

Mercury CEMs: Results of verification test studies at cement plants

The **SM-4** by **ENVEA GmbH** measuring principle is based on atomic absorption at a wavelength of 253,7 nm. It features a low temperature catalytic converter and a highly sensitive and selective detector with a gold trap.

A Relative Accuracy Test Audit (RATA) was run in 2012 in a cement plant in Maryland to confirm the high quality of **ENVEA GmbH's Stack Monitor SM-4** (Table 1).

Simultaneously tested was another Mercury CEM manufactured by another company (Table 2). In comparison to a relative accuracy of 12.8% (2 runs excluded) the **ENVEA GmbH's SM-4** shows a very good result with a relative accuracy of 3.1% (2 runs excluded).

All testing was conducted in accordance with the regulations set forth by the United States Environmental Protection Agency (EPA) using EPA Reference Method 30B as well as applicable procedures found in Performance Specifications (PS) 12A.

In 2013 other RATAs were run on a **ENVEA GmbH SM-4 Stack Monitor** at a cement plant in Missouri. The results are shown in table 3 and 4.

Even at the very low mercury concentrations (below $0.5 \mu\text{g}/\text{Nm}^3$) they show a relative accuracy of 8.5% (both raw mills operating) and 5.9% (raw mills not operating) and lie well below the allowed relative accuracy level of 20%.



Results:

The tests in Missouri as well as the test in Maryland have proven the SM-4 to be a highly accurate and reliable instrument for continuous mercury monitoring in stack gas of cement plants.

Table 1

SM-4 RATA Results

Run	Start Time	End Time	Mercury concentration (µg/scm)				DIFF	%DIFF
			Reference Method (RM)			C _{CMMS-AVG}		
1	07:38	08:08	18.473	18.816	18.645	18.952	-0.307	-1.6%
2	08:44	09:14	18.136	18.722	18.429	19.194	-0.765	-4.2%
3	09:48	10:18	18.644	20.044	19.344	19.529	-0.185	-1.0%
4**	10:49	11:19	17.619	18.226	17.923	19.324	-1.401	-7.8%
5	11:48	12:18	14.161	14.749	14.455	15.131	-0.676	-4.7%
6**	12:45	13:15	12.667	13.645	13.156	14.162	-1.006	-7.6%
7	13:51	14:21	20.561	20.022	20.291	20.610	-0.319	-1.6%
8	15:01	15:31	18.672	18.887	18.779	19.212	-0.433	-2.3%
9	16:00	16:30	18.216	18.926	18.571	18.747	-0.176	-0.9%
10	17:02	17:32	18.101	18.587	18.344	18.551	-0.207	-1.1%
11	18:10	18:40	18.404	19.502	18.953	18.346	0.607	3.2%

All runs included (n=11) Average 17.899 18.342 -0.443
Confidence Coefficient 0.351

Relative Accuracy 4.4%

2 runs excluded (n=9) Average 18.423 18.697 -0.2735
Confidence Coefficient 0.301

Relative Accuracy 3.1%

NIST Standard Temperature 293.15 °K

** Indicates data from this run are not included in second set of RATA calculations.

BIAS CHECK (n=9)

Mean Difference (d): -0.2735
Confidence Coefficient (cc): 0.3014
Bias Check: d < cc; bias check passes

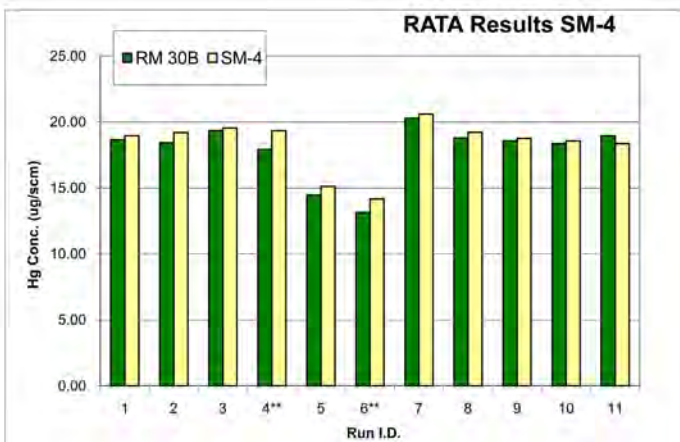


Table 2

RATA Results (Comparison)

Run	Start Time	End Time	Mercury concentration (µg/scm)				DIFF	%DIFF
			Reference Method (RM)			C _{CMMS-AVG}		
1**	07:38	08:08	18.473	18.816	18.645	15.453	3.192	17.1%
2	08:44	09:14	18.136	18.722	18.429	15.597	2.832	15.4%
3**	09:48	10:18	18.644	20.044	19.344	16.060	3.284	17.0%
4	10:49	11:19	17.619	18.226	17.923	17.910	0.013	0.1%
5	11:48	12:18	14.161	14.749	14.455	16.257	-1.802	-12.5%
6	12:45	13:15	12.667	13.645	13.156	11.948	1.208	9.2%
7	13:51	14:21	20.561	20.022	20.291	19.390	0.901	4.4%
8	15:01	15:31	18.672	18.887	18.779	16.640	2.139	11.4%
9	16:00	16:30	18.216	18.926	18.571	16.140	2.431	13.1%
10	17:02	17:32	18.101	18.587	18.344	16.100	2.244	12.2%
11	18:10	18:40	18.404	19.502	18.953	20.780	-1.827	-9.6%

All runs included (n=11) Average 17.899 16.570 1.329
Confidence Coefficient 1.238

