



# **CUAP**

## **Common Understanding of Assessment Procedure**

for Presentation to EOTA Approval Bodies

for a European Technical Approval according to  
Article 8.2 b of the Construction Products Directive

### **Fly Ash for Concrete**

ETA request No 03.01/34

**September 21, 2004**  
**Amended 2005-05-04 by ETA-Danmark A/S**  
**Final Version June 2005**

**January 30, 2008**  
**Updated by BMC Certificatie**  
**Final Version March 2008**

drafted by BMC Certification  
Büchnerweg 3  
2803 GR Gouda  
The Netherlands  
Tel.: +31 182 53 23 00  
Fax: +31 182 57 02 16  
E-mail: [bmc@bmc-cert.nl](mailto:bmc@bmc-cert.nl)

## Contents

- 1 Definition of the construction product
- 2 Intended use of the construction product
- 3 Relevant characteristics of the construction product and verification methods to be evaluated in the ETA
- 4 Verification methods for determining the relevant characteristics of the construction product
- 5 Requirements and general provisions for limit values and classes relevant for the characteristics of the construction product
- 6 Assumptions under which the fitness of the product for the intended use will be assessed
- 7 Recommendations for the manufacturer
- 8 System of attestation of conformity
- 9 CE marking

### Annex A

Suitability tests of fly ash from co-combustion

### Annex B

Method for the characterisation of mineralogical composition

### Annex C

References

**Update January 30, 2008**

*Because of the official publication of EN450-1 and EN450-2 in 2005 and the publication of the amendment A1 to EN450-1 in October 2007, this CUAP 03.01/34 "Fly Ash for concrete" (final version June 2005), was updated in accordance to the clauses of these published standards.*

## 1 Definition of the construction product

Fly ash, a fine powder of mainly spherical, glassy particles, derived from burning of pulverized coal, with or without co-combustion materials, which has pozzolanic properties and consists essentially of  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$ , the content of reactive  $\text{SiO}_2$  as defined and described in EN 197-1 being at least 25 % by mass

Fly ash is obtained by electrostatic or mechanical precipitation of dust-like particles from the flue gases of furnaces fired with pulverized coal, with or without co-combustion materials.

Fly ash may be processed, for example by classification, selection, sieving, drying, blending, grinding or carbon reduction, or by combination of these processes, in adequate production plants. Such processed fly ash may consist of fly ashes from different sources, each conforming to the definition given in this clause. If one or more of incoming fly ashes are obtained from co-combustion, then the processed fly ash shall be considered as fly ash from co-combustion.

In deviation of EN450\*, there is no limitation to types of co-combustion materials. The maximum percentage of co-combustion material is 40% by mass and the maximum proportion of fly ash derived from co-combustion materials is limited to 35% by mass.

Provided that the biomass used for co-combustion is made from a specified virgin wood, i.e. not recycled wood, the maximum percentage of co-combustion material can be increased to 50 % by mass.

Municipal and industrial waste incineration ashes do not conform to the definition given in this clause.

NOTE 1 In the EC PG Working document PG 177 (February 18, 2004) M 128 "products related to concrete, mortar and grout" is amended. It is stated that it has been agreed with CEN and EOTA that ETA's can be granted for fly ash for which a standard cannot yet be elaborated (CPD article 8.2a). Also three further requirements have been added for fly ash (particle density, initial setting time and water requirement).

## 2 Intended use of the construction product

Siliceous fly ash is used as a type II addition for production of concrete, including in particular cast-in-situ or prefabricated structural concrete conforming to European standard EN 206-1. Fly ash according to this CUAP may also be used in mortars and grouts.

### 3 Relevant characteristics of the construction product to be evaluated in the ETA

The relevant essential requirements are indicated in table 1

Table 1 Relevant essential requirements for fly ash

<b>ER</b>	<b>Essential requirements</b>	<b>Relevant</b>	<b>Not relevant</b>
ER 1	Mechanical resistance and stability	x	
ER 2	Safety in case of fire		x
ER 3	Hygiene, health and the environment	x	
ER 4	Safety in use		x
ER 5	Protection against noise		x
ER 6	Energy economy and heat retention		x
*	Durability and serviceability	x	

\* Related aspects of durability, serviceability and identification

In table 2 the relevant characteristics and verification methods are given

Table 2 Overview of relevant characteristics and verification methods

ER	Corresponding ID paragraph for works	Corresponding ID paragraph for product performance	Relevant product characteristics	CUAP clause for verification method	CUAP clause for relevant limit value or classification	
ER 1 Mechanical resistance and stability	ID 1 Paragraph 2 and 3	ID 1	Activity Index	4.1.1	5.1.1	
			Initial setting time*	4.1.2	5.1.2	
	Paragraph 4.2. Provisions concerning works or parts of them	Paragraph 4.3 Provisions concerning products	Fineness	4.1.3	5.1.3	
			Soundness - expansion - Free CaO	4.1.4	5.1.4	
				4.1.5	5.1.5	
			ID 1 Appendix Paragraph 3	ID 1 Appendix Paragraph 3	Loss on ignition	4.1.6
	Composition - Sum of contents of SiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub> and Fe <sub>2</sub> O <sub>3</sub> - Total content of alkalis - Reactive SiO <sub>2</sub> - SO <sub>3</sub> - Cl - Reactive CaO - MgO - Soluble phosphate	4.1.7			5.1.7	
		4.1.8			5.1.8	
		4.1.9			5.1.9	
		4.1.10			5.1.10	
		4.1.11			5.1.11	
		4.1.12			5.1.12	
		4.1.13			5.1.13	
		4.1.14			5.1.14	
		Particle density*			4.1.15	5.1.15
		Water requirement*	4.1.16	5.1.16		
ER 3 Hygiene, health and the environment		ID 3 Paragraph 3 (3.3.1.1.1, 3.3.5 sub 3.3.5.2) Paragraph 4	ID 3 Paragraph 3 (3.3.1.1.1, 3.3.5 sub 3.3.5.3) Paragraph 4	Release of dangerous substances	4.2.1	5.2.1
** Working life and Durability		Common part of IDs	Common part of IDs	Durability	4.3.1	5.3.1
Durability and serviceability		Paragraph 5.1 of ER 1 and of ER 3	Paragraph 5.2 of ER 1 and of ER 3	Suitability of fly ash from co-combustion	4.3.2	5.3.2

