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Descriptors : Water pipelines, sewage pipes, tubes, accessories, sandstone products, quality control, tests, sampling

English version

Vitrified clay pipes and fittings and pipe joints for drains and sewers - Part 2: Quality control and sampling

Tuyaux et accessoires en grès et assemblages de tuyaux pour les réseaux de branchement et d'assainissement - Partie 2: Contrôle de la qualité et échantillonage

Steinzeugrohre und Formstücke sowie Rohrverbindungen für Abwasserleitungen und -kanäle - Teil 2: Güteüberwachung und Probenahme

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CEN

European Committee for Standardization
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Foreword

This part of the European Standard for vitrified clay pipes is the second of three parts which were drafted by WG2 "Vitrified clay pipes" of the Technical Committee CEN/TC 165 "Waste Water Engineering", Secretariat of which is held by DIN.

"Vitrified clay pipes and fittings and pipe joints Part 1: Requirements" contains the complete specification, "Vitrified clay pipes and fittings and pipe joints Part 3: Test methods" contains the necessary statements on the testing methods.

On drafting this standard the provisional results already available of CEN/TC 165/WG1 "General requirements on pipes, fittings, pipe joints including sealings and manholes" were taken into account. When further results are received, any necessary amendment will be made.

In accordance with the Common CEN/CENELEC Rules, the following countries are bound to implement this European Standard:-

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Vitrified clay pipes in permanent or in temporary contact with water intended for human consumption will not affect the quality of that water. Therefore this standard does not contravene the EC-Council Directives 75/440, 79/869, 80/778.

This standard takes into account the essential requirements of the EC-Council Directive for construction products (89/106) and the Draft Directive on the treatment of municipal waste water (COM (89) 518).

1 General

1.1 Object and field of application

This part of this European Standard specifies requirements for manufacturer's internal quality control, third party assessment and inspection.

NOTE: Where reference is made to clauses in EN 295-1 and EN 295-3 it is clearly stated.

1.2 References

EN 295-1	1991	Vitrified clay pipes and fittings and pipe joints for drains and sewers : Part 1: Specification.
EN 295-3	1991	Vitrified clay pipes and fittings and pipe joints for drains and sewers : Part 3: Test Methods.
EN 29002	1987	Quality Systems - Model for quality assurance in production and installation.
EN 45011	1989	General criteria for certification bodies operating product certification.
EN 45012	1989	General criteria for certification bodies operating quality system certification.
ISO 2859-1	1989	Sampling procedures for inspection by attributes : Part 1 Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.
ISO 2859-2	1989	Sampling procedures for inspection by attributes : Part 2 Sampling plans indexed by limiting quality (QL) for isolated lot inspection.
ISO 3951	1989	Sampling procedures and charts for inspection by variables for percent nonconforming.
ISO/DIS10012	1990	Measurement and calibration systems.

1.3 Definitions

1.3.1 Batch.

A clearly identifiable collection of units manufactured essentially from the same materials and under the same conditions (see 3.2.2, 3.5.2 and 3.9.1 as appropriate).

1.3.2 Isolated batch.

A clearly identifiable collection of unassessed units not exceeding 3200 in number manufactured essentially from the same materials but not necessarily all manufactured or fired at the same time.

1.4 Internal quality control and third party assessment

1.4.1 Quality supervision

Quality supervision shall comprise internal control (1.4.2) and third-party assessment and inspection (1.4.3).

1.4.2 Internal control

Internal quality control shall comprise continuous inspection carried out by the manufacturer as part of an approved third party assessment to ensure compliance with the requirements of EN 295 under a quality system complying with EN 29002.

1.4.3 Inspection and audits by third party assessors

The third party inspection shall be carried out at least twice a year without previous notice.

The assessors shall visit the manufacturer's works to inspect testing and to check records. In addition, the third party assessor shall carry out audits according to Table 1.

The third party assessors shall comply with the requirements of EN 45011 and EN 45012.

1.5 Sampling of fired ware (EN 29002 : 1987 Clause 4.9)

1.5.1 Selection of samples

The samples of fired ware for testing shall be selected at random.

