

INTERNATIONAL STANDARD

**ISO
8403**

First edition
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Metallic coatings — Coatings anodic to the substrate — Rating of test specimens subjected to corrosion tests

*Revêtements métalliques — Dépôts électrolytiques anodiques par rapport au
substrat — Cotation des éprouvettes soumises aux essais de corrosion*



Reference number
ISO 8403 : 1991 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8403 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Sub-Committee SC 7, *Corrosion tests*.

Annex A forms an integral part of this International Standard.

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International Organization for Standardization

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Metallic coatings — Coatings anodic to the substrate — Rating of test specimens subjected to corrosion tests

1 Scope

1.1 This International Standard specifies a method of evaluating the condition of coated test specimens that have been exposed to corrosive environments for test purposes.

It is based on experience of the method with standard 10 cm × 15 cm test panels, exposed on racks at outdoor test sites in natural atmospheres.

Special precautions must be taken when rating similar panels exposed to accelerated corrosion tests. Any modifications needed to adapt the method to rating actual production parts are not considered in this International Standard.

1.2 This method is applicable only to protective coatings that are anodic to the substrate, for example zinc coatings on steel or tin coatings on copper, with or without conversion coatings. It is not intended for use with coatings cathodic to the substrate, for which a rating system is specified in ISO 4540.

NOTE — This specification relates to process control, as applicable to specially prepared test panels. It is not intended for use in rating manufactured items as artefacts. This will be covered in a subsequent International Standard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2064 : 1980, *Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness*.

ISO 4540 : 1980, *Metallic coatings — Coatings cathodic to the substrate — Rating of electroplated test specimens subjected to corrosion tests*.

ISO 8044 : 1989, *Corrosion of metals and alloys — Vocabulary*.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 appearance rating: The severity of possible corrosion defects on the surface of the coating expressed by a letter code from A to H.

3.2 corrosion rating: The amount of corroded area of the surface of the coating expressed by a numerical value.

3.3 corrosion grade: The combined rating for severity and amount of corrosion defects on the coating.

3.4 corrosion: Physicochemical interaction between a metal and its environment which results in changes in the properties of the metal and which may often lead to impairment of the function of the metal, the environment or the technical system of which these form a part.

NOTE — This interaction is usually of an electrochemical nature.

3.5 corrosive environment: Environment that contains one or more corrosive agents.

3.6 corrosive system: System consisting of a metal and all parts of its environment which influence corrosion.

NOTE — Part of the environment may be coating, surface layer, additional electrode, etc.

3.7 corrosion defect: Corrosion effect of the coating and the basis metal, resulting in corrosion damage of the coating and finally the basis metal.

NOTES

1 corrosion effect: Change in the corrosion system caused by corrosion.

2 corrosion damage: Corrosion effect which is considered detrimental to the function of the metal, the environment or the technical system of which these form a part.

3.8 corrosion product: Substance formed by a change of state as a result of corrosion.

3.8.1 Where corrosion has occurred, the corrosion products may be derived from the metal coating as well as from the basis metal. The corrosion products may vary considerably in appearance and distribution, depending on both the coating and the basis metal and the corrosive medium. General corrosion produces a deposit that is more or less equally dispersed all over the metal surface while localized corrosion produces nodules of corrosion products over cavities.

3.8.2 In the following, some usual forms of corrosion and corrosion products which influence appearance are described.

3.8.2.1 staining: Change of appearance of a surface by oxidation, formation of sulfides, etc., with or without slight change of brightness.

3.8.2.2 dulling: Change of appearance of a surface by corrosion attack in such a way that the brightness of the surface is reduced without forming any directly obvious layer of corrosion products.

3.8.2.3 corrosion products from the coatings: For example white corrosion products.

NOTE — **white corrosion products:** Corrosion products on a surface in the form of white to greyish-white, porous deposits on, for example, zinc, tin, and their alloys. Corrosion products on zinc are quite easily formed in humid saline atmospheres and consist mainly of basic zinc salts.

3.8.2.4 corrosion products from the basis metal: patina/USA: for example rust or verdigris.

NOTES

1 **rust:** Visible corrosion products consisting mainly of hydrated iron oxides.

