BS 7371-7:2010

BSI Standards Publication

Coatings on metal fasteners

Part 7: Specification for mechanically applied zinc and zinc based coatings

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Publishing and copyright information

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Contents

Summary of pages
This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 14, an inside back cover and a back cover.

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Foreword

Publishing information

This part of BS 7371 is published by BSI and came into effect on 30 April 2010.

It was prepared by Subcommittee FME/9/1, *Mechanical properties of fasteners*, under the authority of Technical Committee FME/9, *Fasteners*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 7371 supersedes BS 7371-7:1994, which is withdrawn.

Relationship with other publications

Other published Parts of BS 7371 are as follows.

- BS 7371-1, *Specification for general requirements and selection guidelines*[1)].
- BS 7371-2, *Specification for torque/clamping force relationship.*
- BS 7371-3, *Specifications for electroplated zinc coatings.*
- BS 7371-4, *Specification for electroplated nickel, nickel/chromium and* copper/nick*el/chromium coatings.*
- BS 7371-6, *Specification for hot dipped galvanized coatings.*
- BS 7371-8, *Specification for sheradized coatings.*
- BS 7371-9, *Specification for phosphate or phosphate and oil coatings.*
- BS 7371-10, *Specification for organic coatings.*
- BS 7371-11, *Specification for zinc flake non-electrolytically applied cured coatings.*
- BS 7371-12, *Requirements for imperial fasteners.*

Information about this document

This is a full revision of the standard, and introduces the following principal changes.

- Change to Figure B.1.
- Inclusion of hexavalent-chromium-free-type conversion coatings.
- Inclusion of higher thicknesses of coatings.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

1) This is supplementary to all other parts of BS 7371.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Attention is drawn to the restriction placed on the use and supply of hexavalent chromium containing substances by ECC Directive 2000/53/EC of 18th September 2000 on End of Life Vehicles [1] and the amendment of Annex II by Commission Decision of 27th June 2002 (Document No. C(2002) 2238) [2], which prohibits its use on Motor Vehicles less than 3.5 tonnes, marketed after July 2007.

The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) [3] also has similar restrictions which came into force on 31st December 2006.

Introduction

BS 7371 deals with the performance and selection of coatings on metal fasteners and accessories. This part of BS 7371 specifies the requirements for mechanically applied zinc and zinc based coatings.

Mechanically applied zinc and zinc based coatings covered by this part of BS 7371 are for use on fasteners and accessories where the following apply.

a) A coating giving galvanic protection is required for ferrous fasteners.

b) A base treatment is required to improve the corrosion resistance of subsequent coatings on ferrous fasteners, e.g. organic (see BS 7371-10).

c) Avoidance of the risk of hydrogen embrittlement of high tensile steel fasteners is required (see Note to **4.1**).

The coating has a matt silver appearance which can be modified to yellow, olive green or black by a hexavalent chromium conversion (passivation) treatment or an iridescent/silver appearance by a tri-valent or chromium-free treatment applied to improve corrosion resistance. The latter finishes are often supplied with a seal coat to improve damage resistance, corrosion or lubricity.

Additional coatings are available to further modify colour, but these might influence coating performance, e.g. lubricity or electrical conductivity.

Mechanical coating can only be applied by bulk processing.

The shape and size of certain parts may create difficulties in the application of a coating of uniform thickness and reference to the coater is recommended to enquire if a difficulty exists or if it can be overcome by the use of specialized processing methods.

Typically, difficulties arise when bulk processing:

a) parts longer than 150 mm and heavier than 0.5 kg;

b) parts liable to sustain damage when tumbled together;

c) parts with recesses which retain the compacting media (example media: glass beads);

d) parts with shapes that induce nesting and interlocking;

e) the internal surfaces of hollow parts.

