Log Potential Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.22, accept H_o data are from lognormal distribution.

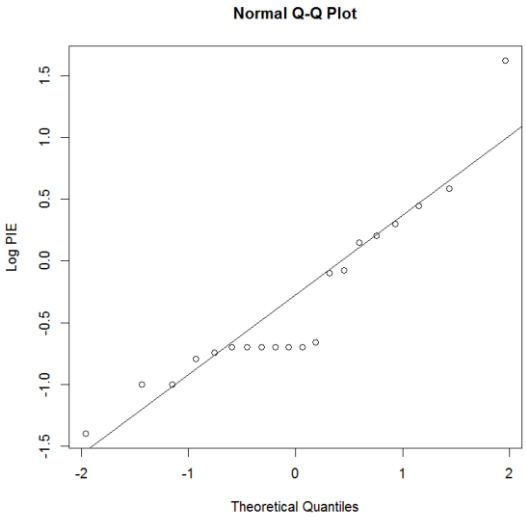

Figure 15 Normal quantile-quantile plot for potmen for HSE and IOM data for Log Potential Inhalation Exposure (mg paint/m3)

Shapiro-Wilk normality test p value = 0.021, reject H_o data are from lognormal distribution.

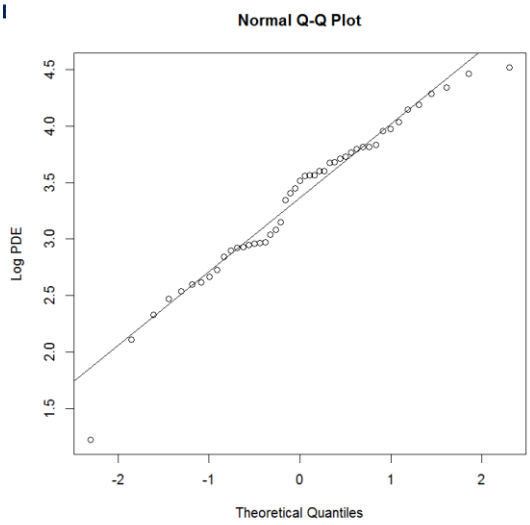

Figure 16 Normal quantile-quantile plot for potmen from HSE, IOM and TNO data for Log Potential Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.17, accept H_o data are from lognormal distribution.

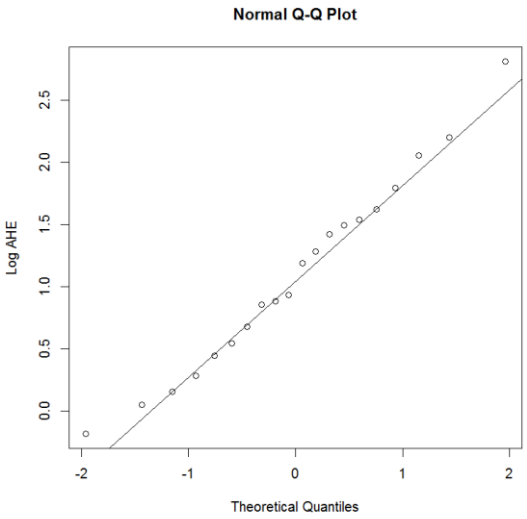

Figure 18 Normal quantile-quantile plot for potmen from HSE , IOM and TNO data for Log Actual Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.97, accept H_o data are from lognormal distribution.

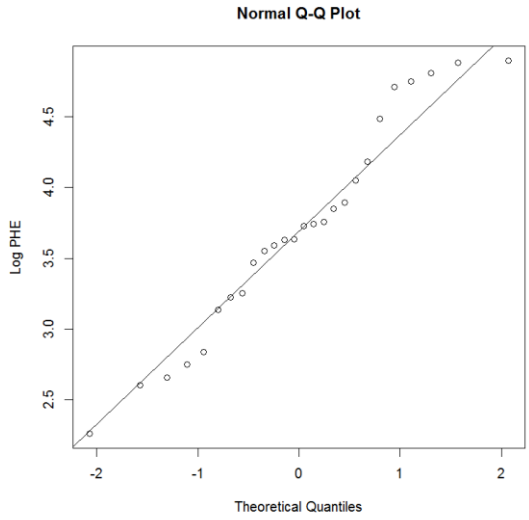

Figure 17 Normal quantile-quantile plot for potmen for HSE , IOM and TNO data for Log Potential Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.35, accept H_o data are from lognormal distribution.

