

BS EN 1369:2012



BSI Standards Publication

# Founding — Magnetic particle testing

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**National foreword**

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The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Fonderie - Contrôle par magnétoscopie

Gießereiwesen - Magnetpulverprüfung

This European Standard was approved by CEN on 1 September 2012.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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## Foreword

This document (EN 1369:2012) has been prepared by Technical Committee CEN/TC 190 "Foundry technology", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1369:1996.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 11 "Surface inspection" to revise EN 1369:1996.

Annex F provides details of significant technical changes between this European Standard and the previous edition.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## **Introduction**

This European Standard complements the general principles of magnetic particle testing given in EN ISO 9934-1 for the additional requirements for castings.

Magnetic particle testing as well as any other non-destructive examination method is a part of a general or specific assessment of the quality of a casting to be agreed between the manufacturer and the purchaser at the time of acceptance of the order.

This European Standard also gives acceptance criteria through severity levels defined by the nature, the area and the dimensions of the discontinuities present.

## 1 Scope

This European Standard specifies a magnetic particle testing method for ferro-magnetic iron and steel castings.

NOTE An iron or steel casting is considered to be ferro-magnetic if the magnetic induction is greater than 1 T (Tesla) for a magnetic field strength of 2,4 kA/m.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2012)*

EN ISO 3059, *Non-destructive testing — Penetrant testing and magnetic particle testing — Viewing conditions (ISO 3059)*

EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles (ISO 9934-1)*

EN ISO 9934-2, *Non-destructive testing — Magnetic particle testing — Part 2: Detection media (ISO 9934-2)*

## 3 Conditions for magnetic particle testing

The manufacturing stage(s) when magnetic particle testing is to be performed shall be clearly defined by agreement between the manufacturer and the purchaser by the time of ordering.

The methods detailed in this standard shall only apply to the agreed surfaces of the castings and the percentage or number of castings to be checked.

The areas of the castings and the percentage of the castings to be inspected shall be indicated in the enquiry.

The sensitivity can differ depending on the method of magnetic particle testing selected.

The order shall specify at least:

- a) the method to be used (type of detection media);
- b) whether the casting is to be demagnetized after testing has been performed (viz. maximum residual field strength values).

And for each area of the casting to be inspected (see Clauses 5 and 6), the following shall be specified:

- c) the type of discontinuity;
- d) the severity level.

NOTE The type of discontinuity and the severity level can vary depending on the area of the casting inspected.

For the classification, depending on the shape of the indication of the discontinuities (see Annex B), reference shall be made to the severity levels defined in Tables 1 and 2 (see 6.1).

The conversion from the severity levels specified in EN 1369:1996 [1] Table 3 to severity levels in Table 2 of the present edition is given in Table A.1.

The indications resulting from a testing can be compared to the reference figures. The reference figures are included for convenience only. In the event of a dispute, reference shall be made to the tables.

## **4 Method of testing**

### **4.1 Operating mode**

The operating mode shall be as described in EN ISO 9934-1.

Detection media shall be in accordance with the requirements of EN ISO 9934-2.

Unless otherwise specified, it is necessary to carry out the testing with magnetizing sequentially in two directions perpendicular to each other (see EN ISO 9934-1), in order to ensure that each discontinuity runs against the flux in at least one direction. When the direction of stress is known, the testing may be performed in one direction only, in order to take into account the most detrimental discontinuity.

NOTE The magnetic images need not necessarily correspond to discontinuities as pseudo-defects can appear.

### **4.2 Qualification of the operators**

Unless otherwise agreed, the testing shall be performed by personnel, qualified in accordance with EN ISO 9712 or by a certification scheme which is considered to be equivalent.

### **4.3 Surface preparation**

The surface to be inspected shall be clean, free from rust, sand, scale, moulding and mould coating residues, oil, grease or any other contaminant which can interfere with a correct testing.

If sand blasting or shot blasting is required, it shall be as light as possible, in order to avoid sealing or closing up possible discontinuities.

The surface to be tested may be painted to provide a contrast before testing (see EN ISO 9934-1).

To detect the smallest indication to be considered, the surface finish shall be in accordance with Table 3, unless otherwise specified at the time of ordering.

It is recommended that the assessment of surface finish be carried out using a visual tactile surface roughness comparator rather than an instrumental method (see EN 1370 [2]).

### **4.4 Conditions of testing**

The testing shall be carried out with the naked eye or at a maximum magnification of three and viewing conditions in conformity with EN ISO 3059.

## **5 Acceptance criteria**

### **5.1 Indications of discontinuities**

The discontinuities that are usually seen on a casting are given in Annex B in the nomenclature (A, B, C, D, E, F, H or K). These discontinuities can give indications, magnetic diagrams and groups of indications on any given surface. These indications can all be of different types.



## 5.2 Definition of magnetic particle indications

### 5.2.1 General

The discontinuity indications revealed by the magnetic particle testing can have different shapes and sizes. The distinction between the discontinuity indications is made depending on the ratio of the length  $L$  of the indication to its width  $W$  in the manner described in 5.2.2 and 5.2.3.

### 5.2.2 Non-linear indications (SM)

The indications are considered to be non-linear when the length  $L$  is smaller than three times the width  $W$ .

The symbol for non-linear indications is SM (S for surface and M for magnetic particle).

### 5.2.3 Linear and aligned indications (LM and AM)

#### 5.2.3.1 Linear indications (LM)

The indications are considered to be linear when the length  $L$  is greater than or equal to 3  $W$ .

The symbol for linear indications is LM (L for linear and M for magnetic particle).

#### 5.2.3.2 Aligned indications (AM)

Indications are considered to be aligned in the following cases:

- non linear: the distance between indications is less than 2 mm and at least three indications are noted;
- linear: the distance between two indications is smaller than the length  $L$  of the longest discontinuity in the alignment.

An alignment of indications is considered to be a unique indication. Its length is equal to the overall length  $L$  of the alignment.

The overall length  $L$  is the developed distance between the starting point of the first discontinuity and the finishing point of the last discontinuity.

EXAMPLE  $L = l_1 + l_2 + l_3 + l_4 + l_5$  (see Figure 1).

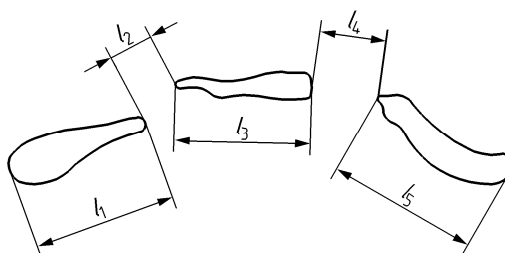


Figure 1 — Example for  $L$

The symbol for aligned indications is AM (A for aligned and M for magnetic particle).

### 5.3 Severity levels

#### 5.3.1 General

The severity levels are designed as a reference scale and are defined depending on the types of indications.