\* Amendment to the mandate M128 (SCC Working Document SCC04/636 26 February 2004)

\*\* Related aspects of durability, serviceability and identification

ID = Interpretative Document to the Essential Requirements

### 3.1 Characteristics for mechanical resistance and stability (ER1)

#### 3.1.1 Activity Index (EN450-1+A1 clause 3.5)

The activity index is the ratio (in percent) of the compressive strength of standard mortar bars, prepared with 75 % test cement plus 25 % fly ash by mass, to the compressive strength of standard mortar bars prepared with 100 % test cement, when tested at the same age.

#### 3.1.2 Initial setting time (EN450-1+A1 clause 5.3.5)

The initial setting time shall be determined on a 25 % fly ash plus 75 % test cement by mass cement paste in accordance with EN 196-3.

NOTE For test cement see EN450-1+A1 clause 3.3

#### 3.1.3 Fineness (EN450-1+A1 clause 5.3.1)

The fineness of fly ash is expressed as the mass proportion in percent of the ash retained when wet sieved on a 0,045 mm mesh sieve and determined in accordance with EN 451-2

#### 3.1.4 Soundness (EN450-1+A1 clause 5.3.3)

Soundness is determined through the expansion on 30 % fly ash plus 70 % test cement by mass in accordance with EN 196-3.

#### 3.1.5 Free CaO (EN450-1+A1 clause 5.2.5)

The content of free calcium oxide shall be determined by the method described in EN 451-1.

#### 3.1.6 Loss on ignition (EN450-1+A1 clause 5.2.2)

The loss on ignition shall be determined in accordance with the principles of the method described in EN 196-2 but using an ignition time of 1 h.

NOTE As the magnitude of the loss on ignition may have an influence on the effect of air-entraining admixtures used for the manufacture of concrete resistant to freezing and thawing, the three loss on ignition categories defined in this CUAP allow the user to take this into account by choosing the appropriate category for each particular application and exposure class, thus following the standards and/or regulations for concrete valid in the place of use.

#### 3.1.7 Sum of contents of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> (EN450-1+A1 clause 5.2.8)

The sum of the contents of silicon dioxide (SiO<sub>2</sub>), aluminium oxide (Al<sub>2</sub>O<sub>3</sub>) and iron oxide (Fe<sub>2</sub>O<sub>3</sub>) shall be determined in accordance with EN 196-2, modified as indicated in clause 5.2.1 of EN450-1+A1.

#### 3.1.8 Total content of alkalis (EN450-1+A1 clause 5.2.9)

The total content of alkalis shall be determined in accordance with EN 196-2 and calculated as Na<sub>2</sub>O (equivalent).

#### 3.1.9 Reactive SiO<sub>2</sub> (EN450-1+A1 clause 5.2.7)

The content of reactive silicon dioxide is defined and described in 3.2 of EN 197-1. Fly ash obtained from combustion of pulverized coal only shall be deemed to satisfy this requirement.

#### 3.1.10 Content of SO<sub>3</sub> (EN450-1+A1 clause 5.2.4)

The content of sulfuric anhydride, SO<sub>3</sub>, shall be determined in accordance with EN 196-2.

#### 3.1.11 Content of Cl (EN450-1+A1 clause 5.2.3)

The content of chloride, expressed as Cl<sup>-</sup>, shall be determined in accordance with EN 196-2.

#### 3.1.12 Reactive CaO (EN450-1+A1 clause 5.2.6)

The content of reactive calcium oxide shall be calculated as stipulated in 3.1 of EN 197-1.

#### 3.1.13 Content of MgO (EN450-1+A1 clause 5.2.10)

The content of magnesium oxide (MgO) shall be determined in accordance with EN 196-2.

3.1.14 Soluble phosphate (EN450-1+A1 clause 5.2.11)

The content of soluble phosphate ( $P_2O_5$ ) shall be determined in accordance with the method described in Annex C of EN450-1+A1.

3.1.15 Particle density (EN450-1+A1 clause 3.4)

The particle density, defined as average density of fly ash particles including voids inside the particles, shall be determined in accordance with EN 196-6.

3.1.16 Water requirement (EN450-1+A1 clause 5.3.6)

The water requirement of fly ash of fineness category S shall be determined by the method described in Annex B of EN450-1+A1.

For fly ash of fineness category N this requirement does not apply.

### 3.2 Characteristics for hygiene, health and the environment (ER3)

3.2.1 Release of dangerous substances and emission of radioactivity

The product must be such that, when installed according to the appropriate provisions of the Member States, it allows for the satisfaction of the ER3 of the CPD as expressed by the national provisions of the Member States and in particular does not cause harmful emission of toxic gases, dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air, soil or water)."

