

## II

(Non-legislative acts)

## REGULATIONS

## COMMISSION REGULATION (EU) No 709/2014

of 20 June 2014

**amending Regulation (EC) No 152/2009 as regards the determination of the levels of dioxins and polychlorinated biphenyls**

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules <sup>(1)</sup>, and in particular Article 11(4) thereof,

Whereas:

- (1) Commission Regulation (EC) No 152/2009 <sup>(2)</sup> includes methods for the determination of the levels of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and dioxin-like polychlorinated biphenyls (PCBs) in feed.
- (2) Requirements should be set out concerning screening methods which identify the samples with significant levels of PCDD/Fs and dioxin-like PCBs (preferably selecting samples exceeding action thresholds and ensuring the selection of samples exceeding maximum levels) and which have a high throughput. With respect to the maximum levels, the false-compliant rate of those screening methods should be below 5 %.
- (3) Where the results achieved with the screening method exceed the cut-off value, the original sample should be analysed by means of a method capable of identifying and quantifying the PCDD/Fs and dioxin-like PCBs contained in the sample. Hereinafter such methods are referred to as 'confirmatory methods'. Technical progress and developments have shown that the use of gas chromatography/tandem mass spectrometry (GC-MS/MS) should be allowed for use as a confirmatory method for checking compliance with the maximum level, in addition to gas chromatography/high resolution mass spectrometry (GC-HRMS).
- (4) Following the experience gained with the application of the rules currently in place, an amendment is appropriate to the current provisions as regards the necessity of duplicate analysis, the judgement of compliance in case of duplicate analysis and the requirement on the acceptable difference between upper-bound and lower-bound results.
- (5) Regulation (EC) No 152/2009 should therefore be amended accordingly.
- (6) The measures provided for in this Regulation are in accordance with the opinion of the Standing Committee on the Food Chain and Animal Health,

<sup>(1)</sup> OJ L 165, 30.4.2004, p. 1.

<sup>(2)</sup> Commission Regulation (EC) No 152/2009 of 27 January 2009 laying down the methods of sampling and analysis for the official control of feed (OJ L 54, 26.2.2009, p. 1).

HAS ADOPTED THIS REGULATION:

*Article 1*

Part B of Annex V to Regulation (EC) No 152/2009 is amended in accordance with the Annex to this Regulation.

*Article 2*

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

This Regulation is binding in its entirety and directly applicable in all Member States.

Done at Brussels, 20 June 2014.

*For the Commission*

*The President*

José Manuel BARROSO

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## ANNEX

In Annex V to Regulation (EC) No 152/2009, Part (B) 'DETERMINATION OF THE LEVELS OF DIOXINS (PCDD/PCDF) AND PCBs' is replaced by the following:

## B. DETERMINATION OF THE LEVELS OF DIOXINS (PCDD/PCDF) AND PCBs

## CHAPTER I

**Methods of sampling and interpretation of analytical results****1. Purpose and Scope**

The samples intended for the official control of the levels of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), dioxin-like polychlorinated biphenyls (PCBs) <sup>(1)\*</sup> and non-dioxin-like PCBs in feed shall be taken in accordance with the provisions of Annex I. The quantitative requirements in relation to the control of substances or products uniformly distributed throughout the feed as provided for in point 5.1 of Annex I shall be applied. Aggregate samples thus obtained shall be considered representative for the lots or sublots from which they are taken. Compliance with maximum levels laid down in Directive 2002/32/EC shall be established on the basis of the levels determined in the laboratory samples.

For the purposes of this Part B, the definitions laid down in Annex I to Commission Decision 2002/657/EC <sup>(2)\*</sup> shall apply.

In addition to those definitions, the following definitions shall apply for the purpose of this part B:

"*Screening methods*" means methods used for selection of those samples with levels of PCDD/Fs and dioxin-like PCBs that exceed the maximum levels or the action thresholds. They shall allow a cost-effective high sample-throughput, thus increasing the chance to discover new incidents with high exposure and health risks to consumers. Screening methods shall be based on bioanalytical or GC-MS methods. Results from samples exceeding the cut-off value to check compliance with the maximum level shall be verified by a full re-analysis from the original sample by a confirmatory method.

"*Confirmatory methods*" means methods that provide full or complementary information enabling the PCDD/Fs and dioxin-like PCBs to be identified and quantified unequivocally at the maximum or in case of need at the action threshold. Such methods utilise gas chromatography/high resolution mass spectrometry (GC-HRMS) or gas chromatography/tandem mass spectrometry (GC-MS/MS).

**2. Compliance of the lot or subplot with the maximum level****2.1. As regards non-dioxin-like PCBs**

The lot complies with the maximum level if the analytical result does not exceed the maximum level of non-dioxin-like PCBs laid down by Directive 2002/32/EC, taking into account the measurement uncertainty.

The lot does not comply with the maximum level if the upper-bound <sup>(3)\*</sup> analytical result confirmed by duplicate analysis <sup>(4)\*</sup> exceeds the maximum level laid down by Directive 2002/32/EC, taking into account the measurement uncertainty. The mean of two determinations, taking into account the measurement uncertainty is used for verification of compliance.

The measurement uncertainty shall be taken into account according to one of the following approaches:

- by calculating the expanded uncertainty, using a coverage factor of 2 which gives a level of confidence of approximately 95 %. A lot or subplot is noncompliant if the measured value minus U is above the maximum level,
- by establishing the decision limit (CC<sub>α</sub>) in accordance with point 3.1.2.5 of Annex I to Decision 2002/657/EC. A lot or subplot is non-compliant if the measured value is equal to or above the CC<sub>α</sub>.

Paragraphs 1, 2 and 3 shall apply for the analytical result obtained on the sample for official control. In case of analysis for defence or reference purposes, the national rules shall apply.

## 2.2. As regards PCDD/F and dioxin-like PCBs

The lot complies with the maximum levels if the result of a single analysis,

- performed by a screening method with a false-compliant rate below 5 %, indicates that the level does not exceed the respective maximum level of PCDD/PCDFs and the sum of PCDD/PCDFs and dioxin-like PCBs laid down by Directive 2002/32/EC,
- performed by a confirmatory method, does not exceed the respective maximum level of PCDD/PCDFs and the sum of PCDD/PCDFs and dioxin-like PCBs laid down by Directive 2002/32/EC, taking into account the measurement uncertainty.

For screening assays a cut-off value shall be established for decisions on sample compliance with the respective maximum levels set for either PCDD/PCDFs, or for the sum of PCDD/PCDFs and dioxin-like PCBs.

The lot does not comply with the maximum level if the upper-bound <sup>(5)</sup>\* analytical result obtained with a confirmatory method and confirmed by duplicate analysis exceeds the maximum level laid down by Directive 2002/32/EC, taking into account the measurement uncertainty <sup>(6)</sup>\*. The mean of two determinations, taking into account the measurement uncertainty, is used for verification of compliance.