1 Scope

This part of BS 7371 specifies requirements for coatings applied by mechanically impacting zinc powder, or zinc based powder on to the component surface in an aqueous medium. The coating is not applied by using impact media accelerated by compressed air or centrifuge methods. The coatings consist principally of zinc and can be lubricated to give controlled torque/clamping force properties when required.

NOTE 1 See, for example, BS 7371-2.

In addition to the requirements in this part of BS 7371, the requirements in BS 7371-1 which are applicable to mechanically applied zinc based coatings apply.

This part of BS 7371 also specifies requirements for:

a) the coating thickness;

b) the type of conversion treatment to be applied, which can be hexavalent, tri-valent or chromium free;

c) the quality assessment of the corrosion resistance of unused coated parts when subjected to neutral salt spray testing;

NOTE 2 See, for example, BS EN ISO 9227.

d) the adhesion test.

The coatings are suitable for application to metal components such as:

1) parallel threaded fasteners and accessories;

2) screws that cut or form their own threads, e.g. self-tapping screws;

NOTE 3 See, for example, BS 4174.

3) woodscrews;

NOTE 4 See, for example, BS 1210.

4) springs and spring components;

5) pipe nuts and connectors with parallel or tapered threads;

6) composite fasteners incorporating non-conducting materials (e.g. rubber-bonded assembly).

When these coatings are applied to non-ferrous fasteners, the only part of the specification that applies is the coating thickness requirements.

Annexes include tables indicating suitable coating grades for standard screw threads and methods of determination of coating thickness.

2 Normative references

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

BS 5411-2, *Methods of test for metallic and related coatings – Part 2: Review of methods of measurement of thickness*

BS 5411-4, *Methods of test for metallic and related coatings – Part 4: Coulometric method for the measurement of coating thickness*

BS 5411-5, *Methods of test for metallic and related coatings – Part 5: Measurement of local thickness of metal and oxide coatings by the microscopical examination of cross-sections*

BS 5411-8, *Methods of test for metallic and related coatings – Part 8: Measurement of coating thickness of metallic coatings: X-ray spectrometric methods*

BS 5411-10, *Methods of test for metallic and related coatings – Part 10: Review of methods available for testing adhesion of electrodeposited and chemically deposited metallic coatings on metallic substrates*

BS 7371-1:2009, *Coatings on metal fasteners – Part 1: Specification for general requirements and selection guidelines*

BS 7371-2, *Coatings on metal fasteners – Part 2*: *Specification for torque/clamping force relationship*

BS EN ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests*

3 Terms and definitions

For the purposes of this part of BS 7371, the terms and definitions given in BS 7371-1 apply.

4 Application and type of coating

4.1 Cleaning and pretreatment

Parts, fasteners and accessories shall be cleaned and pretreated in accordance with BS 7371-1.

NOTE Restrictions applicable to the avoidance of embrittlement of high tensile parts should be observed. It is recommended that high tensile parts should not be used until a minimum of 36 h (preferably 48 h) have elapsed after mechanical processing.

4.2 Type of coating

The coating shall be either matt silver in appearance or modified by passivation types C, D or Bk (see Clause **6**); for conversion treatments, see Table 1 and Table 2.

NOTE 1 The colour can be further modified by the addition of an organic top coat.

The coating shall be electrically conductive and galvanically protective to steel under most climatic conditions.

NOTE 2 The presence of passivate conversion treatments, particularly the coloured ones, decreases electrical conductivity at the surface.

Where specified by the purchaser, the lubricity of the coating shall be modified by the addition of a lubricant (see Clause **8**, item e)] and the torque/clamping force performance of a coated fastener shall conform to BS 7371-2.

NOTE 3 The addition of an organic coating might affect dimensions, lubricity and electrical conductivity.

4.3 Application of coating

The coating shall be applied by compacting zinc powder particles on to correctly prepared metallic substrates in a rotating barrel in the presence of impact media (normally glass beads) and in a suitable chemical solution, without the use of an electric current or applied heat.

