LEBANESE STANDARD
NL 53: 1999

CEMENTS

Portland Cement Type P, Portland Composite Cement
Type Pa With Additives, Composite Cement Type C

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1. Scope

This standard specifies the composition, requirements and criteria to ensure conformity of cements, their constituents and their mixes.
It also specifies the following:

- The properties of cement constituents
- The proportions combined for producing a series of types and classes of cement.
- The mechanical, physical and chemical requirements applied on those types and classes
- The rules for evaluating conformity to those specifications.
- The requirements for marketing information, sampling and testing for acceptance at delivery.
- The manufacturer's auto control system to ensure conformity.

2. Normative References

EN 196-1	Methods of testing cement – Part 1: Determination of Strength
EN 196-2	Methods of testing cement – Part 2: Chemical analysis of cement
EN 196-3	Methods of testing cement – Part 3: Determination of setting time and soundness
ENV 196-4	Methods of testing cement – Part 4: Quantitative determination of constituents
EN 196-5	Methods of testing cement – Part 5: Pozzolanicity Test for Pozzolanic Cements
EN 196-6	Methods of testing cement – Part 6: Determination of Fineness
EN 196-7	Methods of testing cement – Part 7: Methods of Taking and Preparing Samples of Cement
EN 196-21	Methods of testing cement – Part 21: Determination of the Chloride, Carbon Dioxide and Alkali Content of Cement

3. Cement Definition

Cement is a hydraulic binder, i.e. it is a finely ground inorganic material which when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which after hardening retains its strength and stability even under water.

The cement shall, when appropriately mixed with aggregate and water, be capable of producing mortar or concrete and which retains workability for a sufficient time and shall after defined periods attain specified strength levels and possess long-term volume stability.

The hydraulic hardening of cement is primarily due to the hydration of calcium silicates but other chemical compounds may also participate in the hardening process e.g. aluminates.

The sum of the proportions of reactive calcium oxide CaO[1] and reactive silicon dioxide SiO2[2] shall not be less than 50% in mass.

Cements consist of individual small grains of different materials but shall be statistically homogeneous in composition. A high degree of uniformity in all cement properties can be obtained through continuous mass production processes, in particular adequate grinding and homogenization processes.

For the production of cements, it is essential to ensure qualified and specialized staff, and appropriate installations for the testing, evaluation and adjustment of the quality of the product.

The manufacturing procedure of cement should guarantee that the cement composition is maintained between fixed limits.

4. Constituents

4.1. Portland Clinker "k"

Portland Clinker is a hydraulic material which shall consist of not less than two-thirds by mass of calcium silicates[$(CaO)_3$,SiO_2] and [$(CaO)_2$,SiO_2] the remainder containing aluminum oxide $Al2O_3$, iron oxide $Fe2O_3$ and other oxides. The ratio by mass CaO/SiO_2 shall not be less than 2.0. The content of magnesium oxide MgO shall not exceed 4% in mass.

Portland Clinker shall be made by firing and partial fusion of a precisely specified mixture of raw materials (raw meal, paste or slurry) containing CaO, SiO_2, $Al2O_3$, $Fe2O_3$, and small quantities of other materials. The raw paste or slurry shall be finely ground, intimately mixed and therefore homogenous. (White Portland cement may or may not contain iron oxide Fe_2O_3.)

4.2 Granulated Blastfurnace Slag "S"

Blastfurnace Slag is a latent hydraulic material that shows hydraulic properties when properly activated. It shall be constituted of at least 80% by mass of the sum of CaO, MgO and SiO_2. The remaining shall contain $A12O_3$ with small quantities of other compounds. The ratio bymass (CaO+MgO) / (SiO_2) shall be greater than one. Granulated blastfurnace slag is made by rapid cooling of a slag melt of suitable composition, as obtained in melting iron ore in a blastfurnace.