The measurement uncertainty shall be taken into account according to one of the following approaches:

- by calculating the expanded uncertainty, using a coverage factor of 2 which gives a level of confidence of approximately 95 %. A lot or subplot is non-compliant if the measured value minus U is above the maximum level. In case of a separate determination of PCDD/PCDFs and dioxin-like-PCBs, the sum of the estimated expanded uncertainty of the separate analytical results of PCDD/PCDFs and dioxin-like PCBs shall be used for the sum of PCDD/PCDFs and dioxin-like PCBs,
- by establishing the decision limit (CC<sub>α</sub>) in accordance with point 3.1.2.5 of the Annex I to Decision 2002/657/EC. A lot or subplot is non-compliant if the measured value is equal to or above the CC<sub>α</sub>.

Paragraphs 1 to 4 shall apply for the analytical result obtained on the sample for official control. In case of analysis for defence or reference purposes, the national rules shall apply.

## 3. Results exceeding action thresholds as laid down in Annex II to Directive 2002/32/EC

Action thresholds serve as a tool for the selection of samples in those cases where it is necessary to identify a source of contamination and to take measures to reduce or eliminate it. Screening methods shall establish appropriate cut-off values for the selection of those samples. In case significant efforts are necessary to identify a source and to reduce or eliminate the contamination, it might be appropriate to confirm exceedance of the action thresholds is confirmed by duplicate analysis using a confirmatory method and taking into account the measurement uncertainty <sup>(7)</sup>\*.

### CHAPTER II

## **Sample preparation and requirements for methods of analysis used in official control of the levels of dioxins (PCDD/PCDF) and dioxin-like PCBs in feed**

### 1. Field of application

The requirements set out in this Chapter shall be applied where feed is analysed for the official control of the levels of 2,3,7,8-substituted polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) and dioxin-like polychlorinated biphenyls (dioxin-like PCBs) and for other regulatory purposes.

Monitoring for the presence of PCDD/Fs and dioxin-like PCBs in feed may be performed with two different types of analytical methods:

#### (a) Screening methods

The goal of screening methods is to select those samples with levels of PCDD/Fs and dioxin-like PCBs that exceed the maximum levels or the action thresholds. Screening methods should allow cost-effective high sample-throughput, thus increasing the chance to discover new incidents with high exposure and health risks of consumers. Their application should aim at avoiding false-compliant results. They may comprise bioanalytical and GC-MS methods.

Screening methods compare the analytical result with a cut-off value, providing a yes/no-decision over possible exceedance of the maximum level or action threshold. The concentration of PCDD/Fs and the sum of PCDD/Fs and dioxin-like PCBs in samples suspected to be non-compliant with the maximum level must be determined/confirmed by a confirmatory method.

In addition, screening methods may give an indication of the levels of PCDD/Fs and dl-PCBs present in the sample. In case of application of bioanalytical screening methods the result is expressed as Bioanalytical Equivalents (BEQ), whereas in case of application of physico-chemical GC-MS methods it is expressed as Toxic Equivalents (TEQ). The numerically indicated results of screening methods are suitable for demonstrating compliance or suspected noncompliance or exceedance of action thresholds and give an indication of the range of levels in case of follow-up by confirmatory methods. They are not suitable for purposes such as evaluation of background levels, estimation of intake, following of time trends in levels or re-evaluation of action thresholds and maximum levels.

(b) *Confirmatory methods*

Confirmatory methods allow the unequivocal identification and quantification of PCDD/Fs and dioxin-like PCBs present in a sample and provide full information at congener level. Therefore, these methods allow the control of maximum levels and action thresholds, including the confirmation of results obtained by screening methods. Furthermore, results may be used for other purposes such as determination of low background levels in feed monitoring, following of time trends, exposure assessment and building of a database for possible re-evaluation of action thresholds and maximum levels. They are also important for establishing congener patterns in order to identify the source of a possible contamination. Such methods utilise GC-HRMS. For confirming compliance or non-compliance with the maximum level, also GC-MS/MS can be used.

## 2. **Background**

For calculation of Toxic Equivalent (TEQ) concentrations, the concentrations of the individual substances in a given sample shall be multiplied by their respective Toxic Equivalency Factor (TEF) (see footnote (1)\* of Chapter I) and subsequently summed to give the total concentration of dioxin-like compounds expressed as TEQs.

For the purposes of this Part B, the accepted specific limit of quantification of an individual congener means the lowest content of the analyte that can be measured with reasonable statistical certainty, fulfilling the identification criteria as described in internationally recognised standards, for example, in standard EN 16215:2012 (Animal feed — Determination of dioxins and dioxin-like PCBs by GC-HRMS and of indicator PCBs by GC-HRMS) and/or in EPA methods 1613 and 1668 as revised.

The limit of quantification of an individual congener may be identified as

- (a) the concentration of an analyte in the extract of a sample which produces an instrumental response at two different ions to be monitored with a S/N (signal/noise) ratio of 3:1 for the less intensive raw data signal; or
- (b) if for technical reasons the signal-to-noise calculation does not provide reliable results, the lowest concentration point on a calibration curve that gives an acceptable ( $\leq 30\%$ ) and consistent (measured at least at the start and at the end of an analytical series of samples) deviation to the average relative response factor calculated for all points on the calibration curve in each series of samples. The LOQ is calculated from the lowest concentration point taking into account the recovery of internal standards and sample intake.

Bioanalytical screening methods will not give results at the congener level but merely an indication <sup>(8)\*</sup> of the TEQ level, expressed in Bioanalytical Equivalents (BEQ) to acknowledge the fact that not all compounds present in a sample extract that produce a response in the test may obey all requirements of the TEQ-principle.

Screening and confirmatory methods can only be applied for control of a certain matrix if the methods are sensitive enough to detect levels reliably at the action threshold or maximum level.

## 3. **Quality assurance requirements**

- 3.1. Measures shall be taken to avoid cross-contamination at each stage of the sampling and analysis procedure.
- 3.2. The samples shall be stored and transported in glass, aluminium, polypropylene or polyethylene containers suitable for storage without any influence on the levels of PCDD/PCDFs and dioxin-like PCBs in the samples. Traces of paper dust shall be removed from the sample container.

- 3.3. The sample storage and transportation shall be performed in a way that maintains the integrity of the feed sample.
- 3.4. Insofar as relevant, each laboratory sample shall be finely grinded and mixed thoroughly using a process that has been demonstrated to achieve complete homogenisation (for example, ground to pass a 1 mm sieve). Samples shall be dried before grinding if the moisture content is too high.
- 3.5. Control of reagents, glassware and equipment for possible influence of TEQ- or BEQ-based results shall be carried out.
- 3.6. A blank analysis shall be performed by carrying out the entire analytical procedure omitting only the sample.
- 3.7. For bioanalytical methods, all glassware and solvents used in analysis shall be tested to be free of compounds that interfere with the detection of target compounds in the working range. Glassware shall be rinsed with solvents or heated at temperatures suitable to remove traces of PCDD/PCDFs, dioxin-like compounds and interfering compounds from its surface.
- 3.8. Sample quantity used for the extraction shall be sufficient to fulfil the requirements with respect to a sufficiently low working range including the concentrations of maximum levels or action threshold.
- 3.9. The specific sample preparation procedures used for the products under consideration shall follow internationally accepted guidelines.