Table 1 Scope of Audit by Third Party Assessors as applicable

Item No.	Subject of test	Property	Requirements as in EN 295-1	Testing as in EN 295-3	Number of samples
1	Pipes and fittings	Materials and Manufacture	2.1	Visual inspection	Three samples of one nominal size
2		Dimensions	2.2 2.3 2.4 2.5 2.6 2.7 2.8	2 & 3	
3		Marking	6.1	-	
4	Pipes	Crushing Strength	2.9	4	
5		Watertightness	2.14	9	One sample of one nominal size
6	Fittings	Bond strength	2.12.1	7	
7		Impermeability	2.18	13	
8	Joint assemblies	Watertightness	3.2.1	18.2 18.3 18.4	One joint assembly of one nominal size
9		Joint interchange-ability dimensions	3.6	-	Three samples of one nominal size
10		Marking	6.2	-	
11	Polyurethane sealing elements	Tensile strength	3.1.2	15.2	One sample per moulding plant
12		Elongation at break	3.1.2	15.2	
13		Compression set	3.1.2	15.5	
14		Relaxation	3.1.2	15.4	
15		Resistance to ageing	3.1.2	15.6	
16	Rubber sealing elements attached to pipe	Ozone resistance	3.1.1	14	
17	Polypropylene sleeve couplings (Clause 3.1.3)	Melt flow index	3.1.3	16.1	One sample per moulding plant
18		Tensile strength	3.1.3	16.2	
19		Elongation at break	3.1.3	16.2	
20		Elevated temp.	3.1.3	16.3	
21	Polypropylene sleeve couplings (Clause 3.1.4)	Line displacement	3.1.4	17	Three samples of one nominal size
22	Other joint materials	According to items 8-21 above as applicable			

1.5.2 Change in batch condition

For the purposes of these quality control scheme requirements, each of the following, either singly or in combination, illustrate a change in condition, whereby units of fired clay cannot be considered as being from the same batch as they are not manufactured essentially from the same materials and/or under the same condition:

(a) Alterations to firing conditions (other than those required to maintain a setting).

(b) A clay blend formula is changed.

(c) Any experimental work with temperature or clay blends.

1.6 Calibration. (EN 29002 : 1987 Clause 4.10)

The measurement and calibration of inspection equipment shall be carried out in accordance with the requirements of ISO/DIS 10012

2. Records

Records as required by EN 29002 : 1987 shall be maintained for a minimum period of 10 years.

In addition to maintaining records as required by EN 29002 : 1987 Clause 4.9.4, the following records, where applicable to a firm's production, shall be similarly maintained.

(a) Data indicating the blend (or stockpile) of clay used and the dates of production of fired ware manufactured from that blend from any kiln.

(b) Details of pipes and fittings which have been glazed and the glaze used.

(c) Details of fired fittings which have been surface treated after firing together with the specification(s) of materials used.

(d) The specification of materials used for fixing fired parts together with certificates from the material supplier(s) in respect of each consignment showing compliance with the Licencee's specification(s) nominated, as required by EN 29002 : 1987 Clause 4.9.1.1.

(e) Functional dimensions for sealing elements and fairings for every design and nominal size of flexible mechanical joint.

(f) Details of materials used for fairings and non-rubber sealing elements for every design and nominal size of flexible mechanical joint, together with certificates from the material supplier(s) in respect of each consignment showing compliance with the Licencee's specification(s) nominated, as required by EN 29002:1987 clause 4.9.1.1.

3. Quality Control Testing (EN 29002 : 1987 Clause 4.9.3)

3.1 General

3.1.1 Visual inspection

Products shall be visually inspected for freedom from such flaws as would impair their function when in service. Samples shall be selected for testing after the rejection of such flawed products

3.1.2 Rejection after retest

In the event of a batch being rejected after re-testing, it may be 100% tested for the feature in question, and only those items found to comply will be accepted.

NOTE: Any batch of pipes and/or fittings/or joints which has failed to meet the requirements of EN 295-1 may be offered for an alternative specification for which it qualifies if applicable, and marked accordingly.

