

1. Introduction

The working group CEN/TC264/WG17 has prepared a draft standard which describes a method to estimate Fugitive Dust Emission Rates by Reverse Dispersion Modelling (RDM). This document (WG17 N140) contains the general description of the method RDM (calculation procedure) and the requirements for dust samplers (fine and coarse dust) and dispersion models.

A Round Robin Test was carried out at CORUS steel plant (Ijmuiden, NL) from 15 February till 15 April 2005, to implement the method by several laboratories and to proceed to evaluation of the results (ISO 5725) to determine the repeatability and the Reproducibility of the RDM method in order to finalise the draft standard.

A map of the experimental setup at CORUS plant is given in Annexe 2 ; it displays :

- areas of the two fugitive dust sources (S1 and S2) of the plant under investigation ;
- areas of the background dust sources (S3 to S9) outside the plant ;
- the available sampling locations to install dust samplers.

Six laboratories participate in this RRT.

- Fine dust sampling

Five laboratories have carried out hourly measurements of fine dust concentrations, each one using a set of 3 appropriate samplers, and have performed the calculation of emission rate estimates of sources by using the dispersion model "Fugitive Dust Model" (FDM) built by EPA (1993), following the procedure indicate in the draft standard.

		Sampler type	Sampling locations	
Lab 1	(France)	Osiris L (0,6 l/min)	1, 3, 4	
Lab 2	(Germany)	TEOM (2 l/min)	1, 2, 3	
Lab 3	(Germany)	E-BAM (b)	2, 3	Osiris (0,6 l/min) 5
Lab 4	(Belgium)	Grimm L (1,2 l/min)	1, 2, 4	
Lab 5	(The Netherlands)	TEOM (2 l/min)	2, 4, 5	

-Coarse dust sampling

The coarse dust hourly measurements have been carried out by another laboratory (BLAW, The Netherlands) with 4 available coarse dust samplers installed in sampling locations 1 ,2, 3 and 4. Different combinations of data set have been provide to the 5 five laboratories to perform the calculation of emission rate estimates of sources by using the same FDM model.

	Coarse dust data set	
Lab 1	(France)	1 – 3 – 4
Lab 2	(Germany)	1 – 2 – 3
Lab 3	(Germany)	1 – 2 – 3
Lab 4	(Belgium)	1 – 2 – 4
Lab 5	(The Netherlands)	1 – 2 - 4

With this RRT protocol, the repeatability and Reproducibility provided by the results evaluation take into account the variability resulting from the different experimental setup (set of sampling locations) for each laboratory.

2. Results from laboratories

The task of each laboratory was to determine the regular emission rate estimate of the plant dust sources S1 and S2, taking into account the outside background sources which contribute to dust at the sampling locations, by using their hourly dust measurements data, general and hourly meteorological data through mathematical treatment which comprises the following steps (specified in the draft standard) :

- Determination of correlation coefficient R^2_c between dust concentrations of sets of 2 samplers (different sampling locations) : R^2_c value near 1 indicates that dust concentrations of two samplers are dominated by background dust ;
- Determination of the dispersion factor α of the different sources using the FDM and data set (characteristics of sources, meteorological data of the measurement period, environment), and calculation of correlation coefficient R^2_α between α of the sources : R^2_α value $> 0,5$ indicates a correlation between 2 sources which can not be distinguished ; they can be associated in one source by averaging the 2 dispersion factors ;
- The first emission rates (E1, g/s) for the remaining sources are calculated by multiple stepwise regression ;
- F-test is applied to this regression calculation to determine if the calculated rate is significant (significance risk $< 5\%$), the source with non significant E1 has to be eliminated ;
- Determination – analysis of the residues : residues are the difference between measured dust concentrations at the sampling locations and the expected dust concentrations calculated using the emission rate E1 ; the probability plot of normally distributed residues is a straight line : deviations of the straight line indicate that the mean emission (regular) rate values are influence by some extreme dust concentrations (punctual events with short high emission, or very low emission related to weather...), in this case these extreme concentration values are removed from the regular values and listed ;
- Second emission rate values E2, mean or regular emission rate, of sources are then calculated with remained concentrations ;
- Finally, for each significant source, partial coefficient of multiple determination (R^2_d , %) is calculated : it represent the contribution of the source to the variations in the measured concentrations, and the sum of these coefficients is the percentage of the measured concentrations which is explained by the mean emission rates of the dust sources.