#### 4. Requirements for laboratories

- 4.1. In accordance with the provisions of Regulation (EC) No 882/2004, laboratories shall be accredited by a recognised body operating in accordance with ISO Guide 58 to ensure that they are applying analytical quality assurance. Laboratories shall be accredited following the EN ISO/IEC 17025 standard.
- 4.2. Laboratory proficiency shall be proven by the continuous successful participation in inter-laboratory studies for the determination of PCDD/PCDFs and dioxin-like PCBs in relevant feed matrices and concentration ranges.
- 4.3. Laboratories applying screening methods for the routine control of samples shall establish a close cooperation with laboratories applying the confirmatory method, both for quality control and confirmation of the analytical result of suspected samples.

#### 5. Basic requirements to be met by analytical procedure for dioxins (PCDD/PCDFs) and dioxin-like PCBs.

##### 5.1. *Low working range and limits of quantification*

For PCDD/PCDFs, detectable quantities shall be in the upper femtogram ( $10^{-15}$ g) range because of extreme toxicity of some of these compounds. For most PCB congeners limit of quantification in the nanogram ( $10^{-9}$ g) range is already sufficient. For the measurement of the more toxic dioxin-like PCB congeners (in particular non-ortho substituted congeners), the lower end of the working range shall reach the low picogram ( $10^{-12}$ g) levels. For all other PCB congeners a limit of quantification in the nanogram ( $10^{-9}$ g) range is sufficient.

##### 5.2. *High selectivity (specificity)*

- 5.2.1. A distinction is required between PCDD/PCDFs and dioxin-like PCBs and a multitude of other, coextracted and possibly interfering compounds present at concentrations up to several orders of magnitude higher than those of the analytes of interest. For GC-MS methods, a differentiation among various congeners is required, such as between toxic (for example, the seventeen 2,3,7,8-substituted PCDD/PCDFs, and twelve dioxin-like PCBs) and other congeners.
- 5.2.2. Bioanalytical methods shall be able to detect the target compounds as the sum of PCDD/PCDFs, and/or dioxin-like PCBs. Sample clean-up shall aim at removing compounds causing false non-compliant results or compounds that may decrease the response, causing false compliant results.

5.3. *High accuracy (trueness and precision, bioassay apparent recovery)*

5.3.1. For GC-MS methods, the determination shall provide a valid estimate of the true concentration in a sample. High accuracy is required to avoid the rejection of a sample analysis result on the basis of poor reliability of the determined TEQ level. Accuracy is expressed as *trueness* (difference between the mean value measured for an analyte in a certified material and its certified value, expressed as a percentage of this value) and *precision* ( $RSD_R$  relative standard deviation calculated from results generated under reproducibility conditions).

5.3.2. For bioanalytical methods, the bioassay apparent recovery shall be determined. Bioassay apparent recovery means the BEQ level calculated from the TCDD or PCB 126 calibration curve corrected for the blank and then divided by the TEQ level determined by the confirmatory method. It aims at correcting factors like the loss of PCDD/PCDFs and dioxin-like compounds during the extraction and clean-up steps, co-extracted compounds increasing or decreasing the response (agonistic and antagonistic effects), the quality of the curve fit, or differences between the Toxic Equivalency Factor (TEF) and the Relative Potency (REP) values. The bioassay apparent recovery is calculated from suitable reference samples with representative congener patterns around the level of interest.

5.4. *Validation in the range of maximum level and general quality control measures*

5.4.1. Laboratories shall demonstrate the performance of a method in the range of the maximum level, for example, 0,5x, 1x and 2x the maximum level with an acceptable coefficient of variation for repeated analysis, during the validation procedure and during routine analysis.

5.4.2. Regular blank controls and spiking experiments or analysis of control samples (preferably, if available, certified reference material) shall be performed as internal quality control measures. Quality control charts for blank controls, spiking experiments or analysis of control samples shall be recorded and checked to make sure the analytical performance is in accordance with the requirements.

5.5. *Limit of quantification*

5.5.1. For a bioanalytical screening method, the establishment of the limit of quantification (LOQ) is not an indispensable requirement but the method shall prove that it can differentiate between the blank and the cut-off value. When providing a BEQ level, a reporting level shall be established to deal with samples showing a response below this level. The reporting level shall be demonstrated to be different from procedure blank samples at least by a factor of three, with a response below the working range. It shall therefore be calculated from samples containing the target compounds around the required minimum level, and not from an S/N ratio or an assay blank.

5.5.2. The LOQ for a confirmatory method shall be about one fifth of the maximum level.

5.6. *Analytical criteria*

For reliable results from confirmatory or screening methods, the following criteria shall be met in the range of the maximum level or action threshold for the TEQ or BEQ value, respectively, whether determined as total TEQ (as sum of PCDD/PCDFs and dioxin-like PCBs) or separately for PCDD/PCDFs and dioxin-like PCBs:

	Screening with bioanalytical or physico-chemical methods	Confirmatory methods
False-compliant rate <sup>(1)</sup>	< 5 %	
Trueness		- 20 % to + 20 %
Repeatability (RSD <sub>i</sub> )	< 20 %	
Within-laboratory reproducibility (RSD <sub>R</sub> )	< 25 %	< 15 %

<sup>(1)</sup> With respect to the maximum levels.

5.7. *Specific requirements for screening methods*

5.7.1. Both GC-MS and bioanalytical methods may be used for screening. For GC-MS methods the requirements laid down in point 6 shall be met. For cell based bioanalytical methods specific requirements are laid down in point 7.

5.7.2. Laboratories applying screening methods for the routine control of samples shall establish a close cooperation with laboratories applying the confirmatory method.

5.7.3. Performance verification of the screening method is required during routine analysis, by analytical quality control and ongoing method validation. There shall be a continuous programme for the control of compliant results.

5.7.4. Check on possible suppression of the cell response and cytotoxicity:

20 % of the sample extracts shall be measured in routine screening without and with 2,3,7,8-TCDD added corresponding to the maximum level or action threshold, to check if the response is possibly suppressed by interfering substances present in the sample extract. The measured concentration of the spiked sample shall be compared to the sum of the concentration of the unspiked extract plus the spiking concentration. If this measured concentration is more than 25 % lower than the calculated (sum) concentration, this is an indication of potential signal suppression and the respective sample shall be submitted to GC-HRMS confirmatory analysis. Results shall be monitored in quality control charts.

5.7.5. Quality control on compliant samples:

Approximately 2 to 10 % of the compliant samples, depending on sample matrix and laboratory experience, shall be confirmed by GC-HRMS.

5.7.6. Determination of false-compliant rates from quality control data:

The rate of false-compliant results from screening of samples below and above the maximum level or the action threshold shall be determined. Actual false-compliant rates shall be below 5 %. When a minimum of 20 confirmed results per matrix/matrix group is available from the quality control of compliant samples, conclusions on the false compliant rate shall be drawn from this database. The results from samples analysed in ring trials or during contamination incidents, covering a concentration range up to for example 2x the maximum level (ML), may also be included in the minimum of 20 results for evaluation of the false-compliant rate. The samples shall cover most frequent congener patterns, representing various sources.