Table 1 **Designation of passivation (chromate) treatments**

Designation	Type	Typical appearance	Corrosion protection
A	Clear	Transparent clear, sometimes with a bluish tinge	Slight, for example against staining during handling or against high humidity in mildly corrosive conditions
B	Bleached	Transparent with slight iridescence	
Bk	Black	Black with slight iridescence	
C	Iridescent	Yellow iridescent	Considerable, including protection against certain organic vapours
D	Opaque	Olive green, shading to brown or bronze	

NOTE Parts of this table are modified from of BS 6338:1982, Table 1.

Table 2 **Designation of tri-valent based treatments**

Designation	Type	Typical appearance	Corrosion protection
V	Clear	Transparent clear, sometimes with a bluish tinge	Slight
W	Heavy	Transparent with pale coloured iridescence	Good
SL	Sealant with lubrication	Colourless to slight iridescence	Considerable

NOTE Type V and Type W coatings can be blacked by using a subsequent top coat (see BS 7371-10).

5 Coating

5.1 Surface condition

The coating shall be clean, dry and of uniform appearance. All surfaces of a component shall be coated unless otherwise agreed. The coating shall be free from blisters or loosely adhering material.

5.2 Coating thickness

The specified coating thickness [see Clause **8**, item b)] shall be applied using the relationships between nominal, local and batch average thicknesses shown in Table 3. Coating thicknesses for threaded parts shall conform to Annex A. The coating thicknesses shall be measured by the methods described in Annex B.

If a coating thickness other than those given in Table 3 is required, this shall be agreed between the purchaser and the supplier:

Local thickness shall be measured on a significant surface (see Figure B.1 for the measuring areas).

Exceeding the maximum batch average thickness shall not be a cause for rejection if the coated thread is still accepted by an appropriate "GO" gauge, 4h for external threads and 4H for internal threads.

Table 3 **Nominal coating thicknesses**
Measurements in micrometres (µm)

Nominal coating thickness [A)]	Effective coating thickness		
	Minimum local thickness	Batch average thickness	
		min.	max.
5	5	4	6
8	8	7	10
10	10	9	12
12	12	11	15
15	15	14	18
20	20	18	23
25	25	23	28
30	30	27	35
45	43	40	50
55	53	50	62

NOTE 1 BS 7371-1 covers a range of thicknesses up to and including 12 µm. Greater thicknesses are given here as these may be ordered by the purchaser on agreement with the supplier.

NOTE 2 Thicknesses above 40 µm are often referred to as mechanical galvanizing.

[A)] See Annex A.

5.3 Corrosion resistance

For coating thicknesses up to 12 µm, unless otherwise agreed, representative samples from a batch shall be selected in accordance with BS 7371-1 and shall be tested for resistance to neutral salt spray in accordance with BS EN ISO 9227.

For thicknesses above 12 µm, the neutral salt spray test shall only be used if specifically required by the customer. The thickness shall be used for control and referee purposes.

Coatings shall be graded by their corrosion resistance as given in Table 4. Tri-valent chromium or chromium-free coating shall perform as required in Table 4, or be subject to agreement between supplier and customer.

Surfaces which are not significant shall resist neutral salt spray for 50% of the time given in Table 4.

Tests shall not be carried out within 24 h of the coating being applied.

NOTE For routine quality control purposes, evaluation of coating mass or thickness may be used (after the ability of the coating to conform to the corrosion test is established) but for referee purposes the corrosion resistance requirements still apply for coatings up to 12 µm.

5.4 Adhesion

When tested in accordance with BS 5411-10, the metallic coating shall continue to adhere to the basic metal.