[1]Is considered reactive calcium oxide, the proportion of CaO, which in normal conditions of hardening, can form hydrate calcium silicates or hydrate calcium aluminates. In order to evaluate this proportion, the total content of CaO will be deducted from the quantity of calcium carbonate CaCO3 calculated based on the measured content of carbon dioxide CO_2, and from the quantity of calcium sulfate $CaSO_4$ calculated based on the measured content of sulfur trioxide SO3, neglecting the amount of SO_3 formed by the alkalis based on P_2O_5 forming inert tricalcium phosphate $(PO_4)_2Ca_3$.

[2]Reactive silicon dioxide SiO_2 is defined as the proportion of SiO_2 which is combined in solution after dissolving in Hydrochloric acide HCl, when boiled in a solution of potassium hydroxide KOH. The quantity of reactive SiO_2 is determined by deducting the SiO_2 contained in the insoluble residue from the total quantity of SiO_2.

4.3 Natural Pozzolanic Materials

Natural Pozzolanic materials are :

- Substances of volcanic origin or sedimentary rocks with appropriate chemical and mineralogical composition.
- Clay and schist materials activated thermally.

Pozzolanic materials do not harden on their own when mixed with water but react at room temperature in presence of water with calcium hydroxide ($Ca(OH)_2$) to form Calcium Silicate and Calcium Aluminate of calcium that develop the physical resistance. Those compounds are similar to those made up during the hardening of the hydraulic materials. Pozzolanas shall essentially contain active SiO_2 and $A1_2O_3$ the remaining shall contain iron oxide Fe_2O_3 and other oxides. SiO_2 concentration shall at least be 25% by mass. Pozzolanic materials should be properly prepared, i.e., selected, homogenized, dried, and ground to powder according to their condition during production or delivery.

4.4 Fly Ash

4.4.1. Generalities

Fly ash could be of siliceous or calcite nature; the former has natural pozzuolana properties, the latter could have in addition some hydraulic properties. Loss on ignition for fly ash shall not exceed 5% by mass.
Fly ash is obtained by electrostatic or mechanical precipitation of dustlike particles from the flue gases from furnaces fired with pulverized hard coal. Ash obtained by other methods is not considered in this standard.

4.4.2. Silic Fly ash "V"

Siliceous fly ash is a fine powder constituted mainly of vitrified spherical particles having pozzolana properties. It shall contain mainly silicium oxide SiO_2 and aluminum oxide $A1_2O_3$. The proportion of reactive Calcium Oxide shall not be less than 5% by mass and the reactive Silicon Dioxide content shall not be less than 25% by mass.

4.4.3. Calcite Fly ash "W"

Calcite fly ash is a fine powder having hydraulic or pozzolanic properties and shall mainly be composed of active calcium oxide, SiO_2 and $A1_2O_3$. The remaining contains iron oxide Fe_2O_3 and other oxides. The proportion of reactive Calcium Oxide shall be less that 5% by mass. Fly ash containing between 5 and 15% of reactive CaO should contain no less than 25% of SiO_2 by mass.

Calcite fly ash, finely grind containing more than 15% of reactive CaO should present a compressive strength of at least 10N/mm2 at 28 days when used according to European standard EN 196-1. The expansion of calcite fly ash should be less than 10mm (Le Chatelier).

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(3) The reactive Silicon Dioxide SiO_2 is defined as the proportion of SiO_2, which after dissolution in the Hydrochloric acid HCl, will enter the boiles solution of KOH. The reactive quantity of SiO_2 is determined by subtracting from the total SiO_2 the SiO_2 content in the nonsoluble residue, both expressed on a dry sample.

4.5. Limestone "L"
When used in the ratio of 5% or more by mass, it shall satisfy the following:
- $CaCO_3$ content > 90% by mass
- Total Organic Carbon content < 0.2% by mass
- Clay content < 1.20g/100g

In case of siliceous limestone not containing clay, it can be used with a proportion not exceeding 15% by mass.