The RRT reports of the participant laboratories do not display all the results corresponding to the calculation steps (one excepted), only 2 laboratories provide R^2_d values (%) : the most penalizing facts for the evaluation of the results (E2) are :

- calculated emission rates E1 displaying negative values (no physical emission) have been kept till regular E2 calculation ;
- absence of F-test to eliminate non significant results (E1-source);
- F-test was applied but the non significant results (E1-source) have been kept for subsequent calculation (residues, E2).

When non significant E1 results has been correctly removed by the laboratory, it is indicated in the tables of Annexe 2, by “ns” instead of the value, or by “omitted” for the source.

Keeping of such non significant E1 results leads to increase the scattering of the final results E2 – regular emission rates of dust sources and to degrade the value of the Reproducibility of the method. So, to determine the Reproducibility corresponding to the complete application of procedure described in the draft standard, the following pre-treatment of the RRT results has been applied :

- removal of negative E1 results, indicated by **heavy figures** in the tables in Annexe 2 and heavy **ns** replacing E2 value ;
- removal of E1 values which display associated Standard Deviation values (SD of stepwise multiple regression) which are $\geq 50\%$ of the respective E1 value (this criteria corresponds to the 5% risk value of F-test), same heavy indication.

3. Evaluation of the results

After elimination of the non significant results, the statistical evaluation of E2 values found by the laboratories for each source and each particle size fraction of dust (fine dust = PM10 or 5 μ m particle, fractions 10-30 μ m, 30-70 μ m and > 70 μ m) has been carried out following the standard ISO 5725.

The first statistical test applied is the Cochran test applied to compare the variances corresponding to the SD values associated to the E2 values provided by the laboratories for a same source. When the test detects an aberrant variance, the corresponding SD value is rejected (E2 value also) to calculate :

- with the remaining values, the repeatability **r**, which is equal to 2,83 sr (sr = standard deviation of the variances) ;
- and CV**r** which is the percentage of repeatability.

The second test is the Grubb test which allows to compare each remaining value E2 to the E2 average value. When an aberrant value is detected, it is removed, to calculate the Reproducibility value **R** taking into account the all the remaining E2 values and associated variances, and CV**R** which is the percentage of Reproducibility.

The detailed results are presented in several tables given in Annexe 1.

4. Conclusion

If all the steps of the calculation procedure of the method are applied (in particular removal of non significant results), the table hereafter shows that the repeatability **r** and reproducibility **R** of the method, which is the only available method at present time, are acceptable to identify and to distinguish the most emissive fugitive dust sources of a plant, and also to evaluate the emission level versus the background sources :

- the repeatability can vary between 5 to 20 % ;
- the Reproducibility can vary between 7 and 97 %.

Remark : these values of **r** and **R** are determined on the basis of the standard deviation associated to the multiple stepwise regression which provides the emission rate estimates, but they do not take into account the uncertainty due to sampling errors associated to the different kind of appropriate samplers nor to the calibration measurements.

Dust Class		Plant dust sources		Outside background dust sources						
		S1	S2	S3	S4	S5	S6	S7	S8	S9
Fine dust										
PM10 (or 5µm)	E2 aver. (g/s)	0,72	0,31	1,11*	2,46	ns	3,05	1,52	1,66	1
	r %	9	11	14	9	(1 lab)	4	14	18	14
	R %	52	92	14	52		25	38	25	28
Coarse dust										
10-30 µm	E2 aver. (g/s)	0,39	0,18	0,42	0,7	0,56	1,23	0,58	0,3	0,54
	r %	5	21	20	16	20	8	14	29	14
	R %	7	20	65	68	21	39	28	45	85
30-70 µm	E2 aver. (g/s)	0,64	0,21	1,72	2,64	1,35	3,1	0,88	0,89	ns
	r %	5	21	13	12	17	8	20	20	(1 lab)
	R %	33	46	53	89	97	51	14	21	
> 70 µm	E2 aver. (g/s)	1,97	ns	ns	ns	ns	6,36**	ns	ns	ns
	r %	6	(1 lab)	(1 lab)	(1 lab)	(1 lab)	11	(1 lab)	(1 lab)	(1 lab)
	R %	63					35			

E2 = mean emission rate estimate, average of the laboratories results

* One lab rejected for aberrant variance.