Table 4 **Coating designation and corrosion resistance**

Designation [A]	**Nominal coating thickness** µm	**Passivation treatment designation** [B]**; hexavalent chromium containing**	**First appearance of white corrosion product** h	**First appearance of rust** h
Zn 5AM	5	A	—	24
Zn 5BM	5	B	—	24
Zn 5CM	5	C	24	48
Zn 5DM	5	D	48	72
Zn 5BkM	5	Bk	6	24
Zn 8AM	8	A	—	48
Zn 8BM	8	B	12	72
Zn 8CM	8	C	48	96
Zn 8DM	8	D	72	120
Zn 8BkM	8	Bk	12	48
Zn 12AM	12	A	—	72
Zn 12BM	12	B	24	96
Zn 12CM	12	C	72	144
Zn 12DM	12	D	96	168
Zn 12BkM	12	Bk	12	48
		Tri-valent chromium treatments		
Zn 5VM	5	V	—	24
Zn 5WM	5	W	24	48
Zn 8VM	8	V	—	48
Zn 8WM	8	W	48	96
Zn 12VM	12	V	—	72
Zn 12WM	12	W	48	120

NOTE 1 Low coating thicknesses impair passivate (conversion coating) performance.

NOTE 2 A seal can be used to improve performance, suffix SL on V- and W-type coatings.

A) "M" is added to the designation to ensure there is no confusion with electroplated coatings.

B) See Clause **6**.

6 Conversion coating (passivation treatment)

NOTE The use of hexavalent chromium is restricted by EEC Directives [1], [2] and WEEE Directives [3] (see Foreword).

The passivation shall be as designated by the symbols specified in Table 1.

7 Suitability of coatings for components with parallel threads

NOTE 1 The suitability of the coatings specified in this part of BS 7371 for parts with screw threads is limited by the clearance between external and internal threads.

Maximum plating thickness to be applied to parts incorporating standard thread forms shall be as specified in Annex A, in order to minimize the risk of interference when both threaded elements of an assembly are similarly coated.

NOTE 2 Annex C gives guidance for modifying thread dimensions to accommodate thicker coating.

NOTE 3 Modification of male thread dimensions from tolerance class 6g might influence the mechanical properties.

8 Information to be documented and supplied to the coater

The following information shall be fully documented and supplied to the coater.

a) The number and date of this British Standard, i.e. BS 7371-7:2010.

b) The nominal coating thickness (see Table 3) and the coating designation (see Table 4).

c) The type of conversion treatment required (if any) (see Clause **6**), paying particular attention to any chromium restrictions.

d) The hardness and property class of the component to be plated.

e) If lubrication of the coating is required in accordance with BS 7371-2.

f) The significant surfaces, if not as defined in BS 7371-1.

g) Any additional protection required for delivery (see BS 7371-1:2009, Clause **8** and BS 7371-1:2009, Annex D).

h) The requirements of any subsequent operations (e.g. the application of an adhesive).

9 Identification

The coating shall be identified by the number and date of this British Standard, i.e. BS 7371-7:2010 together with the coating designation in accordance with Table 4.

NOTE The passivation (conversion) treatment is included in the designation.

A lubricated condition (see **4.2**) shall be designated by the letter L after the designation.

EXAMPLE 1
A mechanically applied zinc coating of 8 µm thickness with yellow chromate conversion coating and added lubricant would be identified as BS 7371-7:2010, Zn8CML.

EXAMPLE 2
A mechanically applied zinc coating of 12 µm thickness with tri-valent passivate (heavy weight) would be identified as BS 7371-7:2010, Zn12WM.

Mixed zinc-based coating shall be specified in words.

Annex A (normative) Coating thickness for threaded parts

In order to reduce the risk of interference on assembly of threads with plated coatings, the nominal coating thickness shall not exceed one-quarter of the fundamental deviation of the thread as specified in Table A.1.

The effective coating thicknesses measured according to one of the methods specified in Annex B shall conform to the values specified in Table 3.