4.6. Silica Fumes "D"
Silica fumes are very fine particles having a very high concentration of amorphous silicon. If Silica fumes exceed 5% by mass of cement, the following restrictions shall apply:

- SiO_2: > 85% by mass
- Loss on ignition: < 4% by mass
- The specific surface (BET) of untreated Silica fumes: > $15m^2/g$

4.7. Calcium Sulfate
Calcium sulfate shall be added in small quantities to the other constituents of cement during its manufacture in order to control setting. Calcium sulfate can be of gypsum (calcium sulfate dihydrate, $CaSO_4$. $2H_2O$), hemi-hydrate (partially dehydrated gypsum, $CaSO_4$. $1/2H_2O$) or anhydrite (anhydrous calcium sulfate $CaSO_4$) or any mixture thereof. Gypsum and anhydrite are found naturally. Calcium sulfate is also available as a by-product of certain industrial processes.

4.8. Additives
Additives are constituents, which are added to improve the manufacture or the properties of the cement, e.g. grinding aids. The total quantity of such additives shall not exceed 1% by mass of cement. If it is the case, the quantity shall be mentioned on packaging and/or on delivery vouchers. Those additives shall not promote corrosion of the reinforcement or impair the properties of the cement or of the mortar or concrete made from the cement.

5. Types, Composition & Standard Designations of Cement

5.1. Cement Types
There are three main types of cement that are covered by this standard (Table 2):
- Portland Cement **P**
- Portland Composite Cement type **PA**
- Composite Cement type **C**

5.2. Composition
The cement composition shall conform to table 2 and shall declared by the producer.

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(4) The limestone in conformity with EN 197 (paragraph 4.6) or Clay content with the absorption methylen blue test method < *1.2 g/100g.*

5.3. Normalized Designation

Cements shall be identified by their type, and by a number indicating their class. HR symbol shall be given to cement of high strength, and, eventually, the symbol corresponding to one or two particular specifications for usage (See examples on page 16).

5.4 Packing

Cement may be packed in two methods:

- In bulk inside special tankers
- In bags of 50kg for current production, or in bags of 25kg, or in BIG bags of 1000 kg – 3000kg if requested.

When cement is delivered in bulk, the bill to client shall include the type, the particular specifications, and the strength class.

5.5. Delivery in bags

All bags shall show, in addition to the brand of the manufacturer, the type of cement and its strength class and eventually its particular specifications.
The invoice (bill) shall show the type (P, PA, C) according to this standard.

6. Specifications – Cement Types

The types of cement shall be as shown in table 1.

Table 1: Denomination of Cement

Name	Symbol
Portland cement	**Type P**
Ordinary Portland	P-
Portland Composite Cement Portland Composite Cement with pouzzolana Portland Composite Cement with slag Portland Composite Cement with fly ash Portland Composite Cement with limestone	Type PA PA-Z PA-S PA-V PA-L
Composite Cement	**Type- C**
Composite slag cement Composite slag and fly ashes cement	C-S C-SV
Particular Specifications	
High early strength	HR
Moderate sulfate resistance	RMS
High sulfate resistance	RSS
Low heat of hydration	ChB
Low alkali	BTNa

7. Cement Composition

The Cement composition shall be in accordance with table 2.
Percentage of constituents by mass [5]
First and second constituent = sum 100 mass - %

Table 2: Cement Type Composition

TYPE	Clinker	V	S	Z	L	Other[6]
P						
P	95/100	--	--	--	--	0/5
PA						
PA-V	65/94	6/35	--	--	--	0/5
PA-S	65/94	--	6/35	--	--	0/5
PA-Z	75/94	--	--	6/25	--	0/5
PA-L	85/94	--	--	--	6/15	0/5
C						
C-S	35/64	- -	36/65	--	- -	0/5
C-SV	40/64	18/30	18/30	- -	- -	0/5

8. Chemical Requirements

The chemical requirements of cement shall be in accordance with table 3.