** One lab rejected for aberrant variance and result.

ANNEXE 1

Tables of results the RDM Round Robin Test at Corus plant (NL), with removal of non significant results, and values of repeatability and Reproducibility (evaluation following ISO 5725) for the dust sources S1 and S2 of the steel plant, and for outside background sources S3 to S9, for each particle size fraction :

- Fine dust (PM10, or 5 μ m particles)
- Coarse dust :
 - o 10 – 30 μ m fraction ;
 - o 30 – 70 μ m fraction ;
 - o > 70 μ m fraction.

RDM RRT at Corus plant (NL)

**ISO 5727 evaluation of regular Emission rate (2) results for diffuse Fine dust PM10, or smaller than 5µm
Sources S1 and S2 of the plant under investigation**

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation									
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Nb Labs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %		
1	S1	0,422	0,150	36	>200	0,483	0,093										
2		1,180	0,081	7	<-200 >300	1,268	0,078										
3		0,530	0,041	8	<-167 >167	0,540	0,040	4	0,72	0,07	0,19	9,4	0,38	1,06	52,3		
4		0,920	0,810	88	<-100 >100	ns											
5		0,522	0,050	10	<-150 >150	0,577	0,046										
1	S2	0,496	0,266	54	>200	ns											
2		0,110	0,089	81	<-200 >300	ns											
3		ns				ns		2	0,32	0,04	0,10	11,3	0,29	0,82	92,5		
4		2,340	1,130	48	<-100 >100	0,520	0,050										
5		0,130	0,055	42	<-150 >150	0,110	0,050										

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)

**ISO 5727 evaluation of regular Emission rate (2) results for diffuse Fine dust PM10, or smaller than 5µm
Background sources S3 to S6 outside the plant under investigation**

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation								
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Nb Labs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %	
1	S3	3,504	0,568	16	>200	3,370	0,354									
2		1,159	0,197	17	<-200 >300	1,152	0,187	4	1,675	0,219	0,621	13,1	1,147	3,246	68,5	
3		1,170	0,130	11	<-167 >167	1,180	0,120									
4		1,890	2,240	119	<-100 >100	ns		3	1,110	0,153	0,432	13,7	0,158	0,449	14,3	
5		1,072	0,159	15	<-150 >150	0,998	0,143									
1	S4	3,922	0,688	18	>200	3,631	0,429									
2		1,751	0,173	10	<-200 >300	1,749	0,164									
3		1,710	0,090	5	<-167 >167	1,690	0,090	5	2,458	0,220	0,622	8,9	1,291	3,654	52,5	
4		9,070	2,970	33	<-100 >100	4,030	0,110									
5		1,196	0,109	9	<-150 >150	1,192	0,098									
1	S5	?	?	?												
2		0,323	0,228	71	<-200 >300	ns										
3		0,530	0,130	25	<-167 >167	0,510	0,120	1	0,510							
4		-12,82	7,810	-61	<-100 >100	ns										
5		excluded, correlated to S4														
1	S6	3,481	0,348	10	>200	3,020	0,217									
2		4,097	0,206	5	<-200 >300	4,362	0,200									
3		2,710	0,110	4	<-167 >167	2,650	0,100	4	3,054	0,121	0,341	3,9	0,767	2,171	25,1	
4		0,340	3,040	894	<-100 >100	ns										
5		2,438	0,143	6	<-150 >150	2,660	0,132									

sr = SD of the repeatability of labs
r = global repeatability of labs (inter-laboratory)
CVr = sr / E aver. * 100
sR = SD of Reproducibility of results (± included)
R = Reproducibility of final results E (inter-laboratory)
CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)

**ISO 5727 evaluation of regular Emission rate (2) results for diffuse Fine dust PM10, or smaller than 5µm
Background sources S7 to S9 outside the plant under investigation**