Although screening assays shall preferentially aim at detecting samples exceeding the action threshold, the criterion for determining false-compliant rates is the maximum level, taking into account the measurement uncertainty of the confirmatory method.

5.7.7. Potentially non-compliant samples from screening shall always be verified by a full re-analysis of the original sample by a confirmatory method of analysis. These samples may also be used to evaluate the rate of false non-compliant results. For screening methods, the rate of false non-compliant results shall be the fraction of results confirmed to be compliant from confirmatory analysis, while in previous screening the sample has been declared to be potentially non-compliant. Evaluation of the advantageousness of the screening method shall be based on comparison of false-non-compliant samples with the total number of samples checked. This rate shall be low enough to make the use of a screening tool advantageous.

5.7.8. At least under validation conditions, bioanalytical methods shall provide a valid indication of the TEQ level, calculated and expressed as BEQ.

Also for bioanalytical methods carried out under repeatability conditions, the intra-laboratory  $RSD_i$  would typically be smaller than the reproducibility  $RSD_R$ .

6. **Specific requirements for GC-MS methods to be complied with for screening or confirmatory purposes**

6.1. *Acceptable differences between upper-bound and lower-bound WHO-TEQ results*

The difference between upper-bound level and lower-bound level shall not exceed 20 % for confirmation of exceedance of maximum level or in case of need of action thresholds.



## 6.2. *Control of recoveries*

- 6.2.1. Addition of <sup>13</sup>C-labelled 2,3,7,8-chlorine substituted internal PCDD/PCDF standards and of <sup>13</sup>C-labelled internal dioxin-like PCB standards shall be carried out at the very beginning of the analytical method, e.g. prior to extraction in order to validate the analytical procedure. At least one congener for each of the tetra- to octa-chlorinated homologous groups for PCDD/PCDFs and at least one congener for each of the homologous groups for dioxin-like PCBs shall be added (alternatively, at least one congener for each mass spectrometric selected ion recording function used for monitoring PCDD/PCDFs and dioxin-like PCBs). In the case of confirmatory methods, all 17 <sup>13</sup>C-labelled 2,3,7,8-substituted internal PCDD/PCDF standards and all 12 <sup>13</sup>C-labelled internal dioxin-like PCB standards shall be used.
- 6.2.2. Relative response factors shall also be determined for those congeners for which no <sup>13</sup>C-labelled analogue is added by using appropriate calibration solutions.
- 6.2.3. For feed of plant origin and feed of animal origin containing less than 10 % fat, the addition of the internal standards shall be mandatory prior to extraction. For feed of animal origin containing more than 10 % fat, the internal standards shall be added either before or after fat extraction. An appropriate validation of the extraction efficiency shall be carried out, depending on the stage at which internal standards are introduced and on whether results are reported on product or fat basis.
- 6.2.4. Prior to GC-MS analysis, 1 or 2 recovery (surrogate) standard(s) shall be added.
- 6.2.5. Control of recovery is required. For confirmatory methods, the recoveries of the individual internal standards shall be in the range of 60 to 120 %. Lower or higher recoveries for individual congeners, in particular for some hepta- and octa- chlorinated dibenzo-p-dioxins and dibenzofurans, shall be acceptable on the condition that their contribution to the TEQ value does not exceed 10 % of the total TEQ value (based on sum of PCDD/PCDF and dioxin-like PCBs). For GC-MS screening methods, the recoveries shall be in the range of 30 to 140 %.

## 6.3. *Removal of interfering substances*

- Separation of PCDD/PCDFs from interfering chlorinated compounds such as non-dioxin-like PCBs and chlorinated diphenyl ethers shall be carried out by suitable chromatographic techniques (preferably with a florisil, alumina and/or carbon column).
- Gas-chromatographic separation of isomers shall be < 25 % peak to peak between 1,2,3,4,7,8-HxCDF and 1,2,3,6,7,8-HxCDF.

## 6.4. *Calibration with standard curve*

The range of the calibration curve shall cover the relevant range of maximum level or action thresholds.

## 6.5. *Specific criteria for confirmatory methods*

- For GC-HRMS:

In HRMS, the resolution shall typically be greater than or equal to 10 000 for the entire mass range at 10 % valley.

Fulfilment of further identification and confirmation criteria as described in internationally recognised standards, for example, in standard EN 16215:2012 (Animal feed — Determination of dioxins and dioxin-like PCBs by GC-HRMS and of indicator PCBs by GC-HRMS) and/or in EPA methods 1613 and 1668 as revised.

- For GC-MS/MS:

Monitoring of at least 2 specific precursor ions, each with one specific corresponding transition product ion for all labelled and unlabelled analytes in the scope of analysis.

Maximum permitted tolerance of relative ion intensities of  $\pm 15$  % for selected transition product ions in comparison to calculated or measured values (average from calibration standards), applying identical MS/MS conditions, in particular collision energy and collision gas pressure, for each transition of an analyte.

Resolution for each quadrupole to be set equal to or better than unit mass resolution (unit mass resolution: sufficient resolution to separate two peaks one mass unit apart) in order to minimise possible interferences on the analytes of interest.

Fulfilment of the further criteria as described in internationally recognised standards, for example, in standard EN 16215:2012 (Animal feed — Determination of dioxins and dioxin-like PCBs by GC-HRMS and of indicator PCBs by GC-HRMS) and/or in EPA methods 1613 and 1668 as revised, except the obligation to use GC-HRMS.

## 7. Specific requirements for bioanalytical methods

Bioanalytical methods are methods based on the use of biological principles like cell-based assays, receptor-assays or immunoassays. This point 7 establishes requirements for bioanalytical methods in general.

A screening method in principle classifies a sample as compliant or suspected to be non-compliant. For this, the calculated BEQ level is compared to the cut-off value (see 7.3). Samples below the cut-off value are declared compliant, samples equal or above the cut-off value are suspected to be non-compliant, requiring analysis by a confirmatory method. In practice, a BEQ level corresponding to 2/3 of the maximum level may serve as cut-off value provided that a false-compliant rate below 5 % and an acceptable rate for false non-compliant results are ensured. With separate maximum levels for PCDD/Fs and for the sum of PCDD/Fs and dioxin-like PCBs, checking compliance of samples without fractionation requires appropriate bioassay cut-off values for PCDD/Fs. For checking of samples exceeding the action thresholds, an appropriate percentage of the respective action threshold would suit as cut-off value.

Furthermore, in the case of certain bioanalytical methods, an indicative level expressed in BEQs may be given for samples in the working range and exceeding the reporting limit (see 7.1.1 and 7.1.6).

### 7.1. Evaluation of the test response

#### 7.1.1. General requirements

- When calculating the concentrations from a TCDD calibration curve, values at the lower and higher end of the curve will show a high variation (high coefficient of variation (CV)). The working range is the area where this CV is smaller than 15 %. The lower end of the working range (reporting limit) shall be set at least by a factor of three above the procedure blanks. The upper end of the working range is usually represented by the  $EC_{70}$  value (70 % of maximal effective concentration), but lower if the CV is higher than 15 % in this range. The working range shall be established during validation. Cut-off values (see point 7.3) shall be well within the working range.
- Standard solutions and sample extracts shall be tested at least in duplicate. When using duplicates, a standard solution or a control extract tested in 4 to 6 wells divided over the plate shall produce a response or concentration (only possible in the working range) based on a  $CV < 15 \%$ .