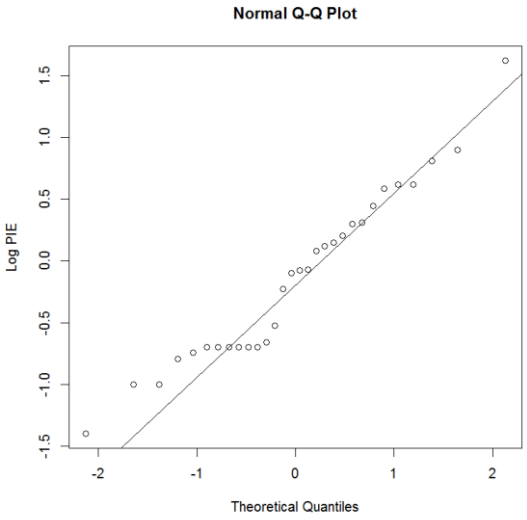

Figure 19 Normal quantile-quantile plot for potmen for HSE , IOM and TNO data for Log Potential Inhalation Exposure (mg paint/m3)

Shapiro-Wilk normality test p value = 0.24, accept H_o data are from lognormal distribution.

Paint removal (sand blasting)

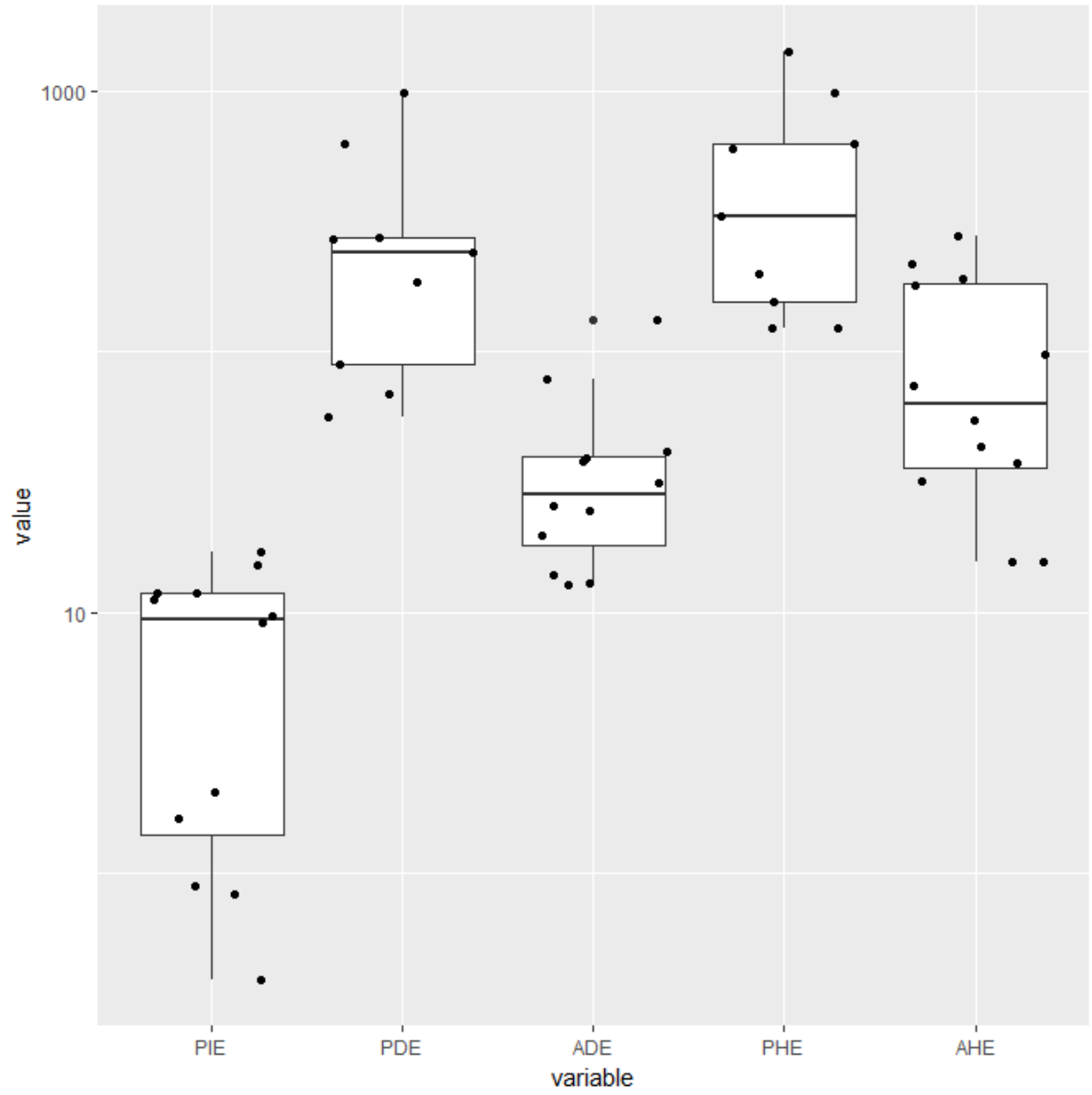

Figure 20 Plots of individual data points for Potential Inhalation Exposures (PIE), Potential Body Exposures (PDE), Actual Body Exposures (ADE), Potential Hand Exposures (PHE), and Actual Hand Exposures (AHE) from TNO study. Exposure units are mg paint/hour for dermal exposures and mg paint/m3 for inhalation exposures. The individual data are imposed on summary box plots which show median (bar), 25th and 75th percentile (lower and upper hinges) values, the whiskers extend from the hinges to 1.5 times the interquartile range unless limited by the minimum or maximum observed.

The assumption that exposure distributions are lognormal was formally assessed by applying a Shapiro-Wilk normality test to log transformed data. Results are reported in the tables summarising the data in the main text and below. In addition, quantile plots were made, as shown below.

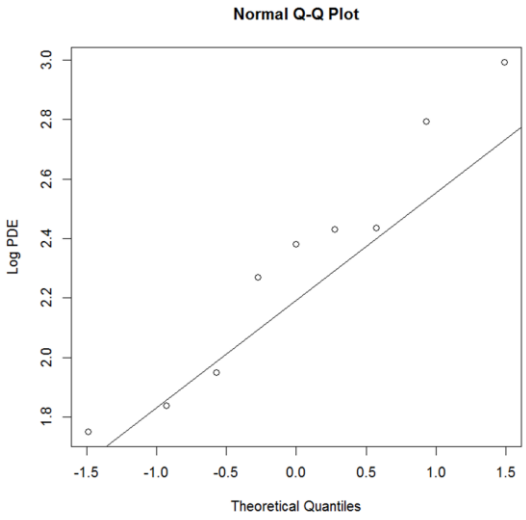

Figure 21 Normal quantile-quantile plot for exposure during sandblasting from TNO data for Log Potential Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.66, accept H_o data are from lognormal distribution.