Table A.1 **Upper limits of nominal coating thickness**

Pitch *P*	Nominal thread diameter [A] *D* mm	Internal thread		External thread					
		Tolerance position G [B]		Tolerance position g [B]		Tolerance position f [B]		Tolerance position e [B]	
		Fundamental deviation µm	Nominal coating thickness max. µm	Fundamental deviation µm	Nominal coating thickness max., all nominal lengths [C] µm	Fundamental deviation µm	Nominal coating thickness max., all nominal lengths [C] µm	Fundamental deviation µm	Nominal coating thickness max. µm
0.2	—	+17	3	−17	3	—	—	—	—
0.25	1; 1.2	+18	3	−18	3	—	—	—	—
0.3	1.4	+18	3	−18	3	—	—	—	—
0.35	1.6 (1.8)	+19	3	−19	3	−34	8	—	—
0.4	2	+19	3	−19	3	−34	8	—	—
0.45	2.5 (2.2)	+20	5	−20	5	−35	8	—	—
0.5	3	+20	5	−20	5	−36	8	−50	12
0.6	3.5	+21	5	−21	5	−36	8	−53	12
0.7	4	+22	5	−22	5	−38	8	−56	12
0.75	4.5	+22	5	−22	5	−38	8	−56	12
0.8	5	+24	5	−24	5	−38	8	−60	15
1	6 (7)	+26	5	−26	5	−40	10	−60	15
1.25	8	+28	5	−28	5	−42	10	−63	15
1.5	10	+32	8	−32	8	−45	10	−67	15
1.75	12	+34	8	−34	8	−48	12	−71	15
2	16 (14)	+38	8	−38	8	−52	12	−71	15
2.5	20 (18; 22)	+42	10	−42	10	−58	12	−80	20
3	24 (27)	+48	12	−48	12	−63	15	−85	20
3.5	30 (33)	+53	12	−53	12	−70	15	−90	20
4	36 (39)	+60	15	−60	15	−75	15	−95	20
4.5	42 (45)	+63	15	−63	15	−80	20	−100	25
5	48 (52)	+71	15	−71	15	−85	20	−106	25
5.5	56 (60)	+75	15	−75	15	−90	20	−112	25
6	64	+80	20	−80	20	95	20	−118	25

NOTE This table is modified, as the thickness on threads with mechanical plating does not vary with length.

A) Information for coarse pitch thread is given for information only, the determining characteristic is the thread pitch.

B) See BS 3643-1 and BS 3643-2.

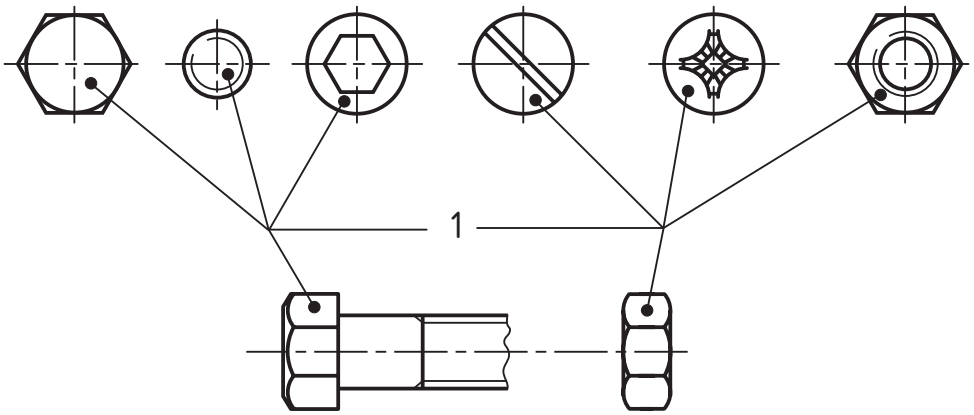
C) Maximum values of nominal coating thickness, if local measurement agreed.

Annex B (normative) Measurement of coating thickness

B.1 Local thickness

The local thickness shall be measured by one of the methods contained in the following British Standards: BS 5411-2, BS 5411-4, BS 5411-5, BS 5411-8. The thickness shall only be measured on the measuring area as shown in Figure B.1.