#### 5.3.2 Non-linear indications

For the non-linear indications, the severity levels (see Table 1) are defined by:

- the length (largest dimension)  $L_1$  of the smallest indication to be taken into account;
- if applicable, the maximum total surface area of the indications in a given surface (the frame 105 mm × 148 mm corresponds to the ISO format A6);
- the maximum length  $L_2$  of the indications.

#### 5.3.3 Linear and aligned indications

For the linear and aligned indications, the severity levels (see Table 2) are defined by:

- the length (largest dimension)  $L_1$  of the smallest indication to be taken into account;
- the maximum length  $L_2$ , isolated or cumulative, of the linear and aligned indications.

#### 5.3.4 Selection of the severity level

The severity levels shall be selected from Tables 1 and/or 2:

- Table 1 corresponds to non-linear indications (isolated) (SM);
- Table 2 corresponds to linear (LM) indications and aligned (AM) indications.

Reference figures corresponding to non-linear, aligned and clustered indications in accordance with Table 1 and Table 2 are represented in Annexes C and D for guidance only.

Table 1 and Table 2 are independent (different severity levels may be selected from these tables).

#### 5.3.5 Designation of severity levels

The requirements in the order or in the specifications shall conform to the terminology used in this European Standard.

Examples of correct terminology are given below.

EXAMPLE 1 non-linear indications: severity level 2 (abbreviation SM 2) (see 5.2.2).

EXAMPLE 2 linear and aligned indications: severity level 5 (abbreviation LM 5/AM 5) (see 5.2.3).

## 6 Classification of the indications and interpretation of results

### 6.1 Classification of the indications using Tables 1 and 2

#### 6.1.1 General

In order to classify a discontinuity indication, it is necessary to place a 105 mm × 148 mm frame in the most unfavourable location, i.e. showing the greatest severity for discontinuities.

#### 6.1.2 Non-linear indications

The length of these indications shall be measured.

Only those indications with a length greater than  $L_1$  shall be taken into account (see Table 1).

A maximum number of two indications of the designated maximum individual lengths are permitted (see Table 1).

The sum of the surface areas of these indications shall be calculated.

If the casting surface is smaller in area than the reference surface area, the surface of the indications should be proportionally reduced.

The severity level of the (SM) indications shall be established using Table 1.

#### 6.1.3 Linear and aligned indications

The length  $L$  of the isolated indications greater than the minimum length taken into account, defined by the required severity level, shall be measured. The sum of the lengths of the indications LM and AM included in the 105 mm × 148 mm frame shall be calculated.

The severity level of the LM and AM indications shall be established using Table 2.

The lengths of the linear and aligned indications greater than the minimum length shall be summated and the result shall be compared to the "cumulative" length specified in Table 2.

### 6.2 Classification of the indications using the reference figures

The severity levels SM 5 and AM 7/LM 7 correspond to the largest indications. The severity levels SM 001, AM 001 and LM 001 correspond to the smallest indications.

The reference figures equating to the non-linear as well as linear and aligned indications (see Tables 1 and 2) are shown in Annexes C and D.

An actual figure and a reference figure are equivalent when the same total surface of indications (non-linear) and/or the same length of linear or aligned indications of similar appearance have been detected.

NOTE 1 The maximum permissible discontinuities may appear simultaneously on the area of 105 mm × 148 mm.

NOTE 2 Non-linear as well as linear and aligned indications can appear simultaneously on the same part of the casting.

### 6.3 Interpretation of results

The casting shall be considered as conforming to this standard when the observed severity level is equal to or better than that specified in the order.

## 7 Cleaning after examination and demagnetization

Unless otherwise specified in the order, parts shall be cleaned after examination.

Demagnetization can be necessary for special applications, further processing and before carrying out retests.

After demagnetization, the use of magnets for handling the castings shall be avoided.

NOTE For further information see EN ISO 9934-1.

## 8 Test report

The test report shall be in accordance with EN ISO 9934-1. A model of a trilingual magnetic particle test report is shown in Annex E.

**Table 1 — Severity levels for magnetic particle testing — Non-linear indications isolated (SM)**

Characteristic		Severity levels						
		SM 001	SM 01	SM 1	SM 2	SM 3	SM 4	SM 5
Direct visual testing		Magnifying glass or eyes		Eyes				
Magnification for observation of magnetic particle indication		≤ 3		1				
Length $L_1$ of the smallest indication to be considered in mm		No indication allowed	0,3	1,5	2	3	5	5
Non-linear indications (SM)	Maximum total surface area allowed in mm <sup>2</sup>	—	—	10	35	70	200	500
	Maximum individual length $L_2$ allowed in mm	No indication allowed	1	2 <sup>a</sup>	4 <sup>a</sup>	6 <sup>a</sup>	10 <sup>a</sup>	16 <sup>a</sup>
See Annex C - Figure		—	—	C.1	C.2	C.3	C.4	C.5
NOTE 1 Only values expressed in this table are valid. Reference figures are for information only (see Annex C).								
NOTE 2 The sensitivity can differ depending on the method of magnetic particle testing selected.								
<sup>a</sup> A maximum number of two indications of the designated maximum individual lengths are permitted.								

**Table 2 — Severity levels for magnetic particle testing — Linear (LM) and aligned (AM) indications**

Characteristics	Severity levels															
	LM 001 AM 001	LM 01 AM 01	LM 1 AM 1	LM 2 AM 2	LM 3 AM 3	LM 4 AM 4	LM 5 AM 5	LM 6 AM 6	LM 7 AM 7							
Direct visual testing	Magnifying glass or eyes		Eyes													
Magnification for observation of magnetic particle indication	≤ 3		1													
Length $L_1$ of smallest indication to be considered (mm)	No indication allowed	0,3	1,5	2	3	5	5	5	5							
Arrangement of indications <sup>a</sup> , isolated (I) or cumulative (C)	I or C		I	C	I	C	I	C	I	C	I	C	I	C		
Maximum length $L_2$ of linear (LM) and aligned (AM) indication allowed (mm)	No indication allowed	1	2	4	4	6	6	10	10	18	18	25	25	45	45	70
See Annex D - Figure	—		D.1		D.2		D.3		D.4		D.5		D.6		D.7	
NOTE 1	Only values expressed in this table are valid. Reference figures are for information only (see Annex D).															
NOTE 2	The sensitivity can differ, depending on the method of magnetic particle testing selected.															
<sup>a</sup>	The linear and aligned indications shall be taken into consideration for the calculation of the cumulative length.															

**Table 3 — Recommended surface finish for magnetic particle testing**

Dimension of smallest indication mm	Visual tactile comparators <sup>a</sup>	
	BNIF [3]	SCRATA [4]
0,3	2/0S2	—
0,3	3/0S1 - 2/0S1 1/0S2	—
0,3	2/0S1 - 1/0S1 1 S2 - 2 S2	—
1,5	1 S1 - 2 S1 3 S2 - 4 S2	A 1 – A 2 —
2	2 S1 - 3 S1 4 S2 - 5 S2	A 2 – A 3 H 1 – H 2
3	unspecified (rough surface)	A 3 – A 4 H 3 – H 4 – H 5
<sup>a</sup> See EN 1370 [2].		