#### 7.1.2. Calibration

##### 7.1.2.1. Calibration with standard curve

- Levels in samples shall be estimated by comparison of the test response with a calibration curve of TCDD (or PCB 126 or a PCDD/PCDF/dioxin-like PCB standard mixture) to calculate the BEQ level in the extract and subsequently in the sample.
- Calibration curves shall contain 8 to 12 concentrations (at least in duplicates), with enough concentrations in the lower part of the curve (working range). Special attention shall be paid to the quality of the curve-fit in the working range. As such, the  $R^2$  value is of little or no value in estimating the goodness of fit in non-linear regression. A better fit shall be achieved by minimising the difference between calculated and observed levels in the working range of the curve, for example by minimising the sum of squared residuals.
- The estimated level in the sample extract shall be subsequently corrected for the BEQ level calculated for a matrix/solvent blank sample (to account for impurities from solvents and chemicals used), and the apparent recovery (calculated from the BEQ level of suitable reference samples with representative congener patterns around the maximum level or action threshold). To perform a recovery correction, the apparent recovery shall be within the required range (see point 7.1.4). Reference samples used for recovery correction shall comply with the requirements laid down in point 7.2.

#### 7.1.2.2. Calibration with reference samples

Alternatively, a calibration curve prepared from at least four reference samples (see point 7.2.4: one matrix blank, plus three reference samples at 0,5x, 1,0x and 2,0x the maximum level or action threshold) may be used, eliminating the need to correct for blank and recovery. In this case, the test response corresponding to 2/3 of the maximum level (see point 7.3) may be calculated directly from these samples and used as cut-off value. For checking of samples exceeding the action thresholds, an appropriate percentage of these action thresholds would suit as cut-off value.

#### 7.1.3. Separate determination of PCDD/PCDFs and dioxin-like PCBs

Extracts may be split into fractions containing PCDD/PCDFs and dioxin-like PCBs, allowing a separate indication of PCDD/PCDFs and dioxin-like PCB TEQ levels (in BEQ). A PCB 126 standard calibration curve shall preferentially be used to evaluate results for the fraction containing dioxin-like PCBs.

#### 7.1.4. Bioassay apparent recoveries

The “bioassay apparent recovery” shall be calculated from suitable reference samples with representative congener patterns around the maximum level or action threshold and expressed as percentage of the BEQ level in comparison to the TEQ level. Depending on the type of assay and TEFs (\*) used, the differences between TEF and REP factors for dioxin-like PCBs can cause low apparent recoveries for dioxin-like PCBs in comparison to PCDD/PCDFs. Therefore, if a separate determination of PCDD/PCDFs and dioxin-like PCBs is performed, bioassay apparent recoveries shall be: for dioxin-like PCBs 20 % to 60 %, for PCDD/PCDFs 50 % to 130 % (ranges apply for the TCDD calibration curve). As the contribution of dioxin-like PCBs to the sum of PCDD/PCDFs and dioxin-like PCBs can vary between different matrices and samples, bioassay apparent recoveries for the sum of PCDD/PCDFs and dioxin-like PCBs reflect these ranges and shall be between 30 % and 130 %. Any implication of substantially revised TEF values for the Union legislation for PCDD/PCDFs and dioxin-like PCBs requires the revision of these ranges.

#### 7.1.5. Control of recoveries for clean-up

The loss of compounds during the clean-up shall be checked during validation. A blank sample spiked with a mixture of the different congeners shall be submitted to clean-up (at least  $n = 3$ ) and the recovery and variability checked by a confirmatory method. The recovery shall be within 60 % to 120 % especially for congeners contributing more than 10 % to the TEQ-level in various mixtures.

#### 7.1.6. Reporting Limit

When reporting BEQ levels, a reporting limit shall be determined from relevant matrix samples involving typical congener patterns, but not from the calibration curve of the standards due to low precision in the lower range of the curve. Effects from extraction and clean-up shall be taken into account. The reporting limit shall be set at least by a factor of three above the procedure blanks.

#### 7.2. Use of reference samples

7.2.1. Reference samples shall represent sample matrix, congener patterns and concentration ranges for PCDD/PCDFs and dioxin-like PCBs around the maximum level or action threshold.

7.2.2. A matrix blank, and where it is not possible, a procedure blank, and a reference sample at the maximum level or action threshold shall be included in each test series. These samples shall be extracted and tested at the same time under identical conditions. The reference sample shall show a clearly elevated response in comparison to the blank sample, thus ensuring the suitability of the test. These samples may be used for blank and recovery corrections.

7.2.3. Reference samples chosen to perform a recovery correction shall be representative for the test samples, meaning that congener patterns may not lead to an underestimation of levels.

7.2.4. Extra reference samples at e.g. 0,5x and 2x the maximum level or action threshold may be included to demonstrate the proper performance of the test in the range of interest for the control of the maximum level or action threshold. Combined, these samples may be used for calculating the BEQ levels in test samples (see point 7.1.2.2).

### 7.3. Determination of cut-off values

The relationship between bioanalytical results in BEQ and results from the confirmatory method in TEQ shall be established, for example by matrix-matched calibration experiments, involving reference samples spiked at 0, 0,5x, 1x and 2x the maximum level (ML), with 6 repetitions on each level (n = 24). Correction factors (blank and recovery) may be estimated from this relationship but shall be checked in accordance with point 7.2.2.

Cut-off values shall be established for decisions over sample compliance with maximum levels or for the control of action thresholds, if relevant, with the respective maximum levels or action threshold set for either PCDD/PCDFs and dioxin-like PCBs alone, or for the sum of PCDD/PCDFs and dioxin-like PCBs. They are represented by the *lower* end-point of the distribution of bioanalytical results (corrected for blank and recovery) corresponding to the decision limit of the confirmatory method based on a 95 % level of confidence, implying a false-compliant rate < 5 %, and on a  $RSD_R < 25$  %. The decision limit of the confirmatory method is the maximum level, taking into account the measurement uncertainty.

The cut-off value (in BEQ) may be calculated in accordance with one of the approaches set out in points 7.3.1, 7.3.2 and 7.3.3 (see Figure 1).