3.2.2 Environmental compatibility

Should there be additional requirements resulting from national laws, regulations and administrative provisions in the place of use of the fly ash regarding e.g.

- the fly ash
- the leachate of concrete produced with fly ash,
- the co-combustion material,

these are to be considered with respect to environmental compatibility. Conformity to the relevant regulations has, where required, to be evaluated before production.

### 3.3 Characteristics for working life and durability

3.3.1 Durability (EN450-1+A1 clause 5.4.1)

The durability of concrete containing fly ash according to this CUAP, shall be established.

3.3.2 Establishment of suitability of fly ash from co-combustion

The suitability of fly ash obtained from combustion of coal with co-combustion materials shall be established and documented by the producer.

## 4 Verification methods for determining the relevant characteristics of the construction product

### 4.1 Verification methods for mechanical resistance and stability

#### 4.1.1 Activity Index (EN450-1+A1 clause 5.3.2)

Preparation of standard mortar bars and determination of the compressive strength shall be carried out in accordance with EN 196-1.

NOTE The result of the activity index tests gives no direct information on the strength contribution of fly ash in concrete, nor is the use of the fly ash limited to the mixing ratio used in these tests.

#### 4.1.2 Initial setting time (EN450-1+A1 clause 5.3.5)

The initial setting time shall be determined on a 25 % fly ash plus 75 % test cement by mass cement paste in accordance with EN 196-3.

#### 4.1.3 Fineness (EN450-1+A1 clause 5.3.1)

The fineness of fly ash shall be expressed as the mass proportion in percent of the ash retained when wet sieved on a 0,045 mm mesh sieve and determined in accordance with EN 451-2.

#### 4.1.4 Soundness (EN450-1+A1 clause 5.3.3)

The expansion shall be determined on 30 % fly ash plus 70 % test cement (see EN450-1+A1 clause 3.3) by mass in accordance with EN 196-3.

#### 4.1.5 Free CaO (EN450-1+A1 clause 5.2.5)

The content of free calcium oxide shall be determined by the method described in EN 451-1.

#### 4.1.6 Loss on ignition (EN450-1+A1 clause 5.2.2)

The loss on ignition shall be determined in accordance with the principles of the method described in EN 196-2 but using an ignition time of 1 h.

NOTE The purpose of the estimation of the loss on ignition is to limit the residue of unburnt carbon in the fly ash. It is sufficient, therefore, to show, through direct measurement of unburnt carbon residue, that the content of unburnt carbon falls within the limits. The content of unburnt carbon shall be determined in accordance with ISO 10694.

#### 4.1.7 Sum of contents of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> (EN450-1+A1 clause 5.2.8)

The sum of the contents of silicon dioxide (SiO<sub>2</sub>), aluminium oxide (Al<sub>2</sub>O<sub>3</sub>) and iron oxide (Fe<sub>2</sub>O<sub>3</sub>) shall be determined in accordance with EN 196-2, modified as indicated in 5.2.1 of EN450-1+A1.

#### 4.1.8 Total content of alkalis (EN450-1+A1 clause 5.2.9)

The total content of alkalis shall be determined in accordance with EN 196-2 and calculated as Na<sub>2</sub>O (equivalent).

#### 4.1.9 Reactive SiO<sub>2</sub> (EN450-1+A1 clause 5.2.7)

The content of reactive silicon dioxide is defined and described in 3.2 of EN 197-1.

#### 4.1.10 Content of SO<sub>3</sub> (EN450-1+A1 clause 5.2.4)

The content of sulfuric anhydride, SO<sub>3</sub>, shall be determined in accordance with EN 196-2.

#### 4.1.11 Content of Cl (EN450-1+A1 clause 5.2.3)

The content of chloride, expressed as Cl<sup>-</sup>, shall be determined in accordance with EN 196-2.

#### 4.1.12 Reactive CaO (EN450-1+A1 clause 5.2.6)

The content of reactive calcium oxide shall be calculated as stipulated in 3.1 of EN 197-1.

#### 4.1.13 Content of MgO (EN450-1+A1 clause 5.2.10)

The content of magnesium oxide (MgO) shall be determined in accordance with EN 196-2.

#### 4.1.14 Soluble phosphate (EN450-1+A1 clause 5.2.11)

The content of soluble phosphate ( $P_2O_5$ ) shall be determined in accordance with the method described in Annex C of EN450-1+A1.

#### 4.1.15 Particle density (EN450-1+A1 clause 5.3.4)

The particle density shall be determined in accordance with EN 196-6.

#### 4.1.16 Water requirement (EN450-1+A1 clause 5.3.6)

The water requirement of fly ash of fineness category S shall be determined by the method described in Annex B of EN450-1+A1.

## 4.2 Verification methods for hygiene, health and the environment

### 4.2.1 Release of dangerous substances and emission of radioactivity

#### 4.2.1.1 Presence of dangerous substances in the product

In addition to any specific clauses relating to dangerous substances contained in this CUAP, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive (89/106/EEC), these requirements need also to be complied with, when and where they apply.

The producer shall submit a written declaration stating types and percentage of co-combustion materials by the fly ash production as well as their ash content (it shall deviate from Amendment to Mandate M/128 Annex 2 for EN450-1+A1).

#### 4.2.1.2 Compliance with the applicable regulations

If the product contains dangerous substances as declared above, the ETA will provide the method(s) which has been used for demonstrating compliance with the applicable regulations in the Member States of destination, according to the dated EU data-base (method(s) of content or release, as appropriate).

## 4.3 Verification methods for working life and durability

### 4.3.1 Durability (EN450-1+A1 clause 5.4.1)

For the durability assessment the chemical and physical tests according to clause 4.1 are carried out.

