Statistical assessment of declared values

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Requirements of the CPR

Building materials shall meet the requirements of the Construction Products Regulation:

- BWR 3: Hygiene, health and environment (release of dangerous substances);
- Declared value of the performances;
- Testing of a performance is identical / the way how to declare the value may vary per product standard / country;
- The level of (statistical) assessment depends on the risk of exceeding the (declared) value and the impact it will give.

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What may be expected of a (statistical) assessment method?

What may be expected of a (statistical) assessment method for the harmonized test standards of CEN/TC 351 to determine the release of dangerous substances from construction products?

- The impact shall be clear and the declared values shall be trustworthy;
- Takes into account the repeatability and reproducibility of the test methods (testing errors for the leaching tests are respectively 20 % - 25 % and around 40 %).

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A common market in Europe

Furthermore at least the following aspects shall be fulfilled for a common market in Europe:

- To obtain a uniform level of environmental protection one quality level for the declaration of performance is required, i.e. a level playing field for all construction products
- Acceptable for all parties involved (producers, users and regulators) and identical through Europe

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CEN/TR 16797-1 & -2:2015

CEN/TC 351/TG 7 has prepared CEN/TR 16797-1&2:2015 keeping in mind the basis for a statistical assessment:

- Developed on the basis of experience with the control of release into soil and water, but is also applicable to indoor air and radiation
- 7 Principles are given for a common and uniform assessment of the declared values
- Good workmanship is rewarded by less testing and/or lower declared value

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Two methods for statistical assessment

In CEN/TR 16797-1&2:2015 two methods for statistical assessment are mentioned:

- Assessment by variables using the coefficient *k*:

$$\text{coefficient k} = \frac{\text{log(maximum value) - average of n log-transformed results}}{\text{standard deviation of n log-transformed results}}$$

- Assessment by attributes

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Coefficient *γ*

In special situations the coefficient *γ* may be used instead of *k*:

When the release or emission is low and the variability in test results is dominated by the test procedure

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2. Options and preconditions of the use of the statistical assessment according CEN/TR 16797-1&2

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Continuous production of construction materials

The method is developed for continuous production of construction materials:

- Not necessary to wait for the test results (up to 64 days for DSLT), i.e. smaller storage area required
- Proper control of the process will result in a lower standard deviation, i.e. lower test frequency and / or lower declared values

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Chaos in Europe?

At this moment there is chaos in Europe:

- Requirements are specified on the reliability of the declared values, but the declared values, i.e. specifications, are not harmonized;
- The intentions are however usually similar.

Based on existing regulations and experience, seven principles are proposed.

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Principle 1

The rules of application verify with a confidence of 90 % that the 50th percentile of the production is less than or equal to the declared value when the scale of declaration is a batch as defined in the product standard.

The term 'declared value' is used, it may be interchanged with the terms 'regulatory class limit' or 'technical class limit'.

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Principle 2

The declared value relates to the performance of the product in a reference test procedure.

The appropriate test method will be defined in the product standard.

Clarification "declared value": According the Construction Product Regulation (CPR) the producer shall "declare" the performance when it is put on the European market.

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Principle 3

The test frequency is permitted to vary. The minimum test frequency is reduced as the risk of exceeding the declared value diminishes, e.g.:

- the distance between the mean value and the declared value increases;
- the standard deviation decreases.

This variable test frequency acts as an incentive to producers to control their products and reduce the environmental impact.

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Principle 4

The production is split into batches in order to facilitate the variable test frequency. For continually produced products, the batch size associated with Principle 1 is not more than one tenth (10 %) of the production over one year and the maximum batch size needs to be defined by the product technical committee.

For continuous production, it may be simpler to split the year into 12 batches, i.e. each month of production represents 1 batch.

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Principle 5 & Principle 6

Principle 5:

For one product and intended use there is a single reference test method. In the case of dispute the reference method has precedence.

Principle 6:

The assessment approach is allowed for products in a production that have a normal, more or less known, variation of release, emission or content. If the factory production control expects that a change in production or materials might lead to products outside the normal variations, a separate assessment procedure should be started.

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Principle 7

For products from specific sources where the mean value is well below the producers declared value, a point may be reached where no-further-testing (NFT) is needed to fulfil Principle 1. Assessment of NFT verifies with a confidence of 99 % that the 90th percentile of the production is less than or equal to the declared value when the scale of declaration is a batch as defined in the product standard.

The NFT procedure is different to the 'without-further-testing' (WFT) procedure: producer's procedure versus generic procedure.

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Examples of the actual use in the Netherlands

Sampling for verification testing each 5 years of, for example, Calcium-Silicate products:

- Sampling according the SQD certification guideline 1004-1
- Two test samples
- Each test sample exists of 3 increments of each 1 CS-masonry brick
- The samples are taken in 2 days during a production period of 2 weeks
- Sampling at random with random numbers

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Sampling plan

description / location	Factory 1	Factory 2	Factory 3	Factory 4	Factory 5
number of autoclaves	16	12	13	3	6
number of carts	19	13	32	36	36
number of bricks per layer	64	84	84	54	54
sampling starts in week	48	48	48	48	48
Sample 1					
week number	**49**	**48**	**49**	**48**	**49**
day (Monday = 1)	**4**	**5**	**1**	**3**	**2**
increment 1					
autoclave number	11	6	8	3	2
cart number	4	9	18	32	12
brick number	40	22	39	32	33
increment 2					
autoclave number	4	12	9	1	4
cart number	12	13	27	23	13
brick number	3	69	14	47	24
increment 3					
autoclave number	5	5	13	3	5
cart number	3	3	25	7	26
brick number	6	71	84	54	54
Sample 2 (back-up)					
week number	**48**	**49**	**48**	**48**	**48**
day (Monday = 1)	**5**	**2**	**1**	**3**	**1**