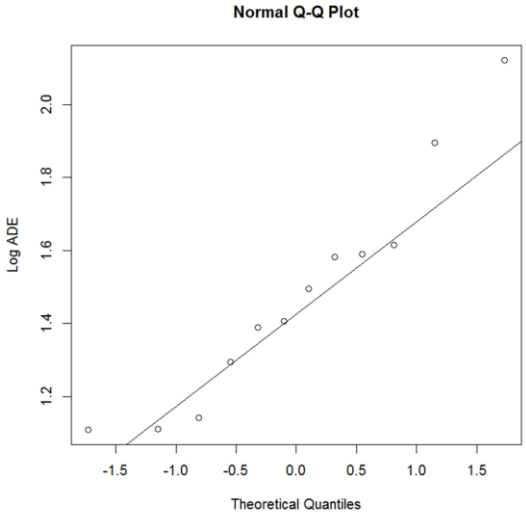

Figure 22 Normal quantile-quantile plot for exposure during sandblasting from TNO data for Log Actual Body Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.38, accept H_o data are from lognormal distribution.

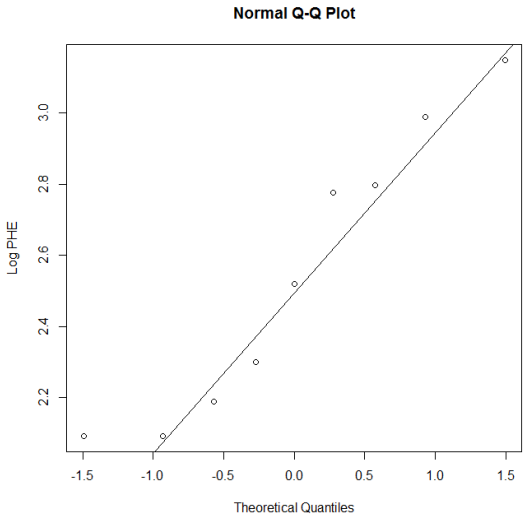

Figure 23 Normal quantile-quantile plot for exposure during sandblasting from TNO data for Log Potential Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.33, accept H_o data are from lognormal distribution.

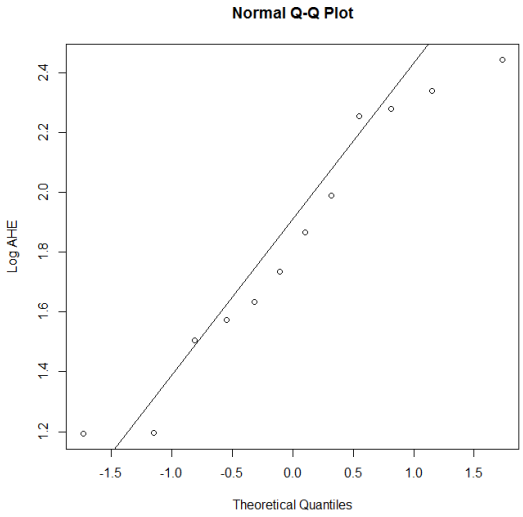

Figure 24 Normal quantile-quantile plot for exposure during sandblasting from TNO data for Log Actual Hand Exposure (mg paint/hour)

Shapiro-Wilk normality test p value = 0.43, accept Ho data are from lognormal distribution.

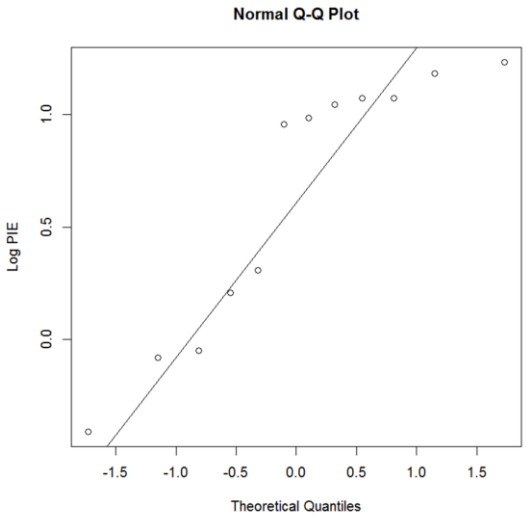

Figure 25 Normal quantile-quantile plot for exposure during sandblasting for TNO data for Log Potential Inhalation Exposure (mg paint/m3)

Shapiro-Wilk normality test p value = 0.030, reject H_o data are from lognormal distribution.

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