### 4.3.2 Establishment of suitability of fly ash from co-combustion

The suitability of fly ash obtained from combustion of coal with co-combustion materials shall be established and documented by the producer according to Annex A.

An initial co-combustion in the furnace using the highest intended amount of co-combustion material shall be performed. A representative sample of fly ash taken from this co-combustion (see clause 7.3 of this CUAP) shall be used to establish the suitability.

## 5 Requirements and general provisions for limit values and classes relevant for the characteristics of the construction product

### 5.1 Requirements for mechanical resistance and stability

#### 5.1.1 Activity index (EN450-1+A1 Table ZA.1)

The activity index at 28 days and at 90 days shall not be less than 75 % and 85 %, respectively.

#### 5.1.2 Initial setting time (EN450-1+A1 Table ZA.1)

The initial setting time shall not be more than twice as long as the initial setting time of a 100% (by mass) test cement paste. The requirements regarding initial setting time specified in EN 197-1 shall be met by the test cement when tested alone. Fly ash obtained from combustion of pulverized coal only shall be deemed to satisfy this requirement.

#### 5.1.3 Fineness (EN450-1+A1 Table ZA.1)

The fineness shall fall within the limits of the categories specified below:

Category N: The fineness shall not exceed 40 %, and it shall not vary by more than  $\pm 10$  percentage points from the declared value.

Category S: The fineness shall not exceed 12 %. The  $\pm 10$  % fineness variation limits are not applicable.

#### 5.1.4 Soundness (EN450-1+A1 Table ZA.1)

Soundness shall not be greater than 10 mm.

Where the free calcium oxide content of the fly ash determined in accordance with 5.2.5 (of EN450-1+A1) does not exceed 1,0 % by mass, this requirement shall be deemed to be satisfied.

#### 5.1.5 Free CaO (EN450-1+A1 Table ZA.1)

Free CaO content shall not be greater than 2,5 % by mass. If the content of free calcium oxide is greater than 1,0 % by mass, then the fly ash shall be tested for conformity to the requirements for soundness.

#### 5.1.6 Loss on ignition (EN450-1+A1 Table ZA.1)

Loss on ignition shall fall within the limits of the categories specified below:

Category A: Not greater than 5,0 % by mass

Category B: Between 2,0 % and 7,0 % by mass

Category C: Between 4,0 % and 9,0 % by mass

#### 5.1.7 Sum of contents of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> (EN450-1+A1 Table ZA.1)

The sum of contents of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> shall not be less than 70 % by mass. Fly ash obtained from combustion of pulverized coal only shall be deemed to satisfy this requirement.

#### 5.1.8 Total content of alkalis (EN450-1+A1 Table ZA.1)

The total content of alkalis shall not exceed 5,0 % by mass. Fly ash obtained from combustion of pulverized coal only shall be deemed to satisfy this requirement.

#### 5.1.9 Reactive SiO<sub>2</sub> (EN450-1+A1 Table ZA.1)

The content of reactive SiO<sub>2</sub> shall not be less than 25 % by mass.

#### 5.1.10 Content of SO<sub>3</sub> (EN450-1+A1 Table ZA.1)

The content of SO<sub>3</sub> shall not be greater than 3,0 % by mass.

#### 5.1.11 Content of Cl (EN450-1+A1 Table ZA.1)

The content of Cl shall not be greater than 0,10 % by mass.

5.1.12 Reactive CaO (EN450-1+A1 Table ZA.1)

The content reactive CaO shall not exceed 10,0 % by mass. Where the total content of calcium oxide determined in accordance with 5.2.1 of EN450-1+A1, does not exceed 10,0 % by mass, the requirement for reactive calcium oxide shall be deemed to be satisfied.

5.1.13 Content of MgO (EN450-1+A1 Table ZA.1)

The content of MgO shall not be greater than 4,0 % by mass.

5.1.14 Soluble phosphate (EN450-1+A1 Table ZA.1)

The soluble phosphate content shall not be greater than 100 mg/kg.

5.1.15 Particle density (EN450-1+A1 Table ZA.1)

The particle density shall not deviate by more than  $\pm 200 \text{ kg/m}^3$  from the value declared by the producer.

5.1.16 Water requirement (EN450-1+A1 Table ZA.1)

The water requirement shall not be greater than 95 % of that for the test cement alone. For fly ash of fineness category N this requirement does not apply.

## 5.2 Requirements for hygiene, health and the environment

5.2.1 Release of dangerous substances (EN450-1+A1 Table ZA.1)

The product/kit shall comply with all relevant European and national provisions applicable for the uses for which it is brought to the market. The attention of the applicant should be drawn on the fact that for other uses or other Member States of destination there may be other requirements which would have to be respected. For dangerous substances contained in the product but not covered by the ETA, the NPD option (no performance determined) is applicable.

## 5.3 Requirements and aspects of durability, serviceability and identification

5.3.1 Durability (EN450-1+A1 Table ZA.1)

The composition and the performance of the fly ash shall be such that durable concrete (see EN 206-1) may be produced when using the fly ash.

Fly ash conforming to this CUAP, fulfilling the chemical requirements in 5.2 of EN450-1+A1 and the physical requirements in 5.3 of EN450-1+A1, shall be deemed to satisfy the durability requirements.

In certain applications, particularly for concrete in severe environmental conditions, the choice of fly ash category may have an influence on the durability of concrete, e.g. frost resistance and resistance to alkali aggregate reactions. In such cases the choice of fly ash category shall follow the appropriate standards and/or regulations valid in the place of use.