3.2 Pipes

3.2.1 Routine testing

Routine testing shall be carried out on pipes for the requirements of EN 295-1 clauses 2.2 to 2.5, 2.9 and 3.6, also Table 11 for the mean values of d_3 and Table 10 for the mean values of d_1 if the diameters are measured to clay surfaces.

3.2.2 Batch sizes

(a) Continuous kilns - not greater than the production drawn from one kiln, within a one week period, sub-divided according to nominal size and strength class.

(b) Intermittent kilns - total production from one kiln, per firing, sub-divided according to nominal size and strength class.

(c) Isolated batch - as in 1.3.2

3.2.3 Sample size for pipes for quality control at the manufacturer's works

Sampling and testing procedures in respect of any batch shall be completed prior to removal from the works and shall be in accordance with either

(a) Clause 4 and Tables 3,4, and 6 and their switching rules which are consistent with ISO 2859 at an AQL of 6.5% and inspection level S3 for sampling of continuing series of batches by attributes.

or

(b) Clause 5 and Tables 8, 9 and 10 and their switching rules which are consistent with ISO 3951 at an AQL of 6.5% and inspection level S3 for sampling of continuing series of batches by variables.

or

(c) Table 7 for sampling of isolated batches by attributes (Maximum batch size 3200).

3.2.4 Retest procedure for pipes from resubmitted rejected batches

Batches rejected under the sampling procedure specified in 3.2.3 or 3.2.5 may be resubmitted once, after the removal of pipes with previously undetected defects, under the tightened procedure given in Table 7 in respect only of the defect that caused initial rejection.

In the event of a batch being rejected after retesting it may be 100% tested for the feature in question and only those items found to comply will be accepted.

3.2.5 Sampling after delivery from the manufacturer's works

Sampling shall be in accordance with Table 3 except where a batch is resubmitted after rejection when 3.2.4 shall then apply.

3.3 Regular test - Pipes to EN 295-1 Clause 2.14 - Water tightness of pipes

These tests shall be carried out at least weekly at the rate of one pipe or pipe section from each nominal size manufactured during that week. In the event of a test failure a further 3 tests shall be carried out on the same nominal size of pipe. Should a further failure on retest occur then the use of the certification mark on the nominal size of pipe affected shall be suspended until the cause of the failure has been identified and eliminated. Use of the certification mark may be reinstated following 3 successful tests on the same nominal size of pipe.

3.4 Optional tests - Pipes to EN 295-1 Clauses 2.10 - Bending tensile strength, 2.11 - Bending moment resistance, 2.13 - Fatigue strength under pulsating load, 2.15 - Chemical resistance, 2.16 - Hydraulic roughness and 2.17 - Abrasion resistance

Optional tests for pipes may be carried out if required by purchasers but only after agreement between the manufacturer and the purchaser.

3.5 Fittings

3.5.1 Routine testing

Where relevant for fittings as shown in Table 2, routine testing shall be carried out on the fittings for the requirements of EN 295-1 Clauses 2.2, 2.3, 2.7, 2.8 also Table 11 for the mean values of d_3 and Table 10 for the mean values d_4 if the diameters are measured to clay surfaces.

Table 2 - Applicable dimensional and performance requirements for fittings EN 295-1 clauses 2.2, 2.3, 2.6, 2.7, 2.8 and 2.18

Fitting group	Minimum Bore*	Length	Water seal+	Angle of Curvature	Branch angle	Imperm-eability+
	2.2	2.3	2.6	2.7	2.8	2.18
Taper & splay pipes	X	X				X
Access & inspection pipes & chambers. Channels & taper channels	X	X				
Bends, taper & rest	X			X		X
Channel bends, access and inspection bends, saddles & oblique saddles	X			X		
Junctions	X	X			X	X
Channel junctions, access junctions, taper channel bends	X	X		X	X	
Trapped gullies, low back traps, syphons and interceptors	X		X			
Trapless gullies, hoppers and raising pieces	X					

The symbol "X" denotes the clause in EN 295-1 applicable.
* Applies to pipeline connections only.
+ Regular test to clause 3.6.