#### 7.3.1. Use of the *lower* band of the 95 % prediction interval at the decision limit of the confirmatory method:

$$\text{Cut-off value} = \text{BEQ}_{\text{DL}} - S_{y,x} * t_{\alpha, f = m - 2} \sqrt{1/n + 1/m + (x_i - \bar{x})^2 / Q_{xx}}$$

with:

$\text{BEQ}_{\text{DL}}$  BEQ corresponding to the decision limit of the confirmatory method, being the maximum level including measurement uncertainty

$S_{y,x}$  residual standard deviation

$t_{\alpha, f = m - 2}$  Student factor ( $\alpha = 5$  %,  $f =$  degrees of freedom, single-sided)

$m$  total number of calibration points (index  $j$ )

$n$  number of repetitions on each level

$x_i$  Sample concentration (in TEQ) of calibration point  $i$  determined by a confirmatory method

$\bar{x}$  mean of the concentrations (in TEQ) of all calibration samples

$Q_{xx} = \sum_{j=1}^m (x_j - \bar{x})^2$  square sum parameter,  $i =$  index for calibration point  $i$

#### 7.3.2. Calculation from bioanalytical results (corrected for blank and recovery) of multiple analyses of samples ( $n \geq 6$ ) contaminated at the decision limit of the confirmatory method, as the *lower* endpoint of the data distribution at the corresponding mean BEQ value:

$$\text{Cut-off value} = \text{BEQ}_{\text{DL}} - 1,64 \times \text{SD}_R$$

With:

$\text{SD}_R$  standard deviation of bioassay results at  $\text{BEQ}_{\text{DL}}$ , measured under within-laboratory reproducibility conditions

- 7.3.3. Calculation as mean value of bioanalytical results (in BEQ, corrected for blank and recovery) from multiple analysis of samples ( $n \geq 6$ ) contaminated at 2/3 of the maximum level or action threshold, based on the observation that this level will be around the cut-off value determined under point 7.3.1 or point 7.3.2:

Figure 1

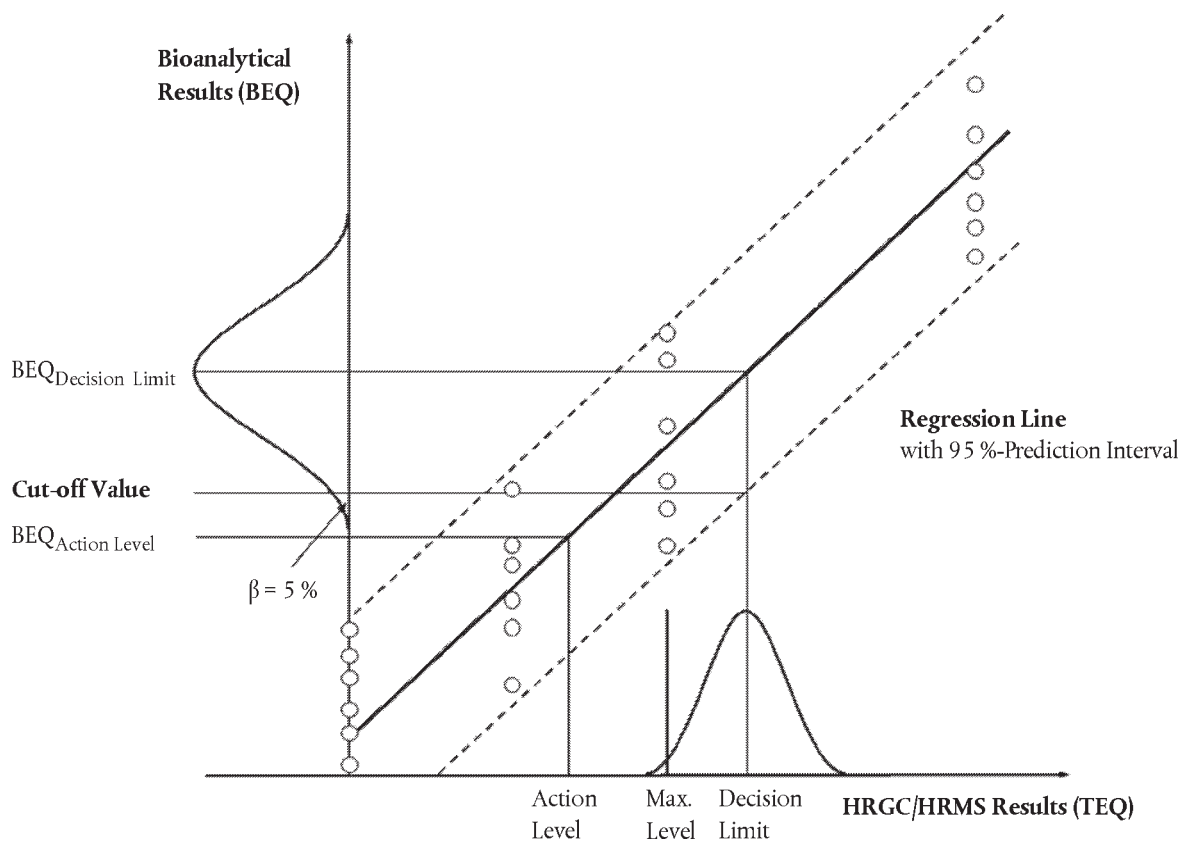


Figure 1 Calculation of cut-off values based on a 95 % level of confidence implying a false-compliant rate < 5 %, and a  $RSD_R < 25$  %:

1. from the lower band of the 95 % prediction interval at the decision limit of the confirmatory method,
2. from multiple analysis of samples ( $n \geq 6$ ) contaminated at the decision limit of the confirmatory method as the lower end-point of the data distribution (represented in the figure by a bell-shaped curve) at the corresponding mean BEQ value.

#### 7.3.4. Restrictions to cut-off values

BEQ-based cut-off values calculated from the  $RSD_R$  achieved during validation using a limited number of samples with different matrix/congener patterns may be higher than the TEQ-based maximum levels or action thresholds due to a better precision than attainable in routine when an unknown spectrum of possible congener patterns has to be controlled. In such cases, cut-off values shall be calculated from an  $RSD_R = 25$  %, or two-thirds of the maximum level or action threshold shall be preferred.

#### 7.4. Performance characteristics

- 7.4.1. Since no internal standards can be used in bioanalytical methods, tests on the repeatability of bioanalytical methods shall be carried out to obtain information on the standard deviation within and between test series. Repeatability shall be below 20 %, intra-laboratory reproducibility below 25 %. This shall be based on the calculated levels in BEQ after blank and recovery correction.
- 7.4.2. As part of the validation process, the test shall be shown to discriminate between a blank sample and a level at the cut-off value, allowing the identification of samples above the corresponding cut-off value (see point 7.1.2).
- 7.4.3. Target compounds, possible interferences and maximum tolerable blank levels shall be defined.

- 7.4.4. The percent standard deviation in the response or concentration calculated from the response (only possible in working range) of a triplicate determination of a sample extract may not be above 15 %.
- 7.4.5. The uncorrected results of the reference sample(s) expressed in BEQ (blank and at the maximum level or action threshold) shall be used for evaluation of the performance of the bioanalytical method over a constant time period.
- 7.4.6. Quality control charts for procedure blanks and each type of reference sample shall be recorded and checked to make sure the analytical performance is in accordance with the requirements, in particular for the procedure blanks with regard to the requested minimum difference to the lower end of the working range and for the reference samples with regard to within-laboratory reproducibility. Procedure blanks shall be controlled in a manner to avoid false-compliant results when subtracted.
- 7.4.7. The results of suspected samples obtained by the confirmatory methods and 2 to 10 % of the compliant samples (minimum of 20 samples per matrix) shall be collected and used to evaluate the performance of the screening method and the relationship between BEQ and TEQ. This database may be used for the re-evaluation of cut-off values applicable to routine samples for the validated matrices.
- 7.4.8. Successful method performance may also be demonstrated by participation in ring trials. The results from samples analysed in ring trials, covering a concentration range up to e.g. 2x maximum level, may be included in the evaluation of the false-compliant rate, if a laboratory is able to demonstrate its successful performance. The samples shall cover most frequent congener patterns, representing various sources.
- 7.4.9. During incidents, the cut-off values may be re-evaluated, reflecting the specific matrix and congener patterns of this single incident.