5.3.2 Establishment of suitability of fly ash from co-combustion

See Annex A of this CUAP

Table 3 Overview of relevant clauses for fly ash and intended use (Table ZA.1 of EN450-1+A1)

<b>Product:</b> Fly ash (Type II addition)			
<b>Intended use:</b> Preparation of concrete, mortar and grout			
<b>Essential Characteristics</b>	<b>Requirement clauses in EN450-1+A1</b>	<b>Levels and/or classes</b>	<b>Notes</b>
Activity index (compressive strength)	5.3.2	None	Requirement expressed in terms of lower limits at 28 and 90 days (in %) Pass/fail
Fineness	5.3.1	None	Requirements expressed in terms of upper limit for sieve residue (in %) for each of two different categories and upper and lower tolerance limits (in %) for one of these categories. Declaration of category. Pass/fail
Soundness – Expansion	5.3.3	None	Requirement expressed in terms of upper limit (in mm). Deemed to satisfy if free CaO does not exceed 1,0 % by mass Pass/fail
Soundness – Free CaO	5.2.5	None	Requirement expressed in terms of upper limit (in % by mass) Pass/fail
Loss on ignition	5.2.2	None	Requirements expressed in terms of upper and lower limits (in % by mass) for each of three different categories. Pass/fail
Composition: Sum of contents of silicon dioxide, aluminium oxide and iron oxide	5.2.8	None	Requirement expressed in terms of lower limit (in % by mass) oxide Pass/fail
Composition: Total content of alkalis	5.2.9	None	Requirement expressed in terms of upper limit (in % by mass). Pass/fail
Composition: Reactive silicon dioxide	5.2.7	None	Requirement expressed in terms of lower limit (in % by mass). Pass/fail

continued

Table ZA.1 continued			
Composition: Sulfuric anhydride	5.2.4	None	Requirement expressed in terms of upper limit (in % by mass) Pass/fail
Composition: Chloride	5.2.3	None	Requirement expressed in terms of upper limit (in % by mass) Pass/fail
Composition: Reactive CaO	5.2.6	None	Requirement expressed in terms of upper limit (in % by mass). Deemed to satisfy if total content of CaO is below 10 % Pass/fail
Composition: Magnesium oxide	5.2.10	None	Requirement expressed in terms of upper limit (in % by mass). Pass/fail
Composition: Soluble phosphate	5.2.11	None	Requirement expressed in terms of upper limit (in mg/kg) Pass/fail
Particle density	5.3.4	None	Requirement expressed as declared value (in kg/m <sup>3</sup> ) with upper and lower tolerance limits Pass/fail
Initial setting time	5.3.5	None	Requirement expressed in terms of upper limit (in minutes) for deviation from the setting time of cement paste without fly ash. Pass/fail
Water requirement	5.3.6	None	Requirement expressed in terms of upper limit (in %) ( <i>only for fly ash of fineness category S</i> ) Pass/fail
Durability	5.4.1	None	Fly ash conforming to EN450-1+A1 is deemed to provide a durable concrete when other requirements for durability of concrete in relevant standards and/or regulations valid in the place of use are fulfilled.
Release of dangerous substances and emission of radioactivity	5.4.2	None	ZA.1 (Notes 1 and 2) and ZA.3 (in EN450-1+A1)

The requirement on a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, producers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option "No Performance Determined" (NPD) in the information accompanying the CE marking (see ZA.3 of EN450-1+A1) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

## **6 Assumptions under which the fitness of the product for the intended use will be assessed**

This CUAP specifies requirements for the chemical and physical properties as well as quality control procedures for siliceous fly ash, for use as a type II addition for production of concrete, including in particular cast-in-situ or prefabricated structural concrete conforming to EN 206-1. Fly ash according to this standard may also be used in mortars and grouts.

It is, however, beyond the scope of this CUAP to specify provisions governing the practical application of fly ash in the production of concrete, i.e. requirements concerning composition, mixing, placing, curing etc. of concrete containing fly ash. As regards such provisions, reference should be made to other European or national standards for concrete, such as EN 206-1.

## 7 Recommendations for the manufacturer

### 7.1 Information to be supplied upon request

Information on the properties listed below shall be supplied to the user upon request:

- Characteristics of the test cement.
- Percentages of coal and percentage(s) of ash from co-combustion material(s)\*
- Declaration of conformity to this CUAP, any standards or regulations valid in the place of use, and the results of suitability tests \*
- A typical chemical oxide composition of the fly ash comprising the contents of silicon dioxide ( $\text{SiO}_2$ ), aluminium oxide ( $\text{Al}_2\text{O}_3$ ), iron oxide ( $\text{Fe}_2\text{O}_3$ ), determined in accordance with EN 196-2 (1994).
- The total content of alkalis determined in accordance with EN 196-2 and calculated as  $\text{Na}_2\text{O}$  (equivalent).
- The declared fineness value (category N only).
- The declared value of particle density.
- The water content for standard consistence of a co-combustion fly ash/test cement paste, as determined by EN 196-3 in connection with determining the initial setting time.
- The water requirement for category S fly ash.

\* these data are available at the notified body

### 7.2 Packaging and labelling

Fly ash may be delivered in suitable bulk-delivery transportation systems or in suitable packages.

Packages and documents related to bulk deliveries shall be marked with name or identification mark of the production plant where the fly ash was manufactured.

NOTE For CE marking and labelling, clause 9 of this CUAP applies.