2 **verdigris; patina/USA:** Green or bluish-green corrosion products on the surface of copper or copper alloy. Verdigris consists mainly of basic copper(II) sulfate and copper(II) carbonate.

4 Principle

4.1 This International Standard establishes a rating system for evaluating the deterioration of the coating and the basis metal. The rating method described in this International Standard shall be applied to evaluate the appearance of the coating as well as the extent of the corrosion.

4.2 The rating designation consists of a letter for appearance rating and a number for corrosion rating. The designation includes an assessment of the overall appearance of the specimen after exposure and a rating of the severity of the corrosion defects.

5 Method of inspection

5.1 It may sometimes be necessary to expose specimens for the test even though they are imperfect in certain respects before exposure. In this case, an inspection shall be made and findings recorded before the specimens are exposed.

5.2 Specimens may be inspected on the exposure racks or may be removed to a more suitable location if necessary. Lighting during inspection shall be as nearly uniform as practical. Direct reflection of the sun or clouds shall be avoided, and various angles of inspection shall be tried to ensure that corrosion defects show up.

5.3 If the condition of the specimen allows, it shall be inspected before cleaning. If dirt, salt deposits, etc., make it impractical to inspect, the specimen may be washed with warm, slowly running water. Sponging gently with water, followed by a water rinse, may be used if the specimen is extremely dirty, but this procedure will tend to upgrade the rating by cleaning off the corrosion products. Specimens should be allowed to dry before they are inspected.

5.4 Defects to be noted and taken into account in rating specimens include only those that can be seen by the unaided eye. ("Unaided eye" includes wearing of correctional glasses, if the inspector normally wears them.)

Optical aids may be used to identify or study defects, after they have been detected by the unaided eye.

5.5 In the case of flat panels, edge defects occurring within 6 mm of the edges of a specimen may be noted in the description but are not normally counted for the numerical rating. Similarly, contact and rack marks, mounting holes, etc., shall be disregarded.

5.6 Rubbing, polishing, etc., of the surface of the specimen may be desirable during or after exposure to study one or another aspect of its condition. Such a procedure shall be confined to the minimum area absolutely necessary, preferably not more than 1 cm² of a 10 cm × 15 cm specimen. Subsequent corrosion in this area will not be representative of the rest of the deposit.

6 Assignment of appearance rating

The appearance of the surface consists of staining, dulling, and corrosion of the coating and of the basis metal. Graduations of change in the appearance of the coating and of the basis metal are given in table 1. No other defects can be recorded by this rating system.

Table 1 — Appearance rating

Appearance rating	Graduation of appearance of the coating
A	No change
B	Slight to moderate staining
C	Severe staining or hardly visible dulling
D	Slight dulling or hardly visible corrosion
E	Severe dulling, or thin layer of corrosion products or pitting, either of which may not uniformly cover the whole surface
F	Layer of corrosion products or pitting corrosion, either of which covers the whole surface
G	Thick layer of corrosion products, or pitting corrosion which covers the whole surface and has deep pits
H	Presence of basis metal corrosion

7 Assignment of corrosion rating

7.1 The numerical rating system is based on the area covered by corrosion defects and is given by the equation

$$R = 3 (2 - \log_{10} A)$$

where

R is the rating;

A is the percentage of the total area covered by corrosion defects.

R is rounded off to the nearest whole number, as indicated in table 2.

Table 2 — Corrosion rating versus area of corrosion defect

Area of corrosion defect (%)	Rating
No defect	10
$A \leq 0,1$	9
$0,1 < A \leq 0,25$	8
$0,25 < A \leq 0,5$	7
$0,5 < A \leq 1,0$	6
$1,0 < A \leq 2,5$	5
$2,5 < A \leq 5$	4
$5 < A \leq 10$	3
$10 < A \leq 25$	2
$25 < A \leq 50$	1
$50 < A$	0

7.1.1 Strict application of the equation in 7.1 will lead to ratings greater than 10 for specimens with extremely small defective areas. Rating 10 is therefore arbitrarily assigned to a specimen with no corrosion defects.

7.1.2 If desired, fractional ratings between 9 and 10 may be assigned to panels judged better than 9 but not perfect. Fractional ratings below 9, although normally not especially useful, may be assigned if desired.