3.5.2 Batch sizes - Fittings

(a) Continuous kilns - not greater than the production drawn from one kiln, within a period of 1 week, sub-divided into nominal size and fitting group.

(b) Intermittent kilns - total production from one kiln, per firing, sub-divided into nominal size and fitting group.

(c) Isolated batches - as in 1.3.2

(d) For fittings made by fixing fired clay parts together, the batch size shall not exceed one week's production.

3.5.3 Sample size - Fittings

Sampling and testing procedures in respect of any batch shall be completed prior to removal from the works and shall be in accordance with either

(a) Clause 4 and Tables 3, 4 and 6 and their switching rules which are consistent with ISO 2859 at an AQL of 6.5% and inspection level S3 for sampling of continuing series of batches by attributes.

or

(b) Clause 5 and Tables 8, 9 and 10 and their switching rules which are consistent with ISO 3951 at an AQL of 6.5% and inspection level S3 for sampling of continuing series of batches by variables.

or

(c) Table 7 for sampling of isolated batches by attributes (maximum batch size 3200).

3.5.4 Retest procedure for fittings from resubmitted rejected batches

Batches rejected under the sampling procedure specified in 3.5.3 may be resubmitted once, after the removal of fittings with previously undetected defects under the tightened procedures given in Table 7 in respect only of the defect that caused initial rejection.

In the event of a batch being rejected after retesting it may be 100% tested for the feature in question and only those items found to comply will be accepted.

3.6 Regular tests - Fittings

3.6.1 Regular test and sampling to EN 295-1 Clause 2.6 - Water seal of fittings

This regular test shall be carried out, as far as practicable, at least at monthly intervals at the rate of one fitting from each nominal size manufactured during that month. Where the dimensions of water seal are governed by a master mould the test may be carried out by measuring the appropriate dimensions of the master mould.

3.6.2 Regular test and sampling to EN 295-1 Clause 2.18 - Impermeability of fittings (excluding junctions)

This test shall be carried out at the rate of at least one fitting from each nominal size manufactured during a month.

Where fittings are fired in a plant alongside pipes, using the same materials and firing process, the impermeability of these fittings is deemed to be that of these pipes. If pipes are not normally fired alongside these fittings, short lengths of pipes made for test purposes, using the same material and firing process as for these fittings, may be tested for compliance with the requirements of this Clause.

3.6.3 Regular test and sampling to EN 295-1 Clause 2.18 - Impermeability of fittings -junctions

This test shall be carried out at the rate of at least one junction from each nominal size manufactured during a month and at least one junction per production day rotating through the sizes up to and including DN300.

3.6.4 Retest procedure and sampling for regular tests to 3.6.2 and 3.6.3

In the event of a regular test failure a further 3 tests shall be carried out in the same nominal size of pipe or fitting. Should a further failure on retest occur, then routine testing shall be instituted according to clause 4.1 - normal inspection, and regular testing may be re-instituted when at least 10 consecutive batches have passed this level of inspection.

3.7 Optional tests for fittings for EN 295-1 Clauses 2.12.2 - Bond strength of adhesive used for fixing fired clay parts together and 2.15 - Chemical resistance

Optional tests for fittings may be carried out if required by the purchaser but only after agreement between the manufacturer and the purchaser.

3.8 Regular tests and sampling to EN 295-1 Clause 2.12.1 - Bond strength of adhesive used for fixing fired clay parts together

Regular tests shall be carried out on the bond strength of adhesive used to fix fired clay parts together. One test piece shall be fabricated for each adhesive mix used. Should test failure occur, the mix shall be rejected.

3.9 Joints - Sleeve design flexible mechanical

3.9.1 Batch sizes

For sampling for examination, each consignment from the manufacturer can be sub-divided if applicable into one design and one nominal size.

3.9.2 Acceptance procedures relating to couplings for sleeve joints purchased from an outside supplier (EN 29002:1987 Clause 4.5.4) to EN 295-1 Clause 3.1.4 - Performance requirement

3.9.2.1 Routine tests and sampling by clayware manufacturer

(a) Inspection and tests on couplings to check freedom from visual defects shall be in accordance with procedures in ISO 2859-1 at an AQL of 2.5% and inspection level II.