### 7.3 Sampling

Spot samples, equally distributed over the production period, shall be taken at the point of release into a bulk-delivery transportation system or into packages, or, alternatively, directly from bulk-delivery transportation systems or packages, using the equipment and principles described in EN 196-7.

For the purpose of carrying out all the analyses and tests needed to show conformity or non-conformity to the requirements, a representative laboratory sample of dry fly ash of at least 0,5 kg is required. This sample shall be obtained by subdividing, such as quartering, a spot sample of at least 2 kg. The laboratory sample shall be dried in a well-ventilated oven at  $(105 \pm 5)^\circ\text{C}$  to constant weight and then cooled in a dry atmosphere

## 8 System of attestation of conformity

The system of attestation of conformity of the fly ash is in accordance with the Commission decision 1999/469/EC of 25 June 1999 as amended by decision 01/596/EC of 8 January 2001 as given in Annex III of the mandate for "Products related to concrete, mortar and grout". This is shown in Table 4 for the indicated intended use and relevant level(s) or class(es):

Table 4 System of attestation of conformity (Table ZA.3 of EN450-1+A1)

Product	Intended use	Level(s) or class(es)	Attestation of conformity system
Additions (type II)	For concrete, mortar and grout	-	1+
System 1+: See Directive 89/106/EEC (CPD) Annex III.2.(i) with audit testing of samples.			

The attestation of conformity of the fly ashes in Table ZA.1 of EN450-1+A1 shall be based on the evaluation of conformity procedure indicated in Table ZA.3 of EN450-1+A1.

The attestation of conformity to the specifications shall be based on clause 8 of EN450-1+A1 and on evaluation of conformity which shall be in accordance with EN450-2.

Table 5 Assignment of evaluation of conformity tasks for fly ash under system 1+ (Table ZA.3 of EN450-1+A1)

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks for the producer	Factory production control (F.P.C)	Parameters related to all relevant characteristics of Table ZA.1	EN450-2, clauses 4.1 and 4.2
	Further testing of samples taken at factory	All relevant characteristics of Table ZA.1	EN450-2, clause 4.3
Tasks for the product certification body	Initial type testing	All relevant characteristics of Table ZA.1, except <i>-release of dangerous substances and emission of radioactivity</i>	EN450-2, clause 5.4 and 5.6
	Initial inspection of factory and of F.P.C	Parameters related to all relevant characteristics of Table ZA.1	EN450-2, clause 5.5
	Continuous surveillance, assessment and approval of F.P.C.	Parameters related to all relevant characteristics of Table ZA.1	EN450-2, clauses 5.2 and 5.3
	Audit testing of samples taken at factory	All relevant characteristics of Table ZA.1, except <i>-release of dangerous substances and emission of radioactivity</i>	EN450-2, clause 5.4

### 8.2 Declaration of conformity

The manufacturer, or his agent established in the Community, shall prepare and keep the declaration of conformity authorizing him to affix the CE marking. This declaration shall include:

- Name and address of the manufacturer, or of his agent established in the Community, and place of manufacture
- Description of the product (type, marking, properties, use) and copy of the information accompanying the CE marking
- The ETA which the product is in conformity with
- Particular conditions applicable to the use of the product
- Identification number of all bodies the manufacturer involved in the conformity attestation procedure
- Name and function of the person entitled to sign on behalf of the manufacturer or his agent established in the Community.

The above mentioned declaration shall be presented in the official language or languages of the Member State in which the product is to be used.

## 9 CE marking

The producer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the accompanying commercial documents e.g. a delivery note (bulk fly ash) or on the packaging (packed fly ash). The following information shall accompany the CE marking symbol:

- Identification number of the notified body
- Name or identifying mark the producer
- Registered address of the producer
- Last two digits of the year in which the marking is affixed
- Number of the EC certificate of conformity
- Number of the ETA
- Description of the product: Fly ash for concrete (type II addition)
- LOI category (A, B or C)
- Fineness category (S or N; if N than no information is needed)

Information on those relevant requirements listed in Table ZA.1 of EN450-1+A1 which are to be declared presented as: declared values and, where relevant, level or class (including “pass” for pass/fail requirements, where necessary) to declare for each requirement as indicated in Table ZA.1 of EN450-1+A1;

- “No performance determined” for characteristics where this is relevant;
- as an alternative, a standard designation which shows some or all of the relevant characteristics (where the designation covers only some characteristics, it will need to be supplemented with declared values for other characteristics as above.

The “No performance determined” (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

The next figure gives an example of the information to be given on the product, label, packaging and/or commercial documents.



## Annex A

### Suitability tests of fly ash from co-combustion

#### A.1 General

The suitability of fly ash obtained from co-combustion of coal with co-combustion materials shall be established and documented by the manufacturer. The maximum percentage of co-combustion material related to the coal is restricted to specific requirements of the fly ash and the performance of fly ash in concrete. Therefore the mineralogical composition shall be tested and an equivalent performance concept is used. Within this concept, it shall be proven that the concrete with fly ash obtained from co-combustion materials has an equivalent performance with respect to the durability of concrete with fly ash compared with a reference concrete.

Suitability is proven if the properties of the fly ash obtained from co-combustion meet the suitability criteria given in A.3.