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Production control sheet

Example of production control sheet to determine testing frequency of sulphates for AAC according the Dutch SQD

Sample code	measured values: serie 1 Xi	serie 2 Xi	average Xi	ln(Xi)	average ln(Xi)	S	k-factor requirement: 165.000	frequency per year
1998	77.595		77.595	11.259				
1998	75.197		75.197	11.228				
1998	78.265		78.265	11.268				
1998	79.812		79.812	11.287				
1998	74.186		74.186	11.214	11.251	0.030	25.56	0.33
1998	83.228		83.228	11.329	11.265	0.046	16.14	0.33
1998	77.111		77.111	11.253	11.270	0.042	17.50	0.33
1998	75.193		75.193	11.228	11.262	0.047	16.11	0.33
1998	78.056		78.056	11.265	11.258	0.045	16.92	0.33
2003	72.000		72.000	11.184	11.252	0.053	14.33	0.33
2006	83.000		83.000	11.327	11.251	0.052	14.61	0.33
2009	88.000		88.000	11.385	11.278	0.079	9.26	0.33
2013	88.000		88.000	11.385	11.309	0.086	8.23	0.20

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Influence of a higher standard deviation

Example of the influence of a higher standard deviation on the test frequency, while the average of ln(Xi) is lower.

Sample code	measured values: serie 1 Xi	serie 2 Xi	average Xi	ln(Xi)	average ln(Xi)	S	k-factor requirement: 165.000	frequency per year
1998	71.024		71.024	11.171				
1998	67.734		67.734	11.123				
1998	71.295		71.295	11.175				
1998	66.601		66.601	11.106				
1998	66.126		66.126	11.099	11.135	0.036	24.69	0.33
1998	64.546		64.546	11.075	11.116	0.037	24.16	0.33
1998	70.950		70.950	11.170	11.125	0.045	19.94	0.33
1998	71.452		71.452	11.177	11.125	0.045	19.65	0.33
1998	72.752		72.752	11.195	11.143	0.053	16.56	0.33
2003	56.000		56.000	10.933	11.110	0.109	8.27	0.33
2006	81.000		81.000	11.302	11.155	0.135	6.35	0.33
2009	60.000		60.000	11.002	11.122	0.151	5.92	1.00
2013	84.000		84.000	11.339	11.154	0.180	4.78	1.00

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Combination of the *k*- and *γ*-factor assessment system

Example of combination of the *k*- and *γ*-factor assessment system:

Sample code	measured values: serie 1 Xi	serie 2 Xi	average Xi	ln(Xi)	barium: average	S	k-factor: 1.500	frequency per year
02.4390	23		23	3.135				
02.4391	32		32	3.466				
02.4392	31		31	3.434				
02.4393	33		33	3.497				
06.2657	39		39	3.664	3.439	0.191	20.24	0.33
06.2658	35		35	3.555	3.523	0.090	41.91	0.33
06.2659	46		46	3.829	3.596	0.155	23.94	0.33
09.0976a	2.9		3	1.065	3.122	1.157	3.62	1.20
13.3495b	15		15	2.708	2.964	1.147	3.79	1.20

Based on *γ*-factor 0,31: all 5 consecutive results are lower than 0,31 × 1.500 = 465 mg/m², resulting in a test frequency of 1 per 5 years, instead of every 10 months

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Résumé / conclusions (1)

The statistical assessment system according to CEN/TR 16797-1&2 has proved by 20 years of experience by various producers / manufacturers that:

1. proper use of the system can in generally lead to acceptance by the user and/or regulator of the construction product when the results meet the requirements (regulatory class limit), i.e. confidence of the environmental quality of the product

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Résumé / conclusions (2)

2. a proper functioning QA/QC system will benefit compared to bad functioning systems: high performance results in a low test frequency and / or low declared emission values
3. based on 2): the quality of production and the construction products in relation to emissions of regulated dangerous substances will improve
4. The producer / manufacturer is free to choose
   - low declared values with a high test frequency

   or
   - high declared values with a low test frequency

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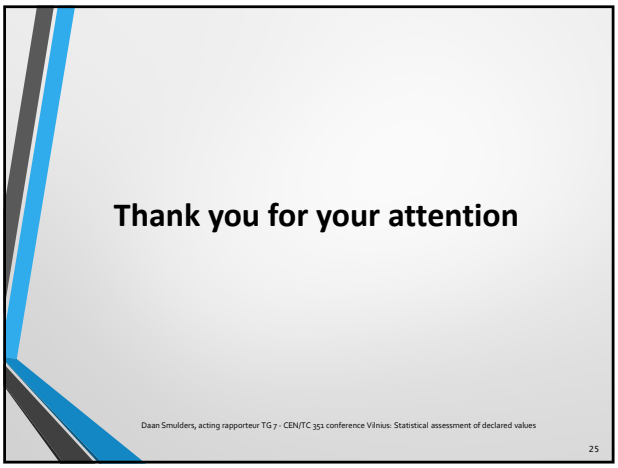
Thank you for your attention
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