(b) Line displacement test. The samples of couplings that have passed visual inspection shall be considered as the batch size for the selection of samples in accordance with procedures in ISO 2859-1 at an AQL of 2.5% and inspection level II.

(c) Samples of couplings that have passed the test shall be clearly identified for use when type testing to clause 3.12..

3.9.2.2 Retest procedures and sampling by clayware manufacturer

(a) Visual defects or line displacement tests. In the event of batches of couplings failing the visual defects check or line displacement test they may be retested in accordance with the procedures in ISO 2859-1 at an AQL of 2.5% and inspection level III.

(b) In the event of a failure on retest for visual defects the batch shall be isolated. Further inspection in accordance with the procedures given in Clause 3.1.2 of these quality control scheme requirements may be carried out. Defective couplings shall be rejected or the whole batch rejected.

(c) In the event of a failure on retest for line displacement the cause of the failure shall be identified and eliminated. All affected stocks shall be rejected or shall be subjected to further inspection in accordance with the procedures given in Clause 3.1.2 of these quality control scheme requirements. Defective couplings shall be rejected or the whole batch rejected.

3.9.3 Acceptance procedures relating to polypropylene couplings made by coupling manufacturers who hold a Certification mark licence to EN 295

3.9.3.1 Routine tests and sampling by coupling manufacturer to EN 295-1 Clause 3.1.3 - Material requirements.

(a) Inspection and tests on mouldings to check conformity with the dimensional ranges specified and freedom from visual defects shall be conducted on not less than one sample every eight hours from each cavity of each tool. Mouldings from each cavity shall carry the mould/cavity identification mark.

(b) Inspection and tests on assembled couplings to check freedom from visual defects shall be in accordance with the procedures in ISO 2859-1 at an AQL of 2.5% and Inspection Level S4, or tighter if required by the manufacturer's quality assurance system.

(c) Melt flow index, tensile strength, elevated temperature and elongation at break tests shall be conducted at a rate of one sample from a coupling from each tool every 48 hours.

3.9.3.2 Retest procedures and sampling which may be carried out by coupling manufacturer.

(a) In the event of a moulding failing the dimensional check a minimum of six further samples from the same cavity shall be selected and checked for the dimension in question. If a failure occurs on re-test all mouldings from that cavity shall be subject to individual examination until the cause of the non-conformity is determined and the necessary corrective action taken.

(b) In the event of batches of couplings failing the visual defects check they may be retested in accordance with the procedures in ISO 2859-1 at an AQL of 2.5% and Inspection Level I or tighter if required by the manufacturer's quality assurance system.

(c) In the event of a failure on retest for visual defects the batch shall be isolated. Further inspection in accordance with the procedures given in Clause 3.1.2 of these quality control scheme requirements shall be carried out. Any defective couplings shall be destroyed or the certification mark removed.

(d) In the event of a moulding failing a test for melt flow index, elevated temperature or tensile strength or elongation at break, select and test three further samples from the same cavity. If a failure occurs on re-test the cause of the non-conformity shall be determined and any necessary corrective action taken.

3.10 Joints - Polyurethane

3.10.1 Regular tests and sampling to EN 295-1 Clause 3.1.2 - Polyurethane sealing elements

3.10.1.1 Hardness and compression set tests shall be conducted at a rate of one sample from each dispensing unit each day.

3.10.1.2 Tensile strength and elongation at break tests shall be conducted at the rate of one sample from each dispensing unit at least once a month.

3.10.1.3 Stress relaxation ($t = 10^4$ min), ageing and hardness change at low temperature. Tests shall be conducted at the rate of one sample from each dispensing unit at six monthly intervals.

3.10.1.4 Joint dimensions shall be measured on three samples from each nominal size and joint design at six monthly intervals.

3.10.2 Evaluation tests and sampling to EN 295-1 Clause 3.1.2 - Polyurethane sealing elements

Stress relaxation ($t = 10^5$ min) tests shall be carried out once for each formulation.