## Annex A (normative)

### Conversion of severity levels of linear (LM) and aligned (AM) indications

The Table A.1 gives the conversion from the severity levels specified in EN 1369:1996, Table 3 to severity levels in Table 2 of the present edition.

This Table A.1 only applies to drawings and specifications based on EN 1369:1996.

This Table A.1 is prepared as a tool for adaptation of specifications and/or drawings based on EN 1369:1996.

**Table A.1 — Conversion between the severity levels**

Severity levels of the present edition	Severity levels of EN 1369:1996		
	Section thickness type a $t \leq 16 \text{ mm}$	Section thickness type b $16 \text{ mm} < t \leq 50 \text{ mm}$	Section thickness type c $t > 50 \text{ mm}$
LM 001 AM 001	LM 001 AM 001	LM 001 AM 001	LM 001 AM 001
LM 01 AM 01	LM 01 AM 01	LM 01 AM 01	LM 01 AM 01
LM 1 AM 1	LM 1 AM 1	—	—
LM 2 AM 2	LM 2 AM 2	LM 1 AM 1	—
LM 3 AM 3	LM 3 AM 3	LM 2 AM 2	LM 1 AM 1
LM 4 AM 4	LM 4 AM 4	LM 3 AM 3	LM 2 AM 2
LM 5 AM 5	LM 5 AM 5	LM 4 AM 4	LM 3 AM 3
LM 6 AM 6	—	LM 5 AM 5	LM 4 AM 4
LM 7 AM 7	—	—	LM 5 AM 5
NOTE $t$ indicates the section thickness.			

## Annex B (Informative)

### Nature of discontinuities and types of corresponding magnetic particle indications

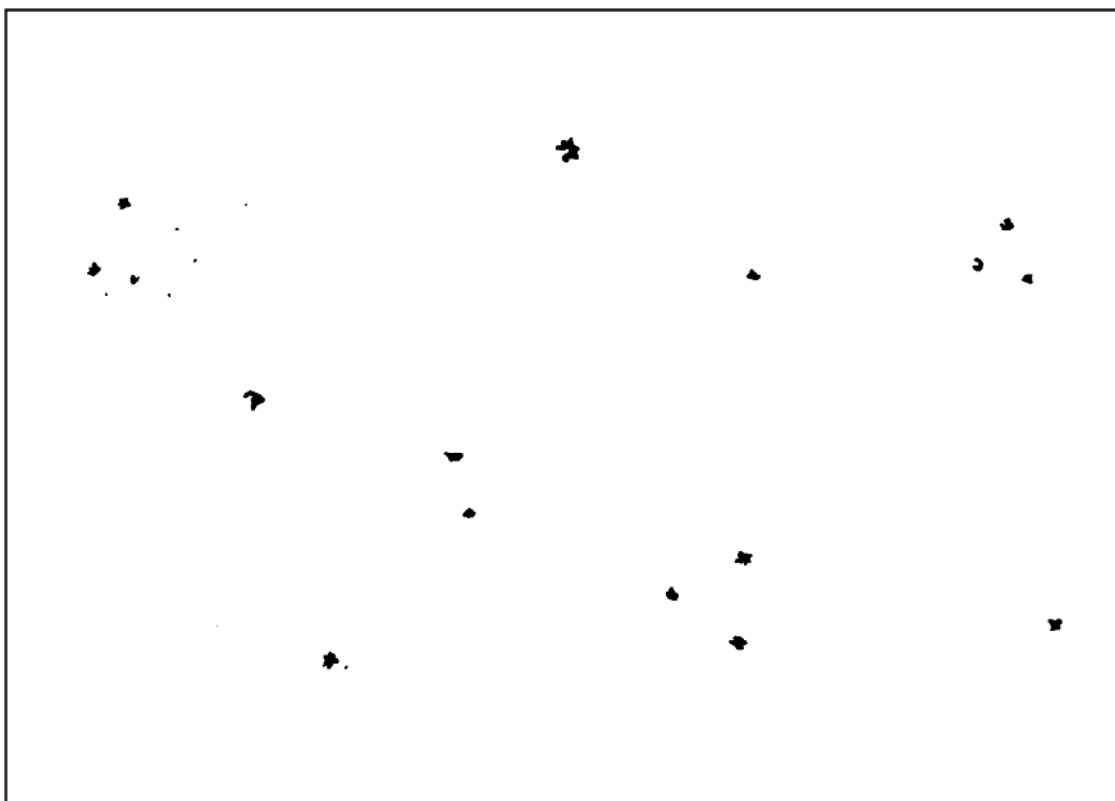
**Table B.1 — Nature of discontinuities and types of corresponding magnetic particle indications**

Nature of discontinuities	Nomenclature	Types of magnetic particle indications		
		non-linear SM	linear LM	aligned AM
Gas porosity	A	X	—	X
Sand and slag inclusions	B	X	—	X
Shrinkage	C	X	X	X
Cracks	D	—	X	X
Hot tears	E	—	X	X
Inserts	F	—	X	X
Laps and cold shuts	H	—	X	X
Graphite flotation <sup>a</sup>	K	no image, but "background" indications		
<sup>a</sup> For cast iron only.				

## **Annex C** (informative)

### **Reference figures — Non-linear indications designated SM**

All reference figures shown in this annex are for guidance only and should be used at a scale of 1:1.