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation								
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Nb Labs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %	
1	S7	2,243	0,490	22	>200	2,227	0,305									
2		0,975	0,288	30	<-200 >300	0,915	0,276									
3		1,390	0,080	6	<-167 >167	1,360	0,080	4	1,520	0,215	0,607	14,1	0,575	1,626	37,8	
4		-0,940	2,810	-299	<-100 >100	ns										
5		1,447	0,081	6	<-150 >150	1,575	0,075									
2	S8	1,657	0,503	30		1,339	0,478									
3		1,450	0,160	11	<-167 >167	1,390	0,150									
4		1,150	4,740	412	<-100 >100	ns		4	1,657	0,301	0,851	18,1	0,420	1,189	25,4	
5		1,847	0,193	10	<-150 >150	1,901	0,181									
1	S8-S9	1,994	0,446	22	> 200	2,002	0,278									
1	S9															
2		1,207	0,193	16	<-200 >300	1,225	0,183									
3		1,060	0,110	10	<-167 >167	1,050	0,100	3	0,997	0,140	0,397	14,1	0,284	0,802	28,5	
4		ns			<-100 >100	ns										
5		0,734	0,138	19	<-150 >150	0,714	0,124									

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 10-30 µm
Sources S1 and S2 of the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S1	0,449	0,036	8	> 100	0,386	0,034								
2		0,556	0,340	61	<-200 >300	ns									
3		0,420	0,020	5	<-118 >118	0,39	0,02	3	0,387	0,022	0,061	5,6	0,019	0,053	4,8
4		0,42	0,02	5	<-100 >100	0,38	0,01								
5		-0,21	0,20	-95	<-75 >75	ns									
1	S2	0,233	0,062	27	> 100	0,169	0,053								
2		- 0,114	0,037	-32	<-200 >300	omitted									
3		ns			<-118 >118	ns		2	0,183	0,038	0,107	20,7	0,036	0,101	19,5
4		-0,06	0,030	-50	<-100 >100	ns									
5		0,183	0,026	14	<-75 >75	0,195	0,019								

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 10-30 µm
Background sources S3 to S6 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S3	0,875	0,158	18	> 100	0,891	0,135								
2		0,312	0,096	31	<-200 >300	0,306	0,096								
3		0,240	0,090	38	<-118 >118	0,24	0,07	5	0,422	0,084	0,237	19,9	0,275	0,779	65,31
4		0,38	0,07	18	<-100 >100	0,29	0,04								
5		0,334	0,066	20	<-75 >75	0,382	0,049								
1	S4	0,834	0,214	26	> 100	0,860	0,183								
2		0,358	0,093	26	<-200 >300	0,337	0,093								
3		9,4	0,4	4	<-118 >118	0,320	0,080	4	0,705	0,114	0,332	16,1	0,481	1,361	68,2
4		0,18	0,10	56	<-100 >100	ns									
5		1,656	0,088	5	<-75 >75	1,305	0,065								
1	S5	0,723	0,146	20	> 100	0,609	0,125								
2		0,514	0,102	20	<-200 >300	0,521	0,102								
3		0,51	0,1	20	<-118 >118	0,490	0,090	4	0,564	0,114	0,324	20,3	0,117	0,330	20,7
4		1,14	0,22	19	<-100 >100	0,64	0,13								
5		Correlated to 4, excluded													
1	S6	1,496	0,103	7	> 100	1,534	0,089								
2		1,816	0,093	5	<-200 >300	1,732	0,089								
3		1,56	0,08	5	<-118 >118	1,530	0,070	5	1,250	0,095	0,268	7,6	0,490	1,386	39,2
4		0,75	0,09	12	<-100 >100	0,78	0,06								
5		1,122	0,193	17	<-75 >75	0,679	0,142								

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 10-30 µm
Background sources S7 to S9 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S7	0,502	0,126	25	> 100	0,659	0,110								
2		0,096	0,135	141	<-200 >300	ns									
3		ns			<-118 >118	ns		3	0,578	0,082	0,231	14,1	0,164	0,465	28,4
4		0,36	0,08	22	<-100 >100	0,67	0,05								
5		0,369	0,076	21	<-75 >75	0,394	0,056								
2	S8	0,215	0,223	104	<-200 >300	ns									
3		ns			<-118 >118	ns									
4		0,470	0,170	36	<-100 >100	0,21	0,10	3	0,300	0,087	0,247	29,0	0,136	0,386	45,3
5		0,464	0,072	16	<-75 >75	0,431	0,053								
1	S8-S9	0,254	0,120	47	> 100	0,261	0,102								
1	S9														
2		0,254	0,092	36	<-200 >300	0,262	0,092								
3		0,3	0,1	21	<-118 >118	0,29	0,05	3	0,539	0,078	0,220	14,4	0,461	1,304	85,4
4		0,090	0,070	78	<-100 >100	ns									
5		1,079	0,117	11	<-75 >75	1,066	0,085								