3.10.3 Retest procedure and sampling for regular tests to 3.10.1.1 and 3.10.1.2

In the event of a sample failing a test, select and test three further samples.

If a failure occurs on retest, the cause of the non-conformity shall be determined and performance tests to EN 295-1 Clause 3.3 and 3.4 shall be conducted on three joint assemblies. Should a failure occur, the batch shall be rejected.

3.10.4 Retest procedure and sampling for regular tests to 3.10.1.3 and 3.10.1.4

In the event of a test failure a further 3 samples shall be tested from the same dispensing unit. Should a failure on retest occur then the use of the certification mark shall be suspended until the cause of the failure has been identified and eliminated. Use of the certification mark may be reinstated following 3 successful tests.

3.11 Rubber sealing elements

3.11.1 Regular test and sampling for rubber sealing elements attached to the pipe to EN 295-1 Clause 3.1.1 - Rubber sealing elements - ozone resistance

Tests for ozone resistance of rubber sealing elements attached to the pipe shall be carried out on a sample from each type of rubber used at a rate of one test at least annually.

3.11.2 Retest procedure and sampling for tests to 3.11.1

In the event of a test failure a further sample shall be tested. Should a failure on retest occur then the use of the certification mark shall be suspended until the cause of the failure has been identified and eliminated. Use of the certification mark may be reinstated following 3 successful tests.

3.12 Moulded plastics internal socket diameter

3.12.1 Regular testing and sampling to EN 295-1 Clause 3.6 - Joint interchangeability and EN 295-1 Table 10, dimension d_4

This diameter shall be measured in three samples from each nominal size and joint design at six monthly intervals.

3.12.2 Retest procedure and sampling for tests to 3.12.1

In the event of a test failure a further 3 samples shall be tested. Should a failure on retest occur then the use of the certification mark shall be suspended on the nominal size of pipe affected until the cause of the failure has been identified and eliminated. Use of the certification mark may be reinstated following 3 successful tests.

3.13 Pipe joint assemblies

3.13.1 Type tests and sampling to EN 295-1 Clauses 3.2.1 - Water tightness of joints, 3.3 - Angular deflection, 3.4 - Shear resistance and 3.7.1 - Chemical and physical resistance to effluent

A type test shall be carried out using an internal pressure at six monthly intervals in accordance with the procedures specified in EN 295-1 Clauses 3.3 and 3.4 on each size of joint assembly and annually for EN 295-1 Clause 3.7.1 on one size of joint assembly representing current production.

3.13.2 Retest procedure and sampling for type tests to 3.13.1

In the event of a type test failure a further 3 samples shall be tested. Should a failure on retest occur then the use of the certification mark on the nominal size of pipe affected shall be suspended until the cause of the failure has been identified and eliminated. Use of the certification mark may be reinstated following 3 successful tests.

3.13.3 Evaluation tests and sampling to EN 295-1 Clauses 3.2.2- Water tightness of joints, 3.3 - Angular deflection, 3.4 - Shear resistance , 3.5 - Invert conformity, 3.8 - Thermal cycling stability and 3.9 - Long term thermal stability

Evaluation tests shall be carried out once for each new joint design or new type of joint material in accordance with the procedures of EN 295-1 Clauses 3.2.2, 3.3, 3.4, 3.5, 3.8 and 3.9 additionally for EN 295-1 Clause 3.4 after the load has been applied for three months.

3.13.4 Optional tests to EN 295-1 Clause 3.7.2 - Chemical and physical resistance to effluent

Optional tests for joint assemblies may be carried out if required by purchaser but only after agreement between the manufacturer and the purchaser.

3.13.5 Sampling after delivery from manufacturer's works

Sampling shall be in accordance with Table 4 and testing to the procedures of EN 295-1 Clauses 3.3 to 3.4.

4. Inspection procedures and switching rules for inspection by attributes - Tables 3 to 7

4.1 Acceptability determination

4.1.1 Single sampling

If the number of defectives found in the sample is equal to or less than the acceptance number, the batch shall be accepted. If the number of defectives is equal to or greater than the rejection number, the batch shall be rejected.