## 8. Reporting of the results

### 8.1. Confirmatory methods

- 8.1.1. Insofar as the used analytical procedure makes it possible, the analytical results shall contain the levels of the individual PCDD/PCDF and dioxin-like PCB congeners and be reported as lower-bound, upper-bound and medium-bound in order to include a maximum of information in the reporting of the results and thereby enabling the interpretation of the results according to specific requirements.
- 8.1.2. The report shall include the method used for extraction of PCDD/PCDFs and dioxin-like PCBs.
- 8.1.3. The recoveries of the individual internal standards shall be made available in case the recoveries are outside the range referred to in point 6.2.5, in case the maximum level is exceeded (in this case, the recoveries for one of the two duplicate analysis) and in other cases upon request.
- 8.1.4. As the uncertainty of measurement is to be taken into account when deciding about the compliance of a sample, this parameter shall be made available. Thus, analytical results shall be reported as  $x \pm U$  whereby  $x$  is the analytical result and  $U$  is the expanded measurement uncertainty using a coverage factor of 2 which gives a level of confidence of approximately 95 %. In the case of a separate determination of PCDD/PCDFs and dioxin-like-PCBs, the sum of the estimated expanded uncertainty of the separate analytical results of PCDD/PCDFs and dioxin-like PCBs shall be used for the sum of PCDD/PCDFs and dioxin-like PCBs.
- 8.1.5. If the uncertainty of measurement is taken into account by applying CCa (as described in point 2.2 of Chapter I of this part B), this parameter shall be reported.
- 8.1.6. The results shall be expressed in the same units and with at least the same number of significant figures as the maximum levels laid down in Directive 2002/32/EC.

### 8.2. Bioanalytical screening methods

- 8.2.1. The result of the screening shall be expressed as “compliant” or “suspected to be non-compliant” (“suspected”).
- 8.2.2. In addition, a result for PCDD/PCDF and/or dioxin-like PCBs expressed in BEQ, and not TEQ, may be given.
- 8.2.3. Samples with a response below the reporting limit shall be expressed as “lower than the reporting limit”.

- 8.2.4. For each type of sample matrix, the report shall mention the maximum level or action threshold on which the evaluation is based.
- 8.2.5. The report shall mention the type of the test applied, the basic test principle and the kind of calibration.
- 8.2.6. The report shall include the method used for extraction of PCDD/PCDFs and dioxin-like PCBs.
- 8.2.7. In case of samples suspected to be non-compliant, the report needs to include a note on the action to be taken. The concentration of PCDD/Fs and the sum of PCDD/Fs and dioxin-like PCBs in those samples with elevated levels has to be determined/confirmed by a confirmatory method.

## CHAPTER III

**Sample preparation and requirements for methods of analysis used in official control of the levels of non-dioxin-like PCBs (PCB # 28, 52, 101, 138, 153, 180)****1. Field of application**

The requirements set out in this Chapter shall be applied where feed is analysed for the official control of the levels of non-dioxin-like polychlorinated biphenyls (non-dioxin-like PCBs) and for other regulatory purposes.

**2. Applicable detection methods**

Gas chromatography/Electron Capture Detection (GC-ECD), GC-LRMS, GC-MS/MS, GC-HRMS or equivalent methods.

**3. Identification and confirmation of analytes of interest**

- 3.1. Relative retention time in relation to internal standards or reference standards (acceptable deviation of +/- 0,25 %).
- 3.2. Gas chromatographic separation of all six indicator PCBs (PCB 28, PCB 52, PCB 101, PCB 138, PCB 153 and PCB 180) from interfering substances, especially co-eluting PCBs, in particular if levels of samples are in the range of legal limits and non-compliance is to be confirmed.

*[Congeners often found to co-elute are for example PCB 28/31, PCB 52/69 and PCB 138/163/164. For GC-MS also possible interferences from fragments of higher chlorinated congeners shall be considered.]*

**3.3. Requirements for GC-MS techniques**

Monitoring of at least:

- (a) two specific ions for HRMS;
- (b) two specific ions of  $m/z > 200$  or three specific ions of  $m/z > 100$  for LRMS;
- (c) 1 precursor and 2 product ions for MS-MS.

Maximum permitted tolerances for abundance ratios for selected mass fragments:

Relative deviation of abundance ratio of selected mass fragments from theoretical abundance or calibration standard for target ion (most abundant ion monitored) and qualifier ion(s):

Relative intensity of qualifier ion(s) compared to target ion	GC-EI-MS (relative deviation)	GC-CI-MS, GC-MS <sup>n</sup> (relative deviation)
> 50 %	± 10 %	± 20 %
> 20 % to 50 %	± 15 %	± 25 %
> 10 % to 20 %	± 20 %	± 30 %
≤ 10 %	± 50 % <sup>(1)</sup>	± 50 % <sup>(1)</sup>

<sup>(1)</sup> Sufficient number of mass fragments with relative intensity > 10 % available, therefore not recommendable to use qualifier ion(s) with a relative intensity of less than 10 % compared to the target ion.

### 3.4. Requirements for GC-ECD techniques

Results exceeding the tolerance shall be confirmed with two GC columns with stationary phases of different polarity.

### 4. Demonstration of performance of method

The performance of the method shall be validated in the range of the maximum level (0,5 to 2 times the maximum level) with an acceptable coefficient of variation for repeated analysis (see requirements for intermediate precision in point (9)).

### 5. Limit of quantification

The blank values shall not be higher than 30 % of the level of contamination corresponding to the maximum level <sup>(10)</sup>\*.

### 6. Quality control

Regular blank controls, analysis of spiked samples, quality control samples, participation in inter-laboratory studies on relevant matrices.

### 7. Control of recoveries

7.1. Suitable internal standards with physico-chemical properties comparable to analytes of interest shall be used.

7.2. Addition of internal standards:

Addition to products (before extraction and clean-up process).

7.3. Requirements for methods using all six isotope-labelled indicator PCB congeners:

(a) results shall be corrected for recoveries of internal standards;

(b) recoveries of isotope-labelled internal standards shall be between 50 and 120 %;

(c) lower or higher recoveries for individual congeners with a contribution to the sum of the six indicator PCBs below 10 % are acceptable.

7.4. Requirements for methods using not all six isotope-labelled internal standards or other internal standards:

(a) recovery of internal standard(s) shall be controlled for every sample;

(b) recoveries of internal standard(s) shall be between 60 and 120 %;

(c) results shall be corrected for recoveries of internal standards.

7.5. The recoveries of unlabelled congeners shall be checked by spiked samples or quality control samples with concentrations in the range of the maximum level. Recoveries for these congeners shall be considered acceptable, if they are between 70 and 120 %.