The verification of conformity shall be according to the European Norm EN 196 - Part 2 :Chemical Analysis of Cement.

9. Physical Requirements

The physical requirements of the cement shall be as shown in table 4. The verification shall be according to European standard EN 196.

(5) The values indicated refer to the center of cement and exclude Calcium Sulfate and the Additives.
(6) The secondary constituants (Others) may be from fillers or in extreme case from the major constituents, except when the latters are incorporated as major constituants in the cement.

Table 3: Chemical Requirements Type P

Symbol	Loss on ignition Max %	Insoluble Residue Max %	MgO Max %	SO_3 Max %	Chlorures Max %	C_3A %	Other	Na_2O Equiv. Max % (a)
TYPE P								
P	5	4	4	3.5	0.1	- -	--	1
P-HR	4	1.0	4	4	0.1	- -	--	1
P-RMS	3	1.0	4	3.5	0.1	< 8.5	*(b)*	0.8
P-RSS	3	1.0	4	3.5	0.1	< 5	--	0.8
P-ChB	3	1.0	4	3.5	0.1	< 7	*(c)*	0.8
P-BTNa	3	1.0	4	3.5	0.1	--	--	0.6
TYPES PA & C								
PA-Z				3.5	0.1			
PA-S				4.5	0.1*(d)*			
PA-V				3.5	0.1			
PA-L				3.5	0.1			
C-S				4.5	0.1*(d)*			
C-SV				4.5	0.1			

10. Table of Equivalence

CEN	LIBNOR	ASTM
CEN I ---	P	TYPE I C 150-92
CEN I ---R	P-HR	TYPE III C 150-92
CEN I---PRISE MER	P-RMS	TYPE II C 150-92
CEN I---PMES	P-RSS	TYPE V C 150-92
CEN II/1 ou B-S--	PA-S (RMS)	IS(MS) C 592-93
CEN II/A ou B-V	PA-V (RMS)	IP(MS) C 592-93
CEN III/A ou B---	C-S RSS/Ch B	S HS-LH C 592-93

(a) Equivalent Na_2O: (Na_2O + 0.658 K_2O)
(b) Al_2O_3 max 6% - Fe_2O_3 max 6% - SiO_2 20% min
(c) C_2S max 35% C_2S min 40%
(d) For cements PA-S and C-S, the content of Chlorures may be greater than 0.1%. In this case, the exact content should be indicated with precision by the producer.

Note: When there is a risk of Alcali reactionif the cement is of type P, then the Na2O equivalent should be less than or equal to 0.6%. If the cement is PA or C, specific tests should be done to verify the behavior of the cement (this rule cannot be applied if the cement is of type C-S if the percent of the slag is greater than or equal to 35% and if the clinker ontent is elss than 0.6% of equivalent Na_2O.

Table 4: Physical Requirements

Type	Fineness Blaine	Setting time Vicat : min	Soundness Le chatelier	Heat of Hydration
	Cm2/g	Minute	mm[7]	J/g (joules/gram)
P	2.800	60	10	---
P-HR	------	45	10	---
P-RMS	2.800	60	10	5J/280
P-RSS	2.800	60	10	5J/280
P-ChB	2.800	60	10	5J/250
PBTNa	2.800	60	10	---
PA, C				
				ChB
PA-Z	3.000	60	10	5J/250
PA-S	3.000	60	10	5J/250
PA-V	3.000	60	10	5J/250
PA-L	3.000	75	10	5J/250
C-S	3.000	75	10	5J/250
C-SV	3.000	-	10	5J/250

Table 5: Mechanical Requirements

	COMPRESSIVE STRENGTH N/mm²			
	Early Strength		Final Strength	
	2 days		28 days	
32.5	---	≥	> 32.5	< 52.5
32.5HR	>13.5	---	>32.5	< 52.5
42.5	>12.5	---	>42.5	<62.5
42.5HR	>20	---	>42.5	<62.5
52.5	>20	---	>52.5	<---
52.5HR	>30	---	>52.5	<---

7) Determination of the hydration heat by means of the method of the dissolution calorimeter

11. Components, Abbreviations & Formulas

The Manufacture of Clinker or Portland Cement, Composite Portland or other cement shall utilize a certain number of chemical combinations that are identified and quantified, of which the most important are used in this standard and are defined below.