7.2 As an aid in judging the defective area, standards of comparison consisting of dot charts are reproduced in annex A. The standards represent the maximum amount of corrosion permissible for a given rating: there is a standard for each rating 1 to 9. A specimen worse than the standard for rating 1 is assigned a rating of 0.

7.3 In rating any given specimen, it is recommended that the appropriate series of dot charts be placed beside it, and the corrosion defects be matched with one of the standards. If the specimen is somewhat better than standard (X), but not as good as standard (X + 1), it is rated (X); if somewhat worse than standard (X) but not as bad as standard (X - 1), it is rated (X - 1).

8 Evaluation of results in the form of corrosion grades

The evaluation of results shall be reported as a corrosion grade showing the severity and the extent of corrosion defects by combining values in tables 1 and 2 (extent of corroded area of the coating and the basis metal and deterioration of the appearance).

Examples of corrosion grades:

- 1) A coating that, after a corrosion test, has hardly visible dulling of the surface over an area of 30 %: C1.
- 2) A coating that, after a corrosion test, has a layer of corrosion products covering an area of 3 % and corrosion products from the basis metal: F4/H.

9 Test report

The test report shall contain the following information:

- a) reference to this International Standard;
- b) the description of the coating system or product tested;
- c) the dimensions and shape of the test specimen, and the nature of the surface tested;
- d) coating thickness;
- e) preparation of the test specimens, including any cleaning treatment applied and any protection given to edges or other special areas;
- f) known characteristics of the coating, with an indication of the surface finish;
- g) the number of test specimens subjected to the test representing each coating or product;
- h) the method, if any, used to clean the specimen during or after test;
- i) the kind of corrosion test, including the relevant standard;
- j) the exposure period or duration and number of test cycles (for accelerated corrosion tests);
- k) the corrosion grade.

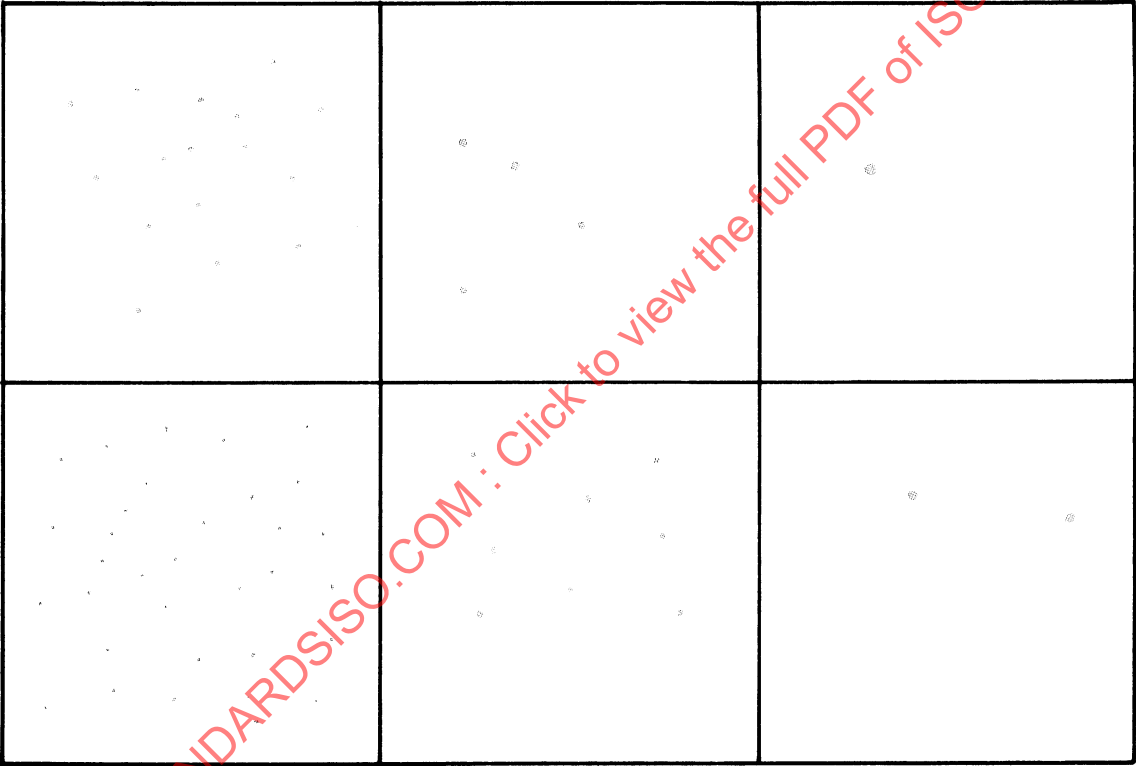
Annex A
(normative)