### 8. Requirements for laboratories

In accordance with the provisions of Regulation (EC) No 882/2004, laboratories shall be accredited by a recognised body operating in accordance with ISO Guide 58 to ensure that they are applying analytical quality assurance. Laboratories shall be accredited following the EN ISO/IEC 17025 standard.

### 9. Performance characteristics: criteria for the sum of the six indicator PCBs at the maximum level

Trueness	- 30 to + 30 %
Intermediate precision (RSD %)	≤ 20 %
Difference between upper and lower-bound calculation	≤ 20 %



## 10. Reporting of the results

- 10.1. Insofar as the used analytical procedure makes it possible, the analytical results shall contain the levels of the individual PCB congeners and be reported as lower-bound, upper-bound and medium-bound in order to include a maximum of information in the reporting of the results and thereby enabling the interpretation of the results according to specific requirements.
- 10.2. The report shall include the method used for extraction of PCBs and lipids.
- 10.3. The recoveries of the individual internal standards shall be made available in case the recoveries are outside the range referred to in point 7, in case the maximum level is exceeded and in other cases upon request.
- 10.4. As the uncertainty of measurement is to be taken into account when deciding about the compliance of a sample, this parameter shall also be made available. Thus, analytical results shall be reported as  $x \pm U$  whereby  $x$  is the analytical result and  $U$  is the expanded measurement uncertainty using a coverage factor of 2 which gives a level of confidence of approximately 95 %.
- 10.5. If the uncertainty of measurement is taken into account by applying CCa (as described in point 2.1 of Chapter I), this parameter shall be reported.
- 10.6. The results shall be expressed in the same units and with at least the same number of significant figures as the maximum levels laid down in Directive 2002/32/EC.

(<sup>1</sup>)<sup>\*</sup> Table of TEF (= toxic equivalency factors) for dioxins, furans and dioxin-like PCBs:

WHO-TEFs for human risk assessment based on the conclusions of the World Health Organization (WHO) — International Programme on Chemical Safety (IPCS) expert meeting which was held in Geneva in June 2005 (Martin van den Berg et al., The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. Toxicological Sciences 93(2), 223-241 (2006)).

Congener	TEF value	Congener	TEF value
<b>Dibenzo-p-dioxins ("PCDDs") and Dibenzo-p-furans ("PCDFs")</b>		<b>"Dioxin-like" PCBs Non-ortho PCBs + Mono-ortho PCBs</b>	
2,3,7,8-TCDD	1		
1,2,3,7,8-PeCDD	1	<b>Non-ortho PCBs</b>	
1,2,3,4,7,8-HxCDD	0,1	PCB 77	0,0001
1,2,3,6,7,8-HxCDD	0,1	PCB 81	0,0003
1,2,3,7,8,9-HxCDD	0,1	PCB 126	0,1
1,2,3,4,6,7,8-HpCDD	0,01	PCB 169	0,03
OCDD	0,0003		
		<b>Mono-ortho PCBs</b>	
2,3,7,8-TCDF	0,1	PCB 105	0,00003
1,2,3,7,8-PeCDF	0,03	PCB 114	0,00003
2,3,4,7,8-PeCDF	0,3	PCB 118	0,00003
1,2,3,4,7,8-HxCDF	0,1	PCB 123	0,00003
1,2,3,6,7,8-HxCDF	0,1	PCB 156	0,00003
1,2,3,7,8,9-HxCDF	0,1	PCB 157	0,00003
2,3,4,6,7,8-HxCDF	0,1	PCB 167	0,00003
1,2,3,4,6,7,8-HpCDF	0,01	PCB 189	0,00003
1,2,3,4,7,8,9-HpCDF	0,01		
OCDF	0,0003		

Abbreviations used: "T" = tetra; "Pe" = penta; "Hx" = hexa; "Hp" = hepta; "O" = octa; "CDD" = chlorodibenzo-dioxin; "CDF" = chlorodibenzofuran; "CB" = chlorobiphenyl.

- (<sup>2</sup>)<sup>\*</sup> Commission Decision 2002/657/EC of 14 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and interpretation of results (OJ L 221, 17.8.2002, p. 8.)
- (<sup>3</sup>)<sup>\*</sup> The concept of “upper-bound” requires using the limit of quantification for the contribution of each non-quantified congener. The concept of “lower-bound” requires using zero for the contribution of each non-quantified congener. The concept of “medium-bound” requires using half of the limit of quantification calculating the contribution of each non-quantified congener.
- (<sup>4</sup>)<sup>\*</sup> In general, the requirements for duplicate analysis as provided for in Annex II, Chapter C point 3 apply. However, for confirmatory methods with the use of <sup>13</sup>C-labelled internal standard for the relevant analytes, the duplicate analysis is only necessary if the result of the first determination applying such confirmatory methods is not compliant. The duplicate analysis is necessary to exclude the possibility of internal cross-contamination or an accidental mix-up of samples. In case the analysis is performed in the frame of a contamination incident, confirmation by duplicate analysis might be omitted in case the samples selected for analysis are through traceability linked to the contamination incident and the level found is significantly above the maximum level.
- (<sup>5</sup>)<sup>\*</sup> The concept of “upper-bound” requires using the limit of quantification for the contribution of each non-quantified congener to the Toxic Equivalent (TEQ). The concept of “lower-bound” requires using zero for the contribution of each non-quantified congener to the TEQ. The concept of “medium-bound” requires using half of the limit of quantification calculating the contribution of each non-quantified congener to the TEQ.
- (<sup>6</sup>)<sup>\*</sup> In general, the requirements for duplicate analysis as provided for in Annex II, Chapter C point 3 apply. However, for confirmatory methods with the use of <sup>13</sup>C-labelled internal standard for the relevant analytes, the duplicate analysis is only necessary if the result of the first determination applying such confirmatory methods is not compliant. The duplicate analysis is necessary to exclude the possibility of internal cross-contamination or an accidental mix-up of samples. In case the analysis is performed in the frame of a contamination incident, confirmation by duplicate analysis might be omitted in case the samples selected for analysis are through traceability linked to the contamination incident and the level found is significantly above the maximum level.
- (<sup>7</sup>)<sup>\*</sup> Identical explanation and requirements for duplicate analysis for control of action thresholds as in footnote (5)<sup>\*</sup> for maximum levels.
- (<sup>8</sup>)<sup>\*</sup> Bioanalytical methods are not specific to those congeners included in the TEF-scheme. Other structurally related AhR-active compounds may be present in the sample extract which contribute to the overall response. Therefore, bioanalytical results cannot be an estimate but rather an indication of the TEQ level in the sample.
- (<sup>9</sup>)<sup>\*</sup> Current requirements are based on the TEFs published in: M. Van den Berg et al, *Toxicol Sci* 93 (2), 223-241 (2006).
- (<sup>10</sup>)<sup>\*</sup> It is highly recommendable to have a lower contribution of the reagent blank level to the level of a contaminant in a sample. It is in the responsibility of the laboratory to control the variation of blank levels, in particular, if the blank levels are subtracted.
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