**Figure C.1 — Severity level SM 1**



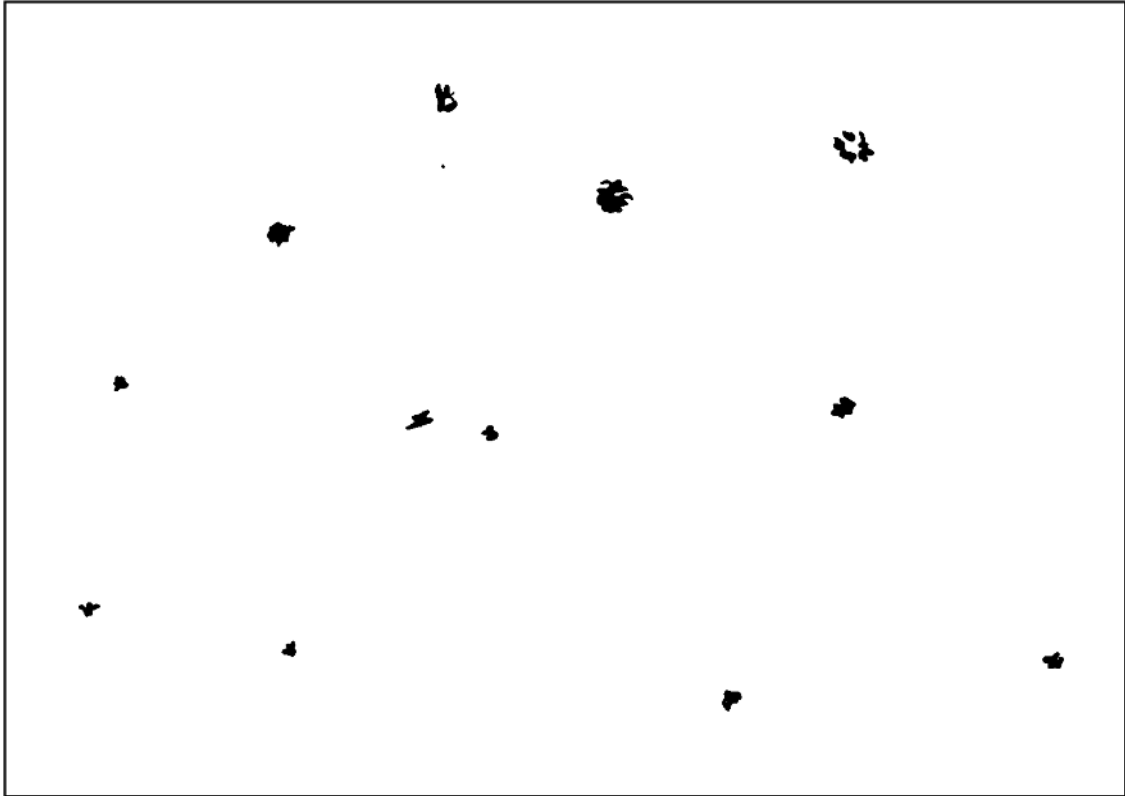


Figure C.2 — Severity level SM 2

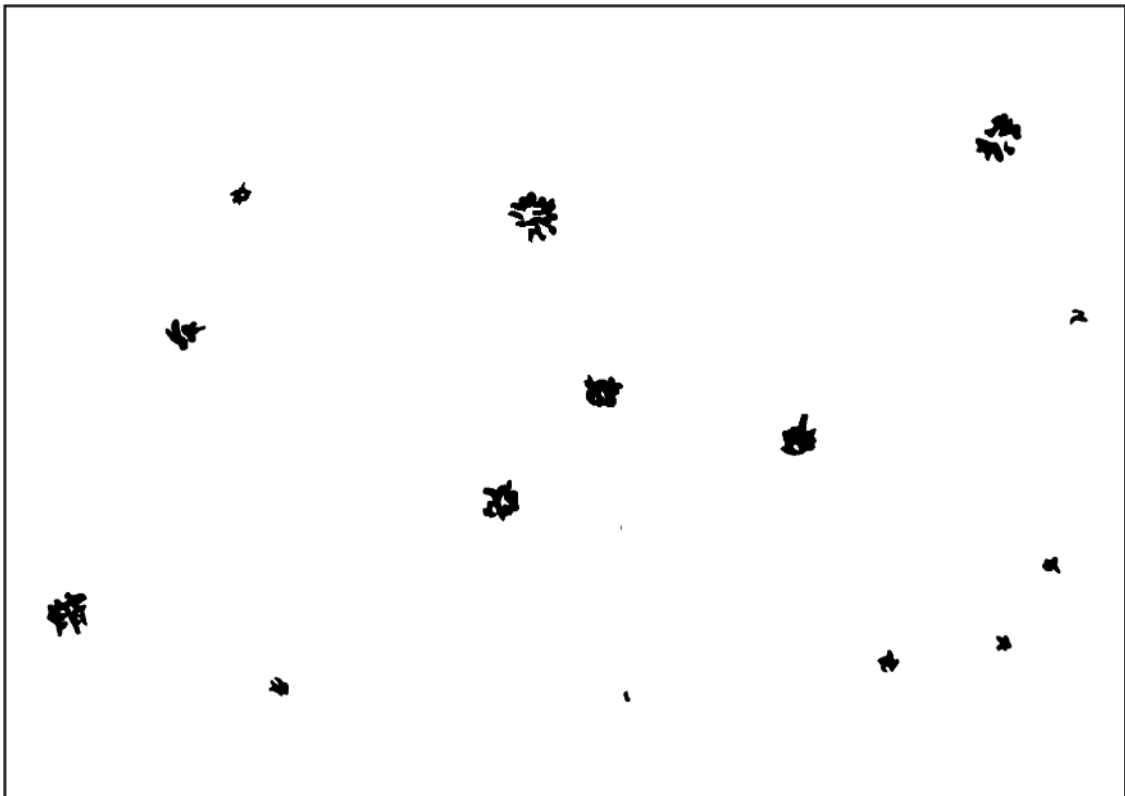


Figure C.3 — Severity level SM 3

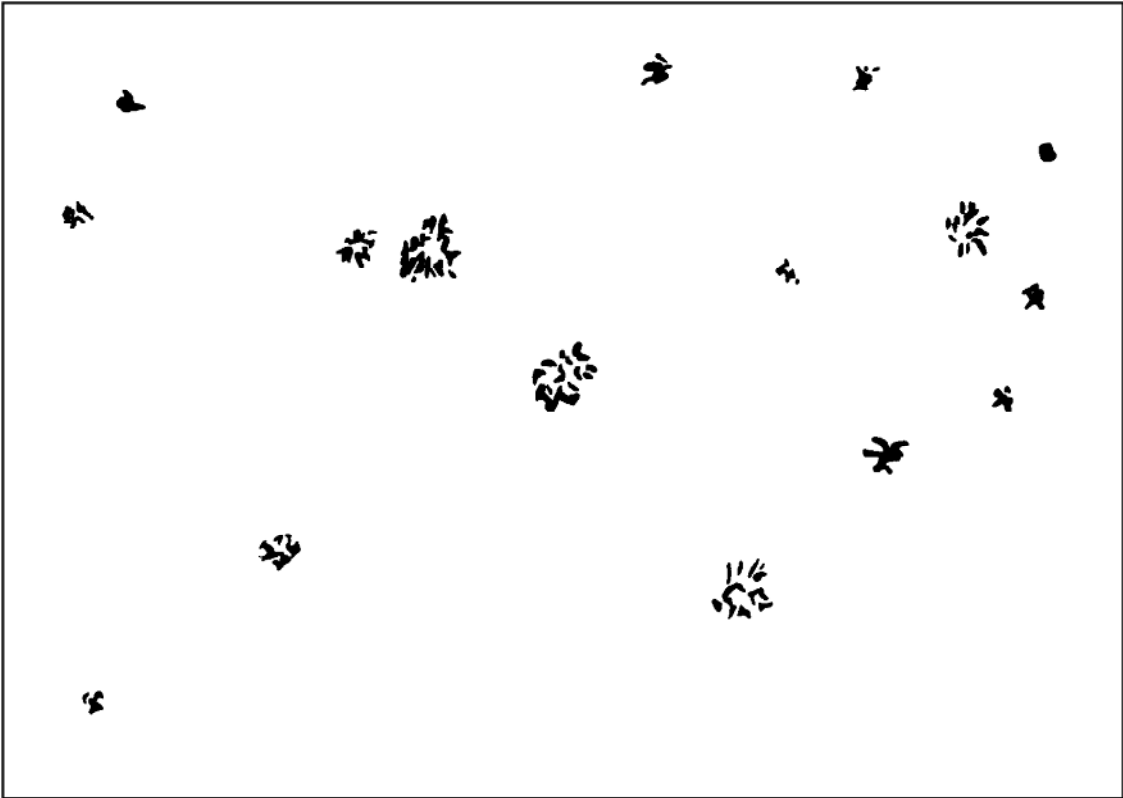


Figure C.4 — Severity level SM 4

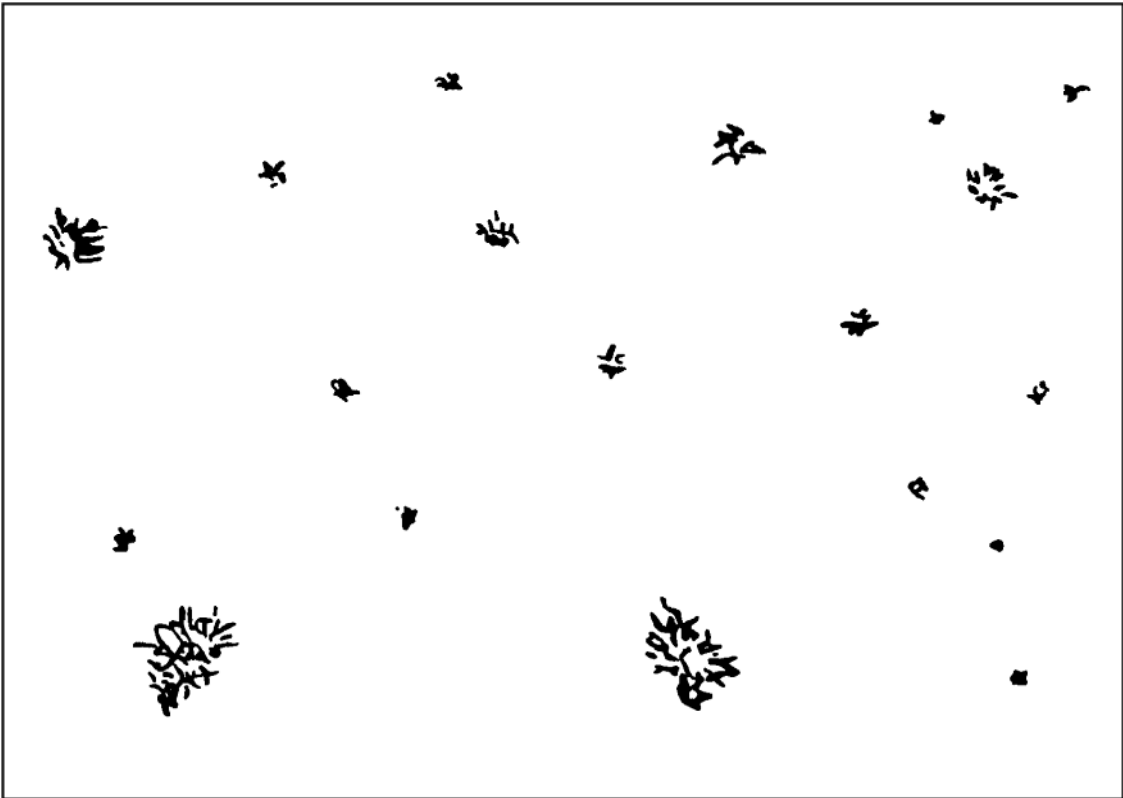