When reduced inspection is in effect and the acceptance number has been exceeded but the rejection number has not been reached, the batch shall be accepted and normal inspection reinstated.

If the rejection number has been reached or exceeded, the batch shall be rejected and normal inspection reinstated.

4.1.2 Double sampling

The number of sample units inspected shall be equal to the first sample size given in the plan. If the number of defectives found in the first sample is equal to or less than the first acceptance number, the batch shall be accepted. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the batch shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection numbers, the second sample of the size given in the plan shall be inspected.

The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number the batch shall be accepted. If the cumulative number of defectives is equal to or greater than the second rejection number, the batch shall be rejected. If this occurs on reduced inspection, normal inspection shall be reinstated for the next batch.

When reduced inspection is in effect and, after inspecting the second sample, the acceptance number has been exceeded but the rejection number has not yet been reached, the batch shall be accepted and normal inspection reinstated.

4.2 Operation of switching rules

4.2.1 Normal inspection

The sample size appropriate to the batch size and the values of acceptance and rejection numbers of defectives shall be in accordance with Table 3. Sample units shall be selected at random.

4.2.2 Normal to reduced inspection

A reduced inspection level as shown in Table 4 may be used when normal inspection is in effect provided that the following conditions are satisfied.

(a) the preceding ten batches (except where they consist of less than 30 sample units in total, see Table 5) have been on normal inspection, and none has been rejected on original inspection;

(b) the total number of defectives in the samples from the ten preceding batches (or such other number required by Table 5) is equal to or less than the applicable number given in Table 5.

When double sampling is in use, all samples inspected should be included, not first samples only.

4.2.3 Reduced to normal inspection

When reduced inspection is in effect, normal inspection shall be reinstated if a batch is rejected, or if a batch is accepted without either acceptance or rejection criteria having been met (see 4.1.1 and 4.1.2).

4.2.4 Tightened inspection

Tightened inspection as shown in Table 6 may be used either when inspecting a new product or when two or more batches have been rejected in any five consecutive batches of normal inspection.

4.2.5 Tightened to normal inspection

Tightened inspection shall continue until five consecutive batches are accepted when normal inspection may be resumed.

4.2.6 Discontinuation of inspection

If ten consecutive batches remain on tightened inspection, the provision of these sampling plans shall be discontinued pending action to improve the quality of the submitted products.

4.3 Tightened inspection for rejected batches

Tightened inspection as shown in Table 7 shall be used when inspecting a batch which has previously been rejected, after removal of pipes with previously undetected visible defects.

5. Inspection procedures and switching rules for inspection by variables - Tables 8 to 10

5.1 Distribution

This method is only applicable for continuous production and where there is reason to believe that the distribution of the variable is normal.

5.2 Acceptability determination

5.2.1 Mean and standard deviation

From a random sample of the appropriate size according to the batch size calculate x the sample mean, and s, the estimated standard deviation of the batch from the sample. If x is below the specification limit the batch shall be rejected.

5.2.2 Acceptability criteria for specification limit

Calculate the quality statistic for the lower specification limit

$$Q_L = \frac{x - L}{s}$$

where L is the lower specification limit

then compare the quality statistic with the acceptability constant k obtained from either Table 8, 9 or 10 as appropriate.

If the quality statistic for the lower specification limit is greater than or equal to the acceptability constant accept the lot; if less reject.

Thus accept if $Q_L >= k$

reject if $Q_L < k$

5.3 Operation of switching rules

5.3.1 Normal inspection

The sample size appropriate to the batch size and the value of the acceptability constant shall be in accordance with Table 8. Sample units shall be selected at random.

5.3.2 Normal to reduced inspection

A reduced inspection level shown in Table 10 may be used when normal inspection is in effect provided that the following conditions are satisfied :

(a) the preceding ten successive batches would have been acceptable if Table 9 had been used.

(b) production is in statistical control.

5.3.3 Reduced to normal inspection

When reduced inspection is in effect, normal inspection shall be reinstated if any of the following occur on original inspection.