#### A.2 Performance of suitability tests

An initial co-combustion test in the boiler using the highest intended amount of co-combustion fuel shall be performed. The part of fly ash originating from pure coal can be calculated from the next equation:

$$Y = (A_c / A_i) \times (100 - M) / M$$

In which:

Y = relative amount of fly ash originating from pure coal

$A_c$  = ash content of the coal (m/m in %)

$A_i$  = ash content of the co-combustion fuel i (m/m in %)

M = percentage co-combustion fuel (m/m in %)

If two or more co-combustion fuels are used together, the part of fly ash originating from pure coal is calculated with equation:

$$Y = (A_c / (A_1 \times C_1 + \dots + A_n \times C_n)) \times ((100 - M) / M)$$

In which:

Y = relative amount of fly ash originating from pure coal

$A_c$  = ash content of the coal (m/m in %)

$A_1$  = ash content of co-combustion fuel 1 (m/m in %)

$A_n$  = ash content of co-combustion fuel n (m/m in %)

$C_1$  = the part of co-combustion fuel 1 in the co-combustion fuel mixture

$C_n$  = the part of co-combustion fuel n in the co-combustion fuel mixture

$C_1 \dots C_n = 1$

M = the total percentage co-combustion fuel (m/m in %)

$$Z = 100 / (Y + 1)$$

In which:

Z = amount of ash from the co-combustion fuel related to the total amount of fly ash (m/m in %)

A representative sample shall be taken from the fly ash produced in this co-combustion test. This sample shall be used for the establishment of conformity to the requirements in 5 of this CUAP.

In addition the following properties must be measured:

- the mineralogical composition as described in annex B;
- the amount of  $P_2O_5$  according to clause 5.2.1 of EN450-1+A1

Note: The results of suitability tests of a different unit of the same power plant may be used if the composition and the amount of the co-combustion fuel are equal to the fly ashes from the unit to be assessed.

#### A.3 Requirements

Suitability is proven if the properties of the fly ash from co-combustion meet the following criteria:

- The requirements in 5 of this CUAP are met
- No minerals have been introduced apart from the minerals mentioned in table A.1.
- The amount of total  $P_2O_5$  is not more than 5% (m/m)

Table A.1 Identified phase in fly ash

Group	Classification	Phases
0	Non-crystalline and organic phases, always present	Amorphous phases Unburnt matter
1	Crystalline phases, nearly always present	Anhydrite ( $CaSO_4$ ) Free lime ( $CaO$ ) Quartz ( $\alpha-SiO_2$ ) Hematite ( $\alpha-Fe_2O_3$ ) Mullite ( $Al_6Si_2O_{13}$ )
2	Crystalline phases, sometimes present	Calcite ( $CaCO_3$ ) Magnetite ( $Fe_3O_4$ )
3	Crystalline phases, incidentally present	Periclase ( $MgO$ ) Rutile ( $TiO_2$ ) Corundum ( $Al_2O_3$ ) Sillimanite ( $Al_2SiO_5$ ) Feldspars

## Annex B

### Method for the characterisation of mineralogical composition

The characterisation method is based upon dissolving of the amorphous phase followed by qualitative analysis of the minerals in the residue. The characterisation method used, is illustrated in Figure 1 and contains mainly of:

- Dissolving of HCl-soluble fraction (step 3a: dilution of compounds of Na, K and Ca like phosphates, sulphates, carbonates)
- Dissolving of the residue of step 3a in boiling KOH solution and analysis of the diluted fraction (step 4a: dilution of amorphous silicate compounds)
- Mineralogical analysis of the residue of step 4a (step 5a). The mineralogical composition is analysed using X-ray diffraction (XRD) for qualitative analysis of the crystalline minerals.
- By dissolving of the in HCl-soluble-compounds and the amorphous phase; the mineralogical fly ash composition is determined at a low detection level.

Explanation of the characterisation steps:

#### 1 Sampling (step 1)

A representative fly ash sample must be taken

#### 2 Sample division (step 2)

The fly ash sample must be divided in two representative sub-samples of 50 grams each. One sub-sample is used for the qualitative XRD analysis (step 3b) the other sub-sample is used for dissolving of HCl-soluble compounds (step 3a) and of KOH-soluble compounds (step 4a).

#### 3 Analysis of the in HCl soluble fraction (step 3a)

- With an accuracy of 0,001 grams, 5,0 grams of fly ash is weight out in a 500 ml PE bottle (**= m<sub>1</sub>**). Then 220 ml of 1:9 supra-pur HCl solution is added
- Shake the suspension for 30 minutes on a shaking machine
- Use a membrane filter (0,2 µm) for filtrating the suspension; collect the eluate;
- Wash out the residue with about 200 ml destilated water in order to remove all chlorides (check with silver nitrate solution). Collect the eluate after filling it up to 500 ml
- Dry the residue at (60 ± 5) °C to constant mass and weigh the residue with an accuracy of 0,001 grams (**=m<sub>2</sub>**)

#### 4 XRD analysis (step 3b)

The mineralogical composition has to be determined qualitatively by X-ray diffraction (XRD).

#### 5 Analysis of fraction soluble in KOH (step 4a)

- Weigh out 2,5 grams (accuracy 0,001 grams) of the dried residue from the in HCl non-soluble fraction (**= m<sub>3</sub>**)
- Put this residue in a 500 ml teflon cup and add 250 ml KOH solution (250 g/l pro analisi) and let it boil for 4 hours
- Then the suspension shall settle for two minutes followed by filtrating over a 0,2 µm membrane filter and collect the eluate (no glassware may be used)
- Wash out the residue with 200 ml boiling water
- Wash out the residue with 250 ml boiling HCl (1:9 suprapur) followed by 250 ml demineralised water until all chlorides have been removed (check with silver nitrate solution). Collect all eluate.
- Burn the residue at (550 ± 5) °C until constant weight and determine this weight with an accuracy of 0,001 grams (**= m<sub>4</sub>**)

#### 6 XRD analysis of residue from step 4 (step 5a)

The mineralogical composition has to be determined qualitatively by X-ray diffraction (XRD).