Name	Abbreviation
Calcium oxide	CaO
Free lime	CaOl
Magnesium oxide	MgO
Aluminate tricalate	C_3A
Alkalis equivalent expressed in Na_2O eq.	$Na_2O+(0.658)(K_2O)$

Table 6 : Examples of denominations and Correspondences

P 52.5	HR
P 42.5	RO
P 42.5	RSS
PAZ 42.5	RMS
C-S 42.5	RSS-ChB
P 42.5	BT Na
HR	Early Strength
RO	ORDINARY STRENGTH
RMS	MODEERATE SULFATE RESISTANCE
RSS	HIGH SULFATE REISITANCE
ChB	LOW HEAT OF HYDRATION
BT Na	LOW ALKALI CONTENT

P 52.5 – MR: HR Portland cement type P class 52.5 High Early Strength.
PAZ 42.5 – RMS: Composite Portland cement type PA class 42.5 moderate sulfate resistance.

12. Conformity Criteria

12.1 Definitions
For this standard, the definitions listed below shall apply.

12.1.1 Statistical Quality Control
Quality control using statistical methods, such as charts and sampling procedures.

12.1.2 Auto Control
Continuous statistical control for cement quality, exercised by the manufacturer.

12.1.3 Batch
A defined cement quantity, presumably produced in uniform conditions.

Note: The quantity can be limited, in consideration to the tonnage or to the length of the period of production.

12.1.4 Delivery
A cement quantity delivered at a certain time and which can consist of one or several batches.

12.1.5 Sample Requirements
1- Defined cement quantity required to make a test.
2- Value of tests.

12.1.6 ***Single Sample***
A quantity of cement taken once from a specific cement quantity.

12.1.7 ***Sample***
One or more single samples taken from a cement quantity for testing.

12.1.8 Specific Sample
An single sample taken from a batch or from a production line.

12.1.9 Average sample
A sample composed of several single samples extracted from the same batch, thoroughly mixed, and if necessary reduced to a suitable quantity or volume.

Note: This type of sample should not be used for the requirements of this standard.

12.1.10 Defect (Non-Conformity)
Non-conformity of a sample to the requirements of articles 6, 7 and 8. The non conformity could be either major or minor one .

12.1.11*Major defect*
Is the defect that could result in a failure or significantly reduce the required properties of cement.

12.1.12 Minor defect
The defect that does not significantlly reduce the required properties of the cement (the cement is still suitable for use).

12.1.13 Multi-Defected (multiple non-conformity)
A sample with one or several defects.

12.1.14 Consumer Risk
The Consumer Risk for which a certain delivery shall be declared compliant with the standard and accepted even when the percentage of default P is larger than P0. It is characterized as the point of the acceptability curve (OC) corresponding to a low probability of acceptance, fixed in advance at 5%.

12.1.15Producer Risk
The Producer Risk for which a product shall be declared non compliant with the standard and not accepted even when the percentage of default P is less than P0. It is characterized as the point of the acceptability curve (OC) corresponding to a low probability of rejection, fixed in advance at 5%.

12.1.16 Acceptance probability
The probability that a batch, containing a given percentage of defects, is accepted by the application of a given sampling plan.

12.1.17 Rejection probability
The probability that a batch, containing a given percentage of defaults, is rejected by application of a given sample plan.