sr = SD of the repeatability of labs
r = global repeatability of labs (inter-laboratory)
CVr = sr / E aver. * 100
sR = SD of Reproducibility of results (± included)
R = Reproducibility of final results E (inter-laboratory)
CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 30-70 µm
Sources S1 and S2 of the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S1	0,834	0,050	6	> 60	0,524	0,034								
2		1,089	0,048	4	<-200 >300	0,937	0,041								
3		0,72	0,03	4	<-100 >100	0,66	0,03	4	0,644	0,031	0,088	4,8	0,214	0,605	33,2
4		0,69	0,03	4	<-50 >50	0,46	0,02								
5		-0,14	0,026	-19	<-80 >80	ns									
1	S2	0,203	0,089	44	> 60	0,175	0,054								
2		0,066	0,063	95	<-200 >300	ns									
3		ns				ns		3	0,211	0,044	0,124	20,8	0,098	0,277	46,3
4		0,13	0,06	46	<-50 >50	0,14	0,04								
5		0,297	0,049	16	<-80 >80	0,314	0,041								

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 30-70µm
Background sources S3 to S6 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S3	3,212	0,465	14	> 60	3,063	0,284								
2		1,228	0,312	25	<-200 >300	1,391	0,302								
3		1,29	0,24	19	<-100 >100	1,30	0,21	5	1,728	0,230	0,651	13,3	0,910	2,574	52,6
4		2,53	0,25	10	<-50 >50	2,13	0,16								
5		0,590	0,192	33	<-80 >80	0,761	0,160								
1	S4	4,837	0,666	14	> 60	2,928	0,455								
2		1,044	0,270	26	<-200 >300	0,967	0,270								
3		0,84	0,24	29	<-100 >100	0,80	0,21	4	2,637	0,305	0,863	11,6	2,359	6,676	89,5
4		-0,76	0,27	-36	<-50 >50	ns									
5		6,700	0,249	4	<-80 >80	5,839	0,209								
1	S5	?	?		> 60	0,437	0,202								
2		0,695	0,188	27	<-200 >300	0,856	0,187								
3		0,86	0,18	21	<-100 >100	0,82	0,16	4	1,349	0,233	0,658	17,2	1,315	3,721	97,5
4		5,73	0,55	10	<-50 >50	3,28	0,34								
5		Correlated to 4, excluded													
1	S6	3,351	0,221	7	> 60	2,011	0,151								
2		4,423	0,186	4	<-200 >300	4,090	0,178								
3		3,83	0,17	4	<-100 >100	3,540	0,150	5	3,097	0,231	0,655	7,5	1,584	4,482	51,1
4		1,32	0,20	15	<-50 >50	0,99	0,12								
5		6,043	0,502	8	<-80 >80	4,854	0,420								

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)

ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust 30-70 µm

Background sources S7 to S9 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S7	?	?		> 60	0,860	0,185								
2		- 2,248	0,392	-17	<-200 >300	omitted									
3		ns				ns		2	0,885	0,149	0,421	19,8	0,126	0,358	14,3
4		0,66	0,15	23	<-50 >50	0,91	0,09								
5		0,065	0,172	265	<-80 >80	ns									
2	S8	- 0,278	0,552	-199	<-200 >300	omitted									
3		ns				ns									
4		1,06	0,36	34	<-50 >50	0,98	0,22	2	0,894	0,176	0,499	19,7	0,188	0,533	21,1
5		0,856	0,140	16	<-80 >80	0,808	0,117								
1	S8-S9	0,016	- 0,506	-3163	> 60	ns									
1	S9														
2		0,520	0,308	59	<-200 >300	ns									
3		ns				ns		1	1,805						
4		-0,76	0,15	-20	<-50 >50	ns									
5		1,827	0,251	14	<-80 >80	1,805	0,209								