#### 7 Calculations

$$w_2 = 100 \times (m_2/m_1) (\%)$$

in which:

$w_2$  = non-soluble fraction in HCl (in % m/m)

$m_1$  = sample weight after dilution, filtrating and drying (in grams)

$m_2$  = sample weight before dilution in HCl (in grams)

$$w_3 = 100 \times (m_4/m_3) (\%)$$

in which:

$w_3$  = non-soluble fraction in KOH (in % m/m)

$m_3$  = sample weight before dilution (in grams)

$m_4$  = sample weight after treatment with KOH solution (in grams)

$$w_{\text{glas}} = w_2 - (w_2 \times w_3/100) - w_1 (\%)$$

in which:

$w_{\text{glas}}$  = glass content (in % m/m)

$w_1$  = loss on ignition (in % m/m)

$w_2$  = non-soluble fraction in HCl (in % m/m)

$w_3$  = non-soluble fraction in KOH (in % m/m)

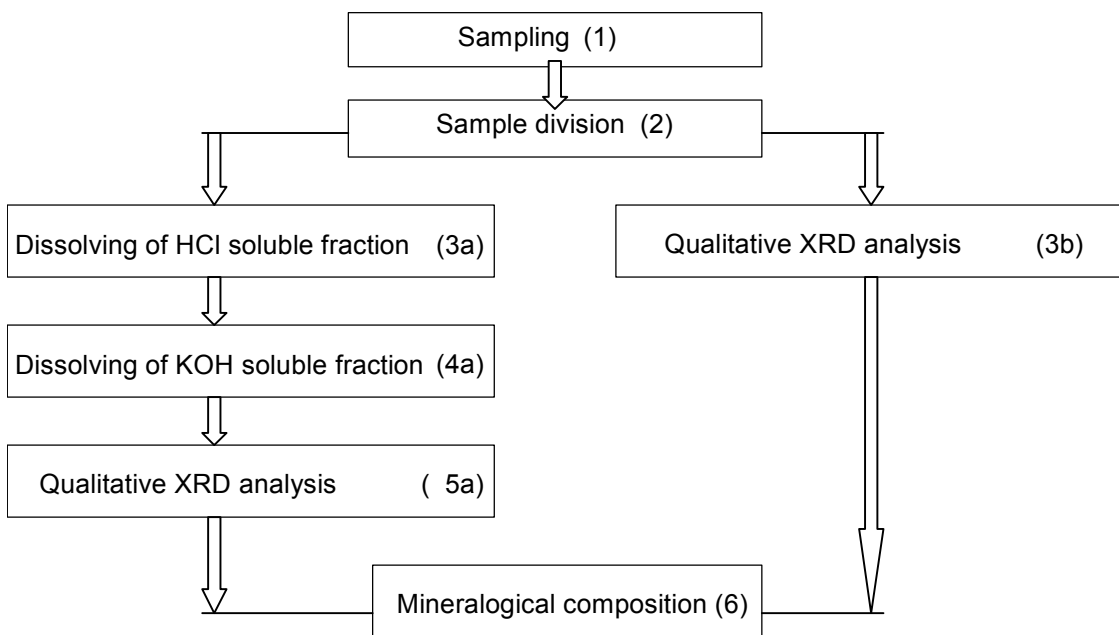


Figure 1 Scheme for the analysis of the mineralogical fly ash composition

## Annex C

### References

- EN450-1+A1, EN450-1:2005+A1:2007 (Amendment A1 included in EN450-1:2005)
- EN450-1:2005, Fly ash for concrete— Part 1:Definition, specifications and conformity criteria
- EN450-2:2005, Fly ash for concrete — Part 2: Conformity evaluation
- EN196-1: 2005, Methods of testing cement — Determination of strength.
- EN196-2: 2005, Methods of testing cement — Chemical analysis of cement.
- EN196-3: 2005, Methods of testing cement — Determination of setting time and soundness.
- EN196-6: 1989, Methods of testing cement — Determination of fineness.
- EN196-7:2007, Methods of testing cement — Methods of taking and preparing samples of cement.
- EN197-1:2000+A1:2001, Cement — Part 1:Composition,specification and conformity criteria for common cements.
- EN206-1:2000+A1:2004+A2:2005, Concrete — Part 1: Specification, production, performance and conformity.
- EN451-1, Methods of testing fly ash — Part 1: Determination of free calcium oxide content.
- EN451-2, Methods of testing fly ash — Part 2: Determination of fineness by wet sieving.
- ISO 10694, Soil Quality — Determination of organic and total carbon after dry combustion.
- EN1015-3:1999, Methods of test for mortar for masonry — Part 3: Determination of consistence of fresh mortar (by flow table)
- ISO 11885:1998, Water quality: — Determination of 33 elements by inductively coupled plasma emission spectroscopy
- CEN CR 1901:1995 — Regional specifications and recommendations for the avoidance of damaging alkali-silica reactions in concrete
- CUR Recommendation 94:July 2007, — Use of fly ash in mortar and concrete (in Dutch), Stichting CUR, PO Box 420 2800 AK Gouda, The Netherlands (3th version)
- KEMA Report: 2003, — Effects of co-combustion on the technical and environmental quality of pulverized coal fly ash as pozzolanic filler in concrete. Report 50231102/KPS/MEC 03-6190. KEMA, PO Box 9035 6800 ET Arnhem, The Netherlands

Note: For undated references the latest edition of the publication referred to, applies (including amendments).