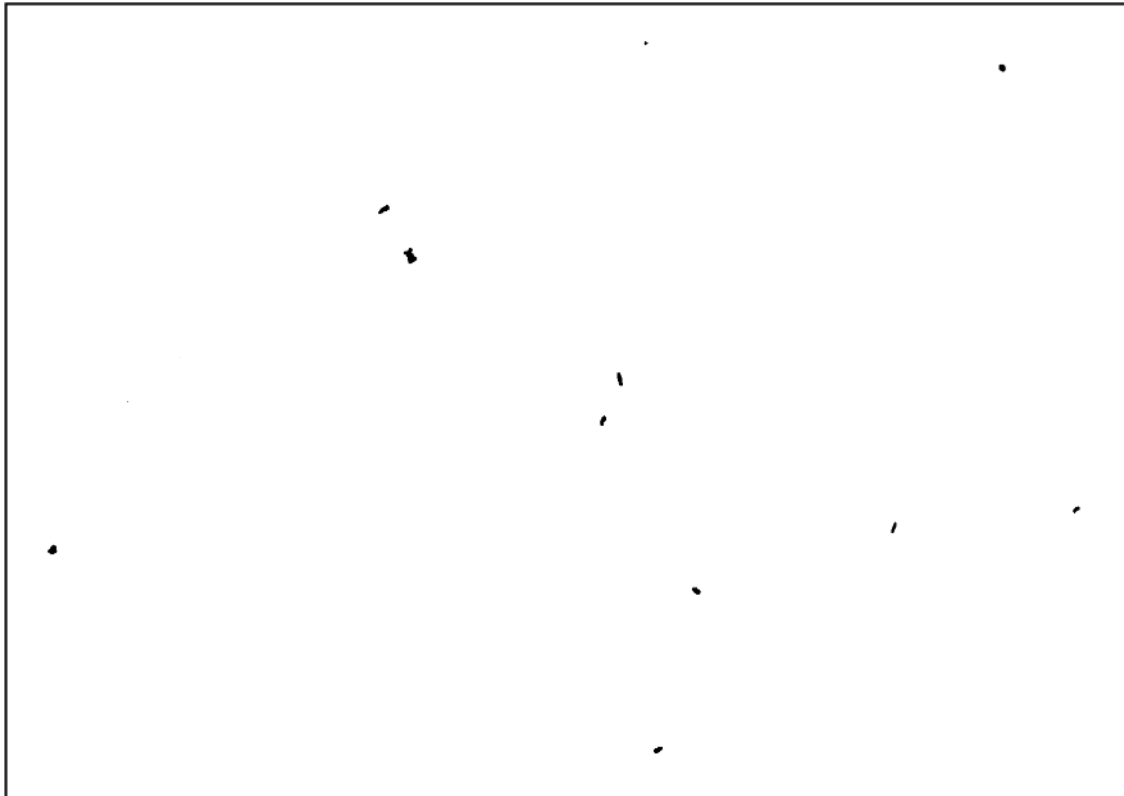


Figure C.5 — Severity level SM 5

## **Annex D** (informative)

### **Reference figures — Linear and aligned indications designated LM and AM**

All reference figures shown in this annex are for guidance only and should be used at a scale of 1:1.