Dot charts

The standard dot charts show the maximum corrosion permissible for a given rating. Corrosion products from the coating and basis metal can overlap each other.

Rating 9

0,1 %



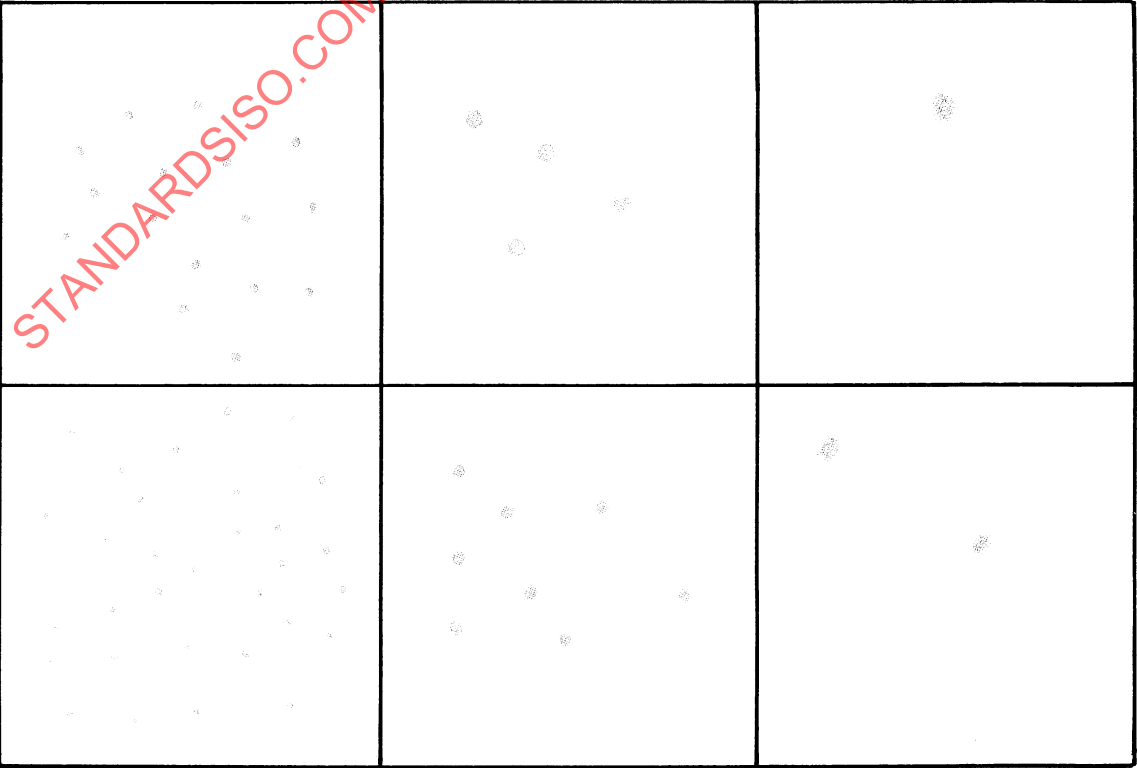
Rating 8

0,25 %



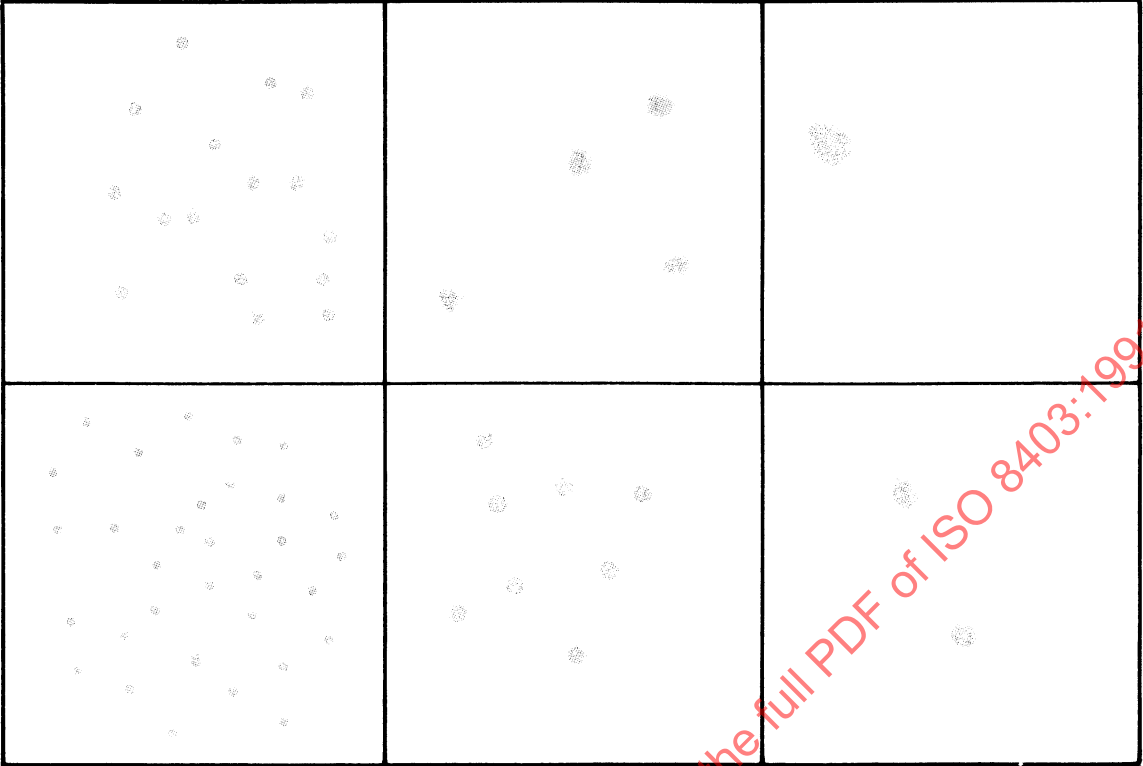
Rating 7

0,5 %