12.2 Introduction

12.2.1 A conformity criteria statistically formulated includes 3 elements.

1. A definition of requirements for a characteristic value, as in Tables 8, 9 and 10.
2. Acceptable percentage of "defects" Pa. In the following standard, it is 10% for thre upper limit and 5% for lower limit.
3. Acceptance probability for a quantity of cement not in conformity with the requirements.

A sampling control procedure will only give an approximate value for defects % in a specified quantity of cement. The more samples are taken, the closer becomes the approximation.

The Probability of Acceptance, also called Consumer Risk, could adjust the degree of approximation by using a sampling plan. In this case, the value of 5% for continuous control will be the basis of conformity evaluation.

12.2.2 The Conformity criteria for a continuous control (see 12.4, 12.5 & 12.6) are based on 12.2.1 paragraph. An additional conformity criterion is included in this standard. In order to have a rejection criteria for the cement which is unsuitable for its intended use, this standard specifies (see 12.7) that a cement quantity containing one or more major defects could be rejected**.**

12.3. Application of Conformity Procedure

12.3.1 Conformity of cement to this standard shall be evaluated in a continuous way. Clause 12 prescribes that the conformity of this cement shall be checked according to statistical quality control based on a continuous control of the manufactured cement. This control is executed by the producer (auto control).

Note: National or International rules could obligate the producer to have the autocontrol supervised by an officially recognized body.

Some delivery or other contractual conditions, usually specified in documents exchanged between the buyer and the supplier, are outside the scope of this standard.

12.3.2 This standard does not cover the control of cement deliveries. However, the application of statistical quality control principles in this standard puts some constraints on the acceptance of cement deliveries which were found conforming to 12.4, 12.5, and 12.6 through continuous control.

A sampling plan for acceptance control upon delivery shall not increase the Consumer Risk to a value higher than what can be deduced from the graph of continuous control according to 12.4, 12.5, and 12.6.

12.4 Conformity Assessment

12.4.1 The assessment shall be based on control exercised through continuous sampling utilizing specific samples of cement taken according to EN196-7.

12.4.2 The continuous inspection shall be done by the manufacturer and shall take place at the plant (auto control). The series of samples used for assessing the conformity shall be taken over a period of no less than 6 months and no more than 12 months.

The minimum testing frequencies are specified in table 7.

Table 7: Minimum Testing Frequencies

Property	Number of samples
Strength Sulfate content initial setting time soundness	1 Per day
Chloride content Loss on ignition Insoluble Residue	1 per week

12.4.3 A test value, which does not comply with the appropriate values in table 3 and 5, is called "Defect". This standard distinguishes between minor and major defects. Special limits are specified for major defects (see 12.7.)

12.5 Conformity Criteria and Procedure for Strength Requirements

12.5.1 The strength requirements in clause 6 comprise:

28 day strength	Lower limit(L)
	Upper limit (U)
2 (or7) day strength	Lower limit (L)

12.5.2 For strength requirements, the conformity procedure is based upon sampling inspection by variables.
In principle, the overall percentage of defects in the batch from which samples are taken is estimated from the test results. Conformity requires that the estimate does not exceed the acceptable percentage of defects.

Note: For practical calculations, the so-called acceptability constant K_a is used for the evaluation of conformity instead of the percentage of defects see table A-1

12.5.3 The sampling plan (including the number of single spot samples to be taken) is established by means of the following parameters:

- Acceptable overall percentage of defects
- Acceptable Consumer Risk.

The two parameters together are used for the selection of sampling for continuous auto control.
Some typical sampling plans for inspection by variables are shown in Annex A. Any other plan that satisfies the values in table 8 is acceptable, in principle, for the conformity procedure.

Table 8: Parameters Determining Conformity Procedure

Description	**Strength At 2(7) & 28 days**	**Strength at 28D U**	**Phy & Chem Prop**
Continuous Inspection	By variable	By variable	By Attribute
% of Defects	5%	10%	10%
Consumer's risk	5%	5%	5%
Note: The sampling plans for receiving inspection of a certain batch of cement should be based on the Producer Risk and not the Consumer Risk (See 12.15 and 12.1.16 for definitions).			