**Figure D.1 — Severity level LM 1 - AM 1**

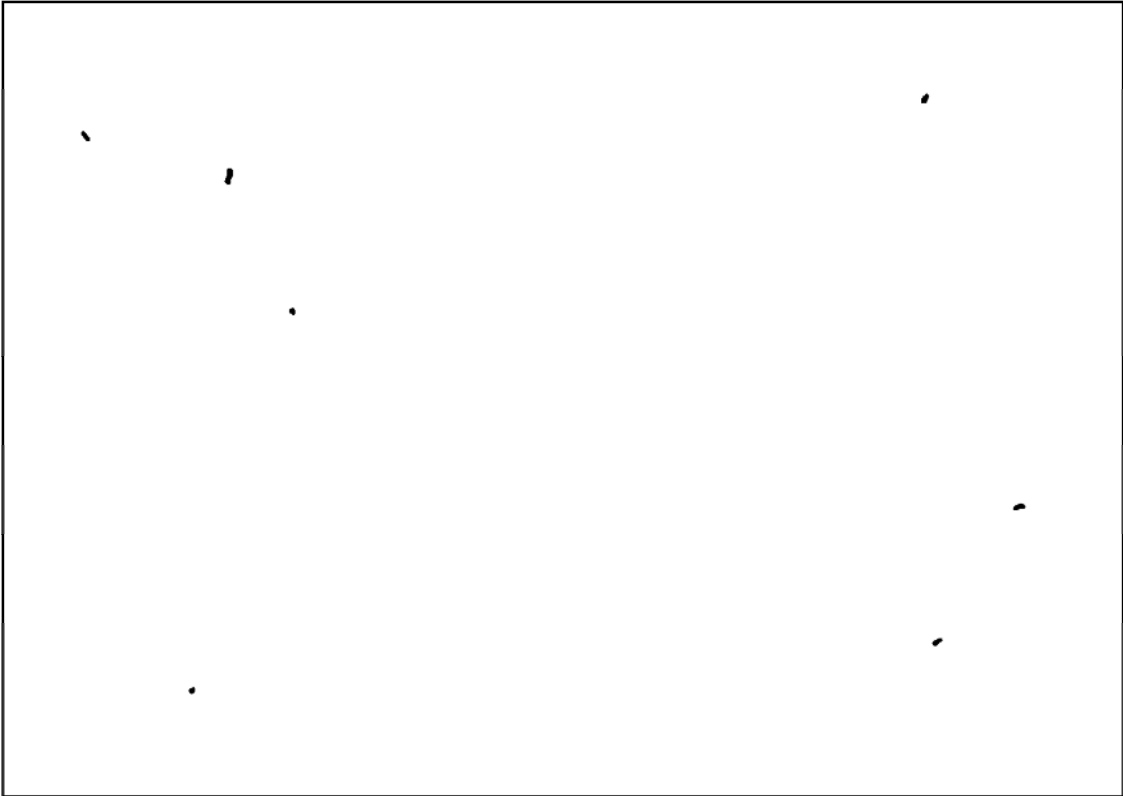


Figure D.2 — Severity level LM 2 - AM 2

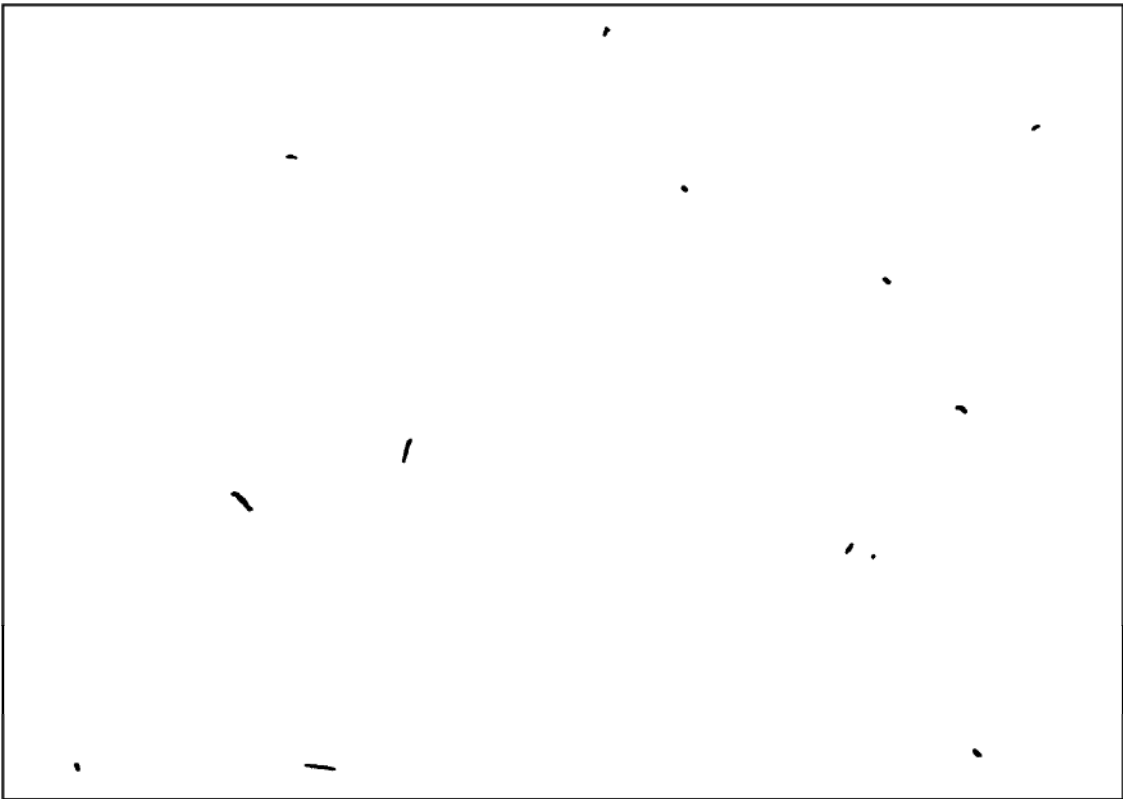


Figure D.3 — Severity level LM 3 - AM 3



Figure D.4 — Severity level LM 4 - AM 4

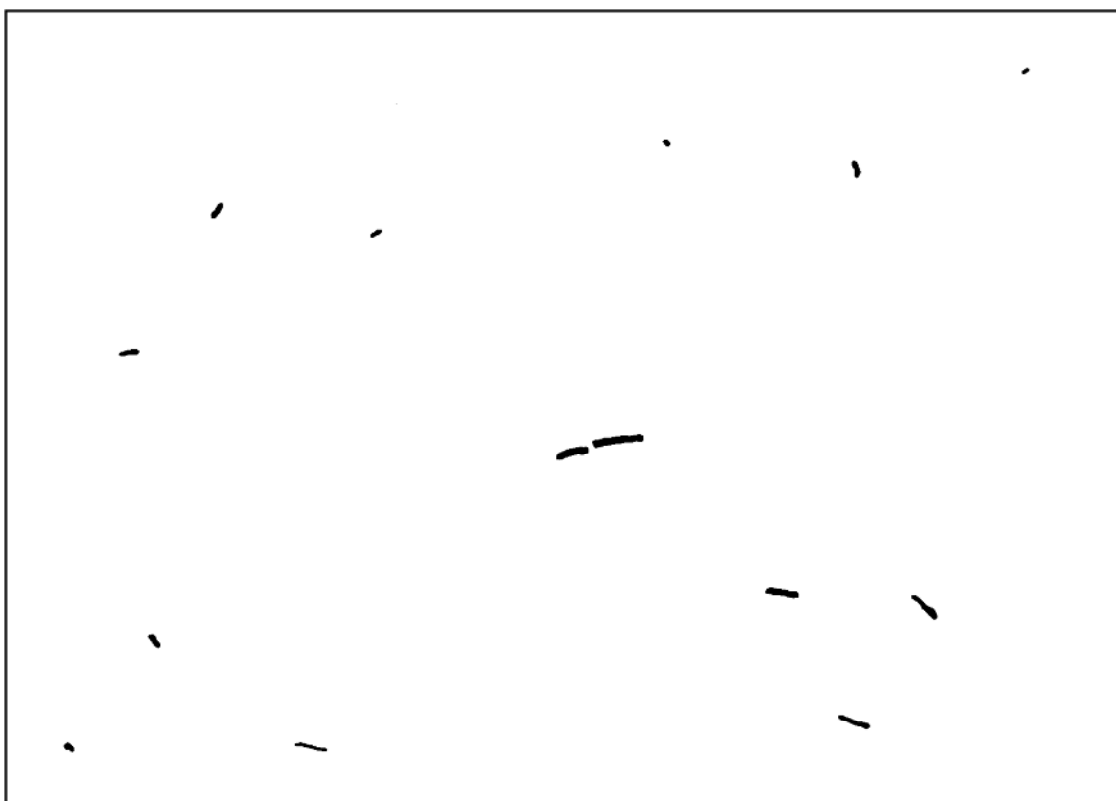


Figure D.5 — Severity level LM 5 - AM 5

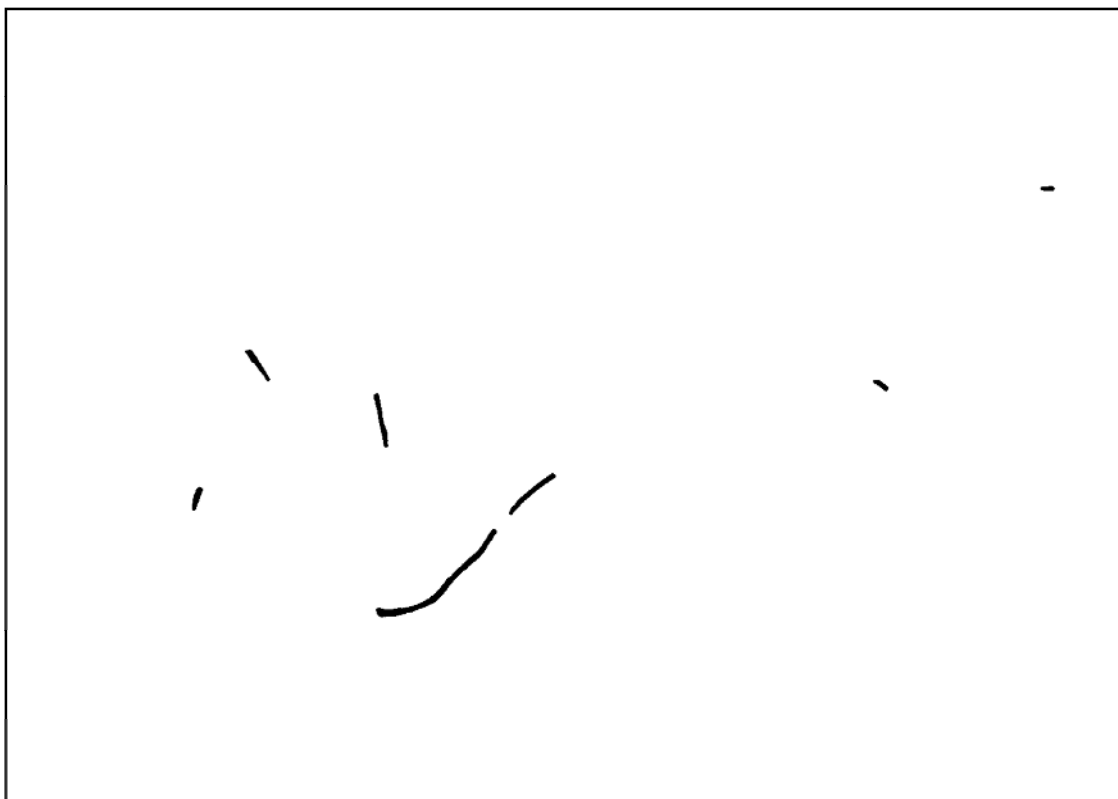


Figure D.6 — Severity level LM 6 - AM 6

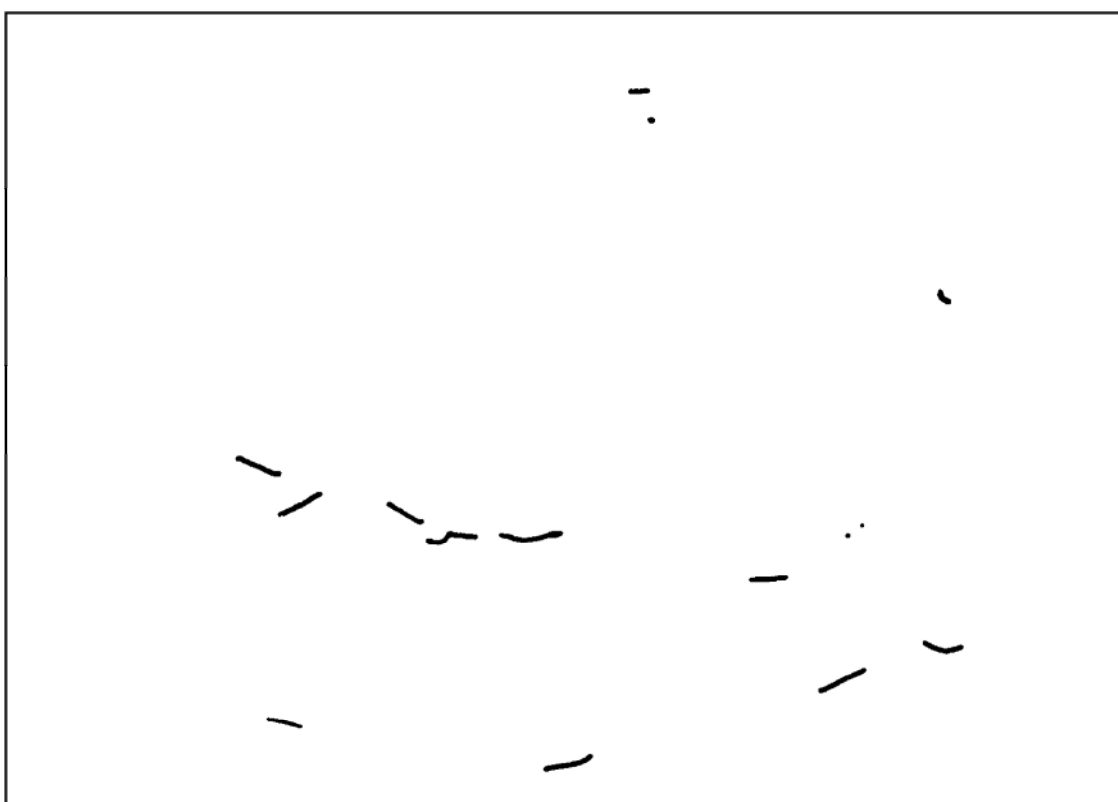


Figure D.7 — Severity level LM 7 - AM 7

## Annex E (informative)

## Model of a magnetic particle test report

Company	Magnetic particle test report		No.	
Société	Contrôle par magnétoscopie - Rapport d'essais		N°	
Firma	Prüfbericht zur Magnetpulverprüfung		Nr.	
			Sheet	
			Page	
			Blatt	
			According to	
			Conforme à	
			Entsprechend	
Customer		Order No.		
Client		Commande n°		
Kunde		Bestell-Nr.		
Specification		Material	Heat No.	
Spécification		Nuance	Coulée n°	
Vorschrift		Werkstoff	Schmelze Nr.	
Identification	Quantity	Casting designation	Lot No.	Drawing No.
Marquage	Quantité	Désignation des pièces	n° du lot	Plan n°
Kennzeichnung	Menge	Gussstückbezeichnung	Los Nr.	Zeichnung Nr.
Area examined - Zone contrôlée - Prüfbereich				
<input type="checkbox"/> 100 %				
<input type="checkbox"/> testing scheme - plan de contrôle - Prüfplan				
<input type="checkbox"/> cavity root - fonds affouillements - Ausmuldung für Schweißung				
Stage - Stade - Zustand				
<input type="checkbox"/> after heat treatment - après traitement thermique - nach Wärmebehandlung				
<input type="checkbox"/> before stress relieving - avant détensionnement - vor Spannungsarmglühen				
Testing conditions - Conditions d'examen - Prüfbedingungen				
Apparatus - Appareil - Gerät				
.....				
Magnetic particle reference - Référence du produit indicateur - Prüfmittelbezeichnung				
.....				
Surface condition - Etat de surface - Oberflächenzustand				
<input type="checkbox"/> shot-blasted - grenailté - gestrahlt				