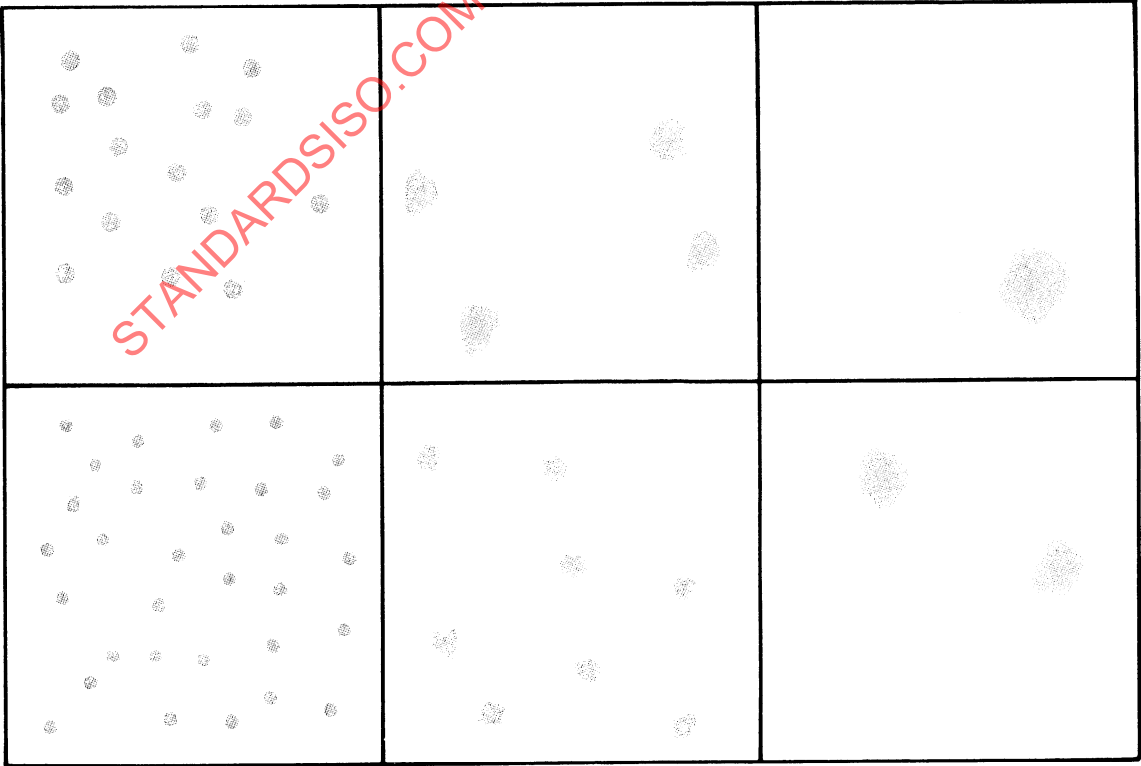
Rating 6

1 %



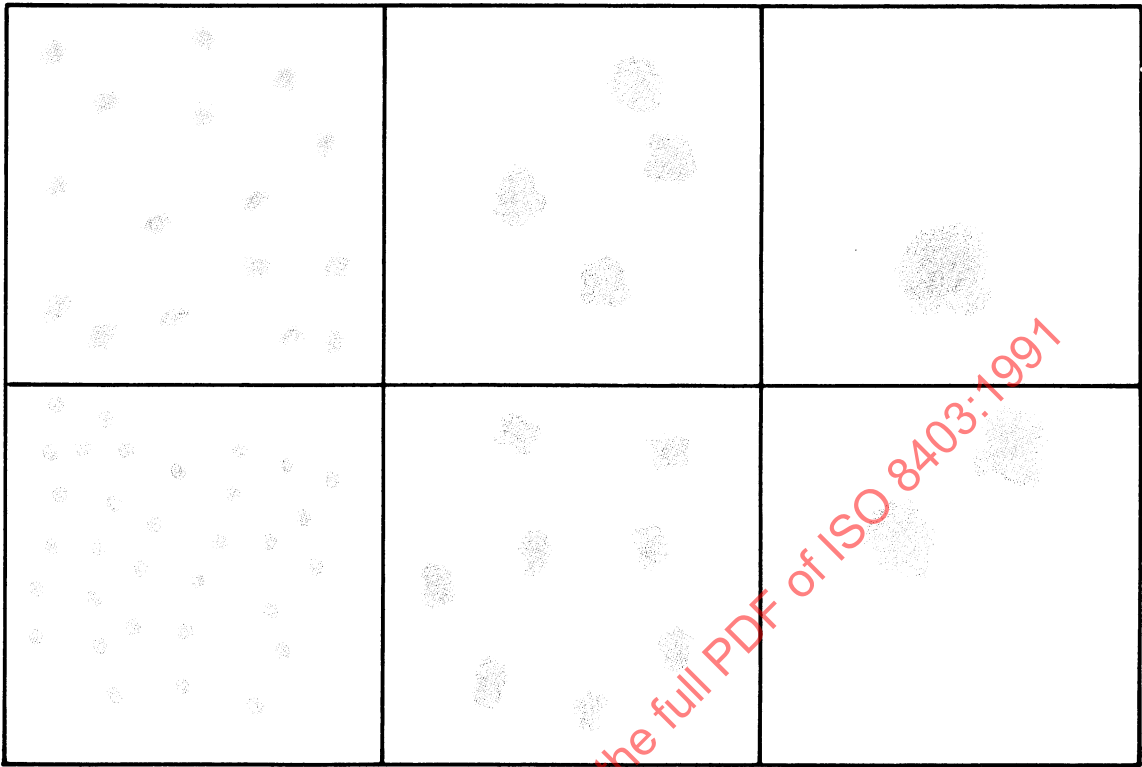
Rating 5

2,5 %



Rating 4

5 %



Rating 3

10 %