12.6 Conformity criteria and procedure for physical and chemical properties.

12.6.1 Clauses 8 & 9 specify the requirements for the following properties:

- Physical properties:
  - initial setting time
  - soundness.
- Chemical properties:
  - loss on ignition
  - insoluble residue
  - sulfate content,
  - chloride content,
  - % additives.

The conformity shall be assessed for one property at a time.

12.6.2 For physical and chemical requirements, the conformity procedure shall be based on sampling inspection by attributes.

The number of defective items is counted and compared with an estimated number of defects calculated from the number of tests and the specified acceptable overall percentage of defects.

In order to improve inspection efficiency the cement producer is allowed to employ inspection by variables (see 12.5) this is preferable for sulfate content in the case where it is close to the specified limit.

12.6.3 The sampling plan (including the number of spot samples to be taken) is established on the same basis as in 12.5 (see table 8).
Several other plans suitable for inspection by attribute are shown in Annex A. Any other plan satisfying the values of table 8 is acceptable, in principle, for the conformity procedure.

12.7 Limits of Major Defects.

A quantity of cement yielding one or more major defective samples does not conform to the requirements of the present standard.

In general, a major defect is defined as a deviation from the requirement in articles 8, 9,and 10 and so large, that the use of the cement for its intended purpose is likely to be reduced and that, in extreme cases, may even produce a failure. Table 9 presents a more specific definition for the different properties. If a test result deviates
by more than the value in this table, the sample shall be denoted as Major Defect.

Table 9: Major Defects

PROPERTIES	DAYS	DEVIATION FROM REQUIREMENTS
Compressive strength Lower Limit (7 days)	28 2	- 2.5 N/mm^2 - 2.0 N/mm^2
Compressive strength Upper Limit	28	Values non specified
Setting time • Strength Class 32.5 & 42.5 • Strength Class 52.5 Stability soundness Loss on ignition Sulfate Content Chloride Content Insoluble Residue % Additive		- 15 min - min + 1 min non specified + 0.5% + 0.01% not specified not specified

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ANNEXE A

TYPICAL SAMPLING PLANS

A.0 Introduction
This clause contains a number of sampling plans for the following two alternatives
- Continuous inspection by variables
- Continuous inspection by attributes

The number of samples and the minimum testing frequency are specified in 12.4.2

A.1 Inspection by variables
In this case, the mean value X and the standard deviation, s, of the complete series of test results (one result per sample) are calculated. The conformity criteria are:

$$X-K_aS > L$$
$$X+K_aS < U$$

where:
K_a is the acceptability constant
L is the specified lower limit
U is the specified upper limit.

The acceptability constant K_a depends on the parameters specified in table 5 and on the number of test results (n). Values of K_a are listed in table A.1

TABLE A.1: Acceptability constant K_a

N	Pa=5%	Pa=10%
40 à 49	2.13	1.70
50 à 59	2.07	1.65
60 à 79	2.02	1.61
80 à 99	1.97	1.56
100 à 149	1.93	1.53
150 à 199	1.87	1.48
> 200	1.84	1.45

A.2 Inspection by Attributes
In this case the number $\mathbf{C}_d$ of defective test results (one result per sample) in the complete series of samples is counted the conformity is checked by the equation :

$$\mathbf{C}_d < C_a$$

Where the acceptable number of defects C_a depends on the parameters specified in table A.2.

Table A.2 Acceptable Number of Defects For A 5% Risk

% of acceptable defects: 10%	C_a
Number of test results n[1]	
20 to 39	0
40 to 54	1
55 to 69	2
70 to 84	3
85 to 99	4
100 to 109	5
[1] If the number of test results n is less than 20 (for an acceptable percentage of defects of 10%), it is not possible to utilize a statistical conformity criterion. In this case, C_a will always be zero.	