<input type="checkbox"/> ground - meulé - geschliffen				
<input type="checkbox"/> machined - usiné - mechanisch bearbeitet				
(continued)				

**Model of a magnetic particle test report (concluded)**

Casting temperature - Température de la pièce moulée - Gussstücktemperatur
<input type="checkbox"/> 0 °C up to/jusqu'à/bis 15 °C
<input type="checkbox"/> 16 °C up to/jusqu'à/bis 60 °C
<input type="checkbox"/> 61 °C up to/jusqu'à/bis 320 °C
<input type="checkbox"/> ..... °C
Magnetization method - Type d'aimantation - Magnetisierungsart
.....
Testing material - Produit indicateur - Prüfmittel
<input type="checkbox"/> dry - sec - trocken
<input type="checkbox"/> wet - humide - nass
<input type="checkbox"/> fluorescent - fluorescent - fluoreszierend
Rod spacing - Distance entre touches - Elektrodenabstand ..... mm
Magnetizing current - Courant d'aimantation - Magnetisierungsstrom ..... A
Type of current - Type de courant - Stromart
<input type="checkbox"/> alternating - alternatif - Wechselstrom
<input type="checkbox"/> direct - continu - Gleichstrom
<input type="checkbox"/> pulsatory - pulsé - pulsierend
Tangential field strength - Valeur du champ tangentiel - Tangentialfeldstärke ..... A/mm
Field indicator - Témoin d'aimantation - Feldanzeiger .....
Testing results - Résultats de l'examen - Prüfergebnisse
According to - Conforme à - Entsprechend
.....
.....
Accepted - Accepté - abgenommen
<input type="checkbox"/> yes - oui – ja
<input type="checkbox"/> no - non – nein
Non-conformance note - Fiche d'anomalie - Beanstandung
.....
.....
<input type="checkbox"/> yes - oui - ja
<input type="checkbox"/> no - non - nein
testing authority - Organisme de contrôle - Abnahmegesellschaft
.....
Quality assurance section - Service assurance qualité - Abteilung Qualitätssicherung
.....
Date/place - Date/lieu - Datum/Ort
.....
Signature of inspector/operator - Signature de l'inspecteur/l'opérateur - Unterschrift des Leiters der Prüfstelle/Prüfers
.....

If applicable, tick the relevant box.  