sr = SD of the repeatability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust larger than 70 µm
Sources S1 and S2 of the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	E aver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S1	2,968	0,232	8	> 100	1,850	0,130								
2		4,322	0,187	4	<-200 >300	4,113	0,150								
3		2,57	0,12	5	<-100 >100	1,890	0,060	5	1,966	0,110	0,312	5,6	1,233	3,489	62,9
4		2,59	0,15	6	<-60 >60	1,53	0,06								
5		0,813	0,176	22	<-100 >100	0,587	0,088								
1	S2	1,690	0,583	34	> 100	1,008	0,319								
2		- 0,505	0,367	-73	<-200 >300	omitted									
3		ns				ns		1	1,010						
4		0,14	0,42	300	<-60 >60	ns									
5		-0,035	0,445	-1271	<-100 >100	ns									

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)
ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust larger than 70 µm
Background sources S3 to S6 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	Eaver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S3	1,621	1,521	94	> 100	ns									
2		0,614	0,933	152	<-200 >300	ns									
3		ns				ns		1	2,214						
4		1,34	0,90	67	<-60 >60	ns									
5		3,610	1,102	31	<-100 >100	2,214	0,550								
1	S4	?	?			?	?								
2		0,586	0,964	165	<-200 >300	ns									
3		ns				ns		0							
4		-1,96	1,360	-69	<-60 >60	ns									
5		-2,879	1,678	-58	<-100 >100	ns									
1	S5	5,105	1,647	32	> 100										
2		2,484	0,968	39	<-200 >300	2,620	0,775								
3		3,43	0,87	25	<-100 >100	ns		1	2,620						
4		16,83	5,01	30	<-60 >60	(-1,30) ns	(1,79)								
5		Correlated to S4, excluded													
1	S6	8,560	1,492	17	> 100	6,555	0,772								
2		8,915	1,093	12	<-200 >300	9,108	0,876	5	10,39	1,37	3,88	13,2	9,28	26,25	89,2
3		6,28	0,97	15	<-100 >100	5,970	0,470								
4		4,99	1,50	30	<-60 >60	3,82	0,54	4	6,36	0,68	1,94	10,8	2,25	6,35	35,3
5		52,966	5,217	10	<-100 >100	26,515	2,747								

sr = SD of the repetability of labs
r = global repeatability of labs (inter-laboratory)
CVr = sr / E aver. * 100
sR = SD of Reproducibility of results (± included)
R = Reproducibility of final results E (inter-laboratory)
CVR = sR / E aver. * 100

RDM RRT at Corus plant (NL)

ISO 5727 evaluation of regular Emission rate (2) results for diffuse Coarse dust larger than 70 µm Background sources S7 to S9 outside the plant under investigation

LAB	Source	Emission rates 1			Residues cut (µg/m ³)	Emission rates 2 (regular)		ISO 5725 statistical evaluation							
		E (g/s)	SD ±	SD / E %		E (g/s)	SD ±	Number of LABs	Eaver. (g/s)	sr (g/s)	r (g/s)	CVr %	sR (g/s)	R (g/s)	CVR %
1	S7	?	?		> 100	?	?								
2		-10,934	1,701	-16	<-200 >300	omitted									
3		ns				ns									
4		1,51	1,04	69	<-60 >60	ns									
5		1,905	1,592	84	<-100 >100	ns									
2	S8	-0,422	3,078	-729	<-200 >300	omitted									
3		ns				ns									
4		-0,94	2,99	-318	<-60 >60	ns									
5		0,760	1,368	180	<-100 >100	ns									
1	S8-S9	?	?		> 100	?	?								
1	S9														
2		0,290	0,873	301	<-200 >300	ns									
3		ns				ns									
4		-0,25	0,79	-316	<-60 >60	ns									
5		8,371	2,863	34	<-100 >100	7,572	1,430								

sr = SD of the repetability of labs

r = global repeatability of labs (inter-laboratory)

CVr = sr / E aver. * 100

sR = SD of Reproducibility of results (± included)

R = Reproducibility of final results E (inter-laboratory)

CVR = sR / E aver. * 100

ANNEXE 2 : Map of experimental setup for RDM Round Robin Test at CORUS plant (NL)