(a) a batch is rejected

(b) production becomes irregular or delayed

(c) other conditions warrant that normal inspection shall be instituted

5.3.4 Tightened inspection

Tightened Inspection as shown in Table 9 shall be used when two batches on original normal inspection are rejected within any five or less successive lots.

5.3.5 Tightened to normal inspection

Tightened inspection shall continue until five consecutive batches are accepted on original inspection when normal inspection may be resumed.

5.3.6 Discontinuation of inspection

If ten consecutive batches remain on tightened inspection the provision of these sampling plans shall be discontinued pending action to improve the quality of the submitted products.

Table 3. Normal inspection for both single and double sampling plans by attributes

Single sampling			
Batch Size	Sample Size	Acceptance Number	Rejection Number
2-50	2	0	1
51-500	8	1	2
501-3200	13	2	3
3201-35000	20	3	4
35001-150000	32	5	6

Double sampling						
Batch Size	1st Sample Size	Acceptance Number	Rejection Number	2nd Sample Size	Acceptance Number	Rejection Number
2-50	not applicable					
51-500	5	0	2	5	1	2
501-3200	8	0	3	8	3	4
3201-35000	13	1	4	13	4	5
35001-150000	20	2	5	20	6	7

Table 4. Reduced inspection for both single and double sampling plans by attributes

Single sampling			
Batch Size	Sample Size	Acceptance Number	Rejection Number
2-50	2	0	1
51-500	3	0	2
501-3200	5	1	3
3201-35000	8	1	4
35001-150000	13	2	5

Double sampling						
Batch Size	1st Sample Size	Acceptance Number	Rejection Number	2nd Sample Size	Acceptance Number	Rejection Number
2-50	not applicable					
51-500	2	0	2	2	0	2
501-3200	3	0	3	3	0	4
3201-35000	5	0	4	5	1	5
35001-150000	8	0	4	8	3	6

Table 5. Limit numbers for reduced inspection

Number of sample units from last ten batches	Limit number of Defectives
20-29	*
30-49	0
50-79	0
80-129	2
130-199	4
200-319	8

*The number of sample units from the last ten batches is not sufficient for reduced inspection. In this instance more than ten batches may be used for the calculation, provided that the batches are the most recent ones in sequence, that they have all been on normal inspection and that none has been rejected while on original inspection.

Table 6. Tightened inspection for both single and double sampling plans by attributes

Single sampling			
Batch Size	Sample Size	Acceptance Number	Rejection Number
2-50	3	0	1
51-3200	13	1	2
3201-35000	20	2	3
35001-150000	32	3	4

Double sampling						
Batch Size	1st Sample Size	Acceptance Number	Rejection Number	2nd Sample Size	Acceptance Number	Rejection Number
2-50	not applicable					
51-3200	8	0	2	8	1	2
3201-35000	13	0	3	13	3	4
35001-150000	20	1	4	20	4	5

Table 7. Tightened inspection for resubmission of rejected batches and isolated batches

Batch Size	Sample Size	Acceptance Number	Rejection Number
2-25	3	0	1
26-500	13	1	2
501-1200	20	2	3
1201-10000	32	3	4
10001-35000	50	5	6
35001-150000	80	8	9

Table 8. Normal inspection by variables

Batch Size	Sample Size	Acceptability Constant (k)
3-280	3	0.765
281-500	4	0.814
501-1200	5	0.874
1201-3200	7	0.955
3201-10000	10	1.03
10001-35000	15	1.09
35001-150000	20	1.12

Table 9. Tightened inspection by variables

Batch Size	Sample Size	Acceptability Constant (k)
3-280	3	0.958
281-500	4	1.01
501-1200	5	1.07
1201-3200	7	1.15
3201-10000	10	1.23
10001-35000	15	1.30
35001-150000	20	1.32

Table 10. Reduced inspection by variables

Batch Size	Sample Size	Acceptability Constant (k)
3-280	3	0.566
281-500	3	0.566
501-1200	3	0.566
1201-3200	3	0.566
3201-10000	4	0.617
10001-35000	5	0.675
35001-150000	7	0.755