Suivant le cas, cocher la case correspondante.  
Falls zutreffend, Entsprechendes ankreuzen.



## Annex F (informative)

### Significant technical changes between this European Standard and the previous edition of EN 1369

**Table F.1 — Significant technical changes between this European Standard and the previous edition of EN 1369**

Clause/Paragraph/Table/Figure	Changes
3; 4.2; 4.3	Clarification and simplification
8	Simplification. "Inspection documents" renamed as "Test report"
Table 1	Was Table 2
Table 2	Was Table 3 with modifications (two new severity levels added)
Table 3	Was Table 5
Annex A	New Annex giving the conversion from the severity levels specified in EN 1369:1996, Table 3 to severity levels given in Table 2 of the present edition
Annex B	Was Table 1
<b>NOTE</b> The technical changes referred to include the significant technical changes from the EN revised but is not an exhaustive list of all modifications from the previous version.	

## Bibliography

- [1] EN 1369:1996, *Founding — Magnetic particle inspection*
- [2] EN 1370, *Founding — Examination of surface condition*
- [3] "BNIF 359 Recommandation Technique du Bureau de Normalisation des Industries de la Fonderie. "Caractérisation d'états de surface des pièces moulées - Utilisation des échantillons types de 110 × 160 mm", available from Editions Techniques des Industries de la Fonderie, B.P. 78, F-92312 Sèvres Cedex, France.<sup>1)</sup>
- [4] "SCRATA comparators for the definition of surface quality of steel castings", available from Steel Castings Technology International, Advanced Manufacturing Park, Brunel Way, Rotherham, S60 5WG, South Yorkshire, United Kingdom.

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1) "BNIF 359 Technical Recommendation issued by Bureau de Normalisation des Industries de la Fonderie - Characterization of surface condition of castings - Use of 110 x 160 mm standard specimens"

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