Relative Accuracy 14.3%

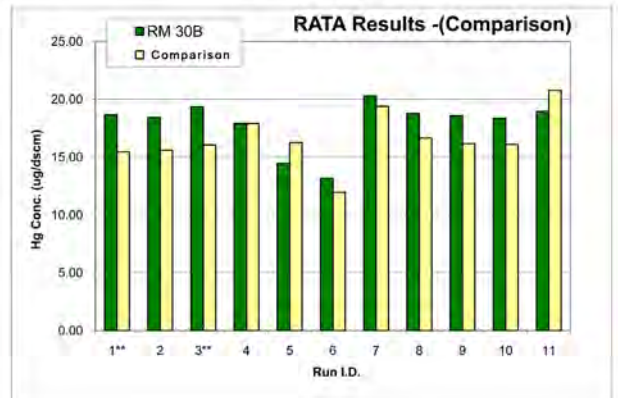
2 runs excluded (n=9) Average 17.656 16.751 0.9043
Confidence Coefficient 1.360

Relative Accuracy 12.8%

** Indicates data from this run are not included in second set of RATA calculations.
NIST Standard Temperature 293.15 °K

BIAS CHECK (n=9)

Mean Difference (d): 0.9043
Confidence Coefficient (cc): 1.3598
Bias Check: d < cc; bias check passes



RESULTS

Table 3

Hg CEMS RATA, Both Raw Mills Operating

Run	Start Time	End Time	Reference Method			Plant Hg CEMS	DIFF	%DIFF
			A-Side µg/Nm ³	B-Side µg/Nm ³	Average µg/Nm ³			
1	03/12 08:11	03/12 08:41	0.357	0.358	0.357	0.400	-0.043	-11.9%
2	03/12 09:24	03/12 09:54	0.357	0.349	0.353	0.390	-0.037	-10.4%
3	03/12 10:24	03/12 10:54	0.304	0.451	0.378	0.350	0.028	7.4%
4	03/12 11:34	03/12 12:04	0.294	0.292	0.293	0.310	-0.017	-5.8%
5	03/12 12:47	03/12 13:17	0.311	0.321	0.316	0.320	-0.004	-1.2%
6	03/12 14:04	03/12 14:34	0.326	0.422	0.374	0.350	0.024	6.4%
7	03/12 15:40	03/12 16:10	0.281	0.290	0.286	0.300	-0.014	-5.0%
8	03/12 16:55	03/12 17:25	0.207	0.205	0.206	0.190	0.016	7.9%
9**	03/12 17:57	03/12 18:57	0.165	0.250	0.207	0.126	0.081	39.1%
10	03/12 19:34	03/12 20:24	0.178	0.172	0.175	0.119	0.056	31.9%

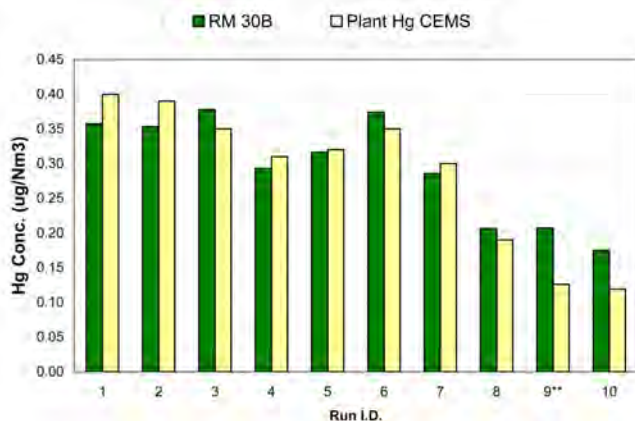
1 runs excluded (n=9) Average 0.304 0.303 0.001
Confidence Coefficient 0.024878

Relative Accuracy 8.5%

** Indicates data from this run are not included in second set of RATA calculations.

BIAS CHECK (n=9)

Mean Difference (d): 0.00108
Confidence Coefficient (cc): 0.025
Bias Check: d < cc; bias check passes



RESULTS

Table 4

Hg CEMS RATA, Raw Mills Not Operating

Run	Start Time	End Time	Reference Method			Plant Hg CEMS	DIFF	%DIFF
			A-Side µg/Nm ³	B-Side µg/Nm ³	Average µg/Nm ³			
1	03/13 07:16	03/13 07:46	119.194	119.655	119.425	118.000	1.425	1.2%
2	03/13 08:28	03/13 08:58	114.221	106.583	111.402	111.570	-0.168	-0.2%
3**	03/13 09:28	03/13 09:58	117.438	94.417	117.438	120.530	-3.092	-2.6%
4	03/13 11:09	03/13 11:39	127.341	127.381	127.361	127.780	-0.419	-0.3%
5	03/13 12:09	03/13 12:39	135.422	138.678	137.050	132.730	4.320	3.2%
6	03/13 13:15	03/13 13:45	136.718	130.873	133.795	131.490	2.305	1.7%
7	03/13 14:16	03/13 14:46	122.454	121.783	122.119	133.740	-11.621	-9.5%
8	03/13 15:53	03/13 16:23	133.905	147.223	140.564	145.450	-4.886	-3.5%
9	03/13 17:10	03/13 17:40	158.376	163.933	161.154	148.380	12.774	7.9%
10	03/13 18:08	03/13 18:38	73.523	83.678	78.600	92.530	-13.930	-17.7%

1 runs excluded (n=9) Average 125.719 126.852 -1.133
Confidence Coefficient 6.261244

Relative Accuracy 5.9%

** Indicates data from this run are not included in second set of RATA calculations.

BIAS CHECK (n=9)

Mean Difference (d): -1.13339
Confidence Coefficient (cc): 6.261
Bias Check: d < cc; bias check passes