Figure B.1 **Measuring area for local coating thickness measurement on fasteners**



Key

1 Measuring area

B.2 Determination of group and batch average coating thickness

B.2.1 Reagents

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

B.2.1.1 *Stripping solution*, consisting of the following:

- hydrochloric acid 800 mL (density 1.16 g/mL to 1.18 g/mL)
- distilled water 200 mL
- antimony trioxide 20 g

B.2.1.2 *Acetone or an organic solvent*.

B.2.2 Procedure

Degrease the group of components in the acetone or organic solvent, dry thoroughly and weigh to an accuracy of 0.01% of the total mass of the group of components; then totally immerse the components in the stripping solution and turn them over to allow free access to all surfaces. After the effervescence has ceased, remove the samples,

wash immediately in running water, and wipe with a soft cloth to remove any loose deposits. Immerse in clean acetone, remove, dry thoroughly and reweigh.

B.2.3 Calculations

B.2.3.1 Group average thickness

Calculate the group average thickness of coating (in µm) using the formula:

$$\text{Thickness} = \frac{K\left(m_0 - m_1\right)}{A}$$

where:

K is a factor dependent on the density of the coating (see **B.2.3.2**);

m_0 is the original mass of the group of components (in g);

m_1 is the final mass of the group of components (in g);

A is the total surface area of the group of components (in cm^2)[2)].

B.2.3.2 Value of *K*

Use 1 410 as the value of K for zinc, assuming a density of 7.1 g/cm^3 for zinc.

B.2.3.3 Batch average coating

Calculate the batch average coating thickness (in µm) from the following formula:

$$\text{Batch average coating thickness} = \frac{\text{Sum of all group average coating thicknesses}}{\text{Number of groups}}$$

Annex C (informative) Guidance on procedures that may be adopted to accommodate thick coatings

When, in order to provide improved corrosion resistance, it is required to deposit coatings thicker than those that appear in Table A.1 or alternatively, when it is required to apply coatings to components of pitches smaller than appear in Table A.1, threads have to be manufactured to special limits and tolerances.

The minimum pitch limits of applicability in Table A.1 may be lowered if (for any particular thread) the normal tolerance is restricted at the maximum metal limits. This provides a greater fundamental deviation or, in the case of tolerance position H, it provides a deviation which does not otherwise exist. Alternatively, the whole tolerance zone may be displaced to provide a greater fundamental deviation.

The minimum fundamental deviation required for particular pitches and deposit thicknesses are given in Table C.1.

2) Surface areas of common metric components are given in BS 7371-1 and surface areas for imperial fasteners in BS 7371-12.

Table C.1 **Minimum fundamental deviation required to accommodate coatings too thick to be applied to standard metric threads**
Measurements in millimetres (mm)

Nominal coating thickness	Minimum fundamental deviation, if local or batch average thickness measurement is agreed
3	12
5	20
8	32
10	40
12	48
15	60
20	80
25	100
30	120
45	180
55	220

NOTE 1 If the tolerance class already has a basic deviation (for example, G, g, f or e), that deviation is deducted from the relevant deviation in Table C.1 to give the minimum additional basic deviation.

NOTE 2 Since the modifications for the thicker deposits might significantly reduce the thread engagement, their application should be agreed between manufacturer and purchaser.

NOTE 3 For thicknesses of 45 µm and above BS ISO 965-4, thread tolerance 6AZ may be used, to oversize the female thread.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1210[3)], *Specification for wood screws*

BS 3643-1, *ISO metric screw threads – Part 1: Principles and basic data*

BS 3643-2, *ISO metric screw threads – Part 2: Specification for selected limits of size*

BS 4174[3)], *Specification for self-tapping screws and metallic drive screws*

BS 6338:1982, *Specification for chromate conversion coatings on electroplated zinc and cadmium coatings*

BS 7371-10, *Coatings on metal fasteners – Part 10: Specification for organic coatings*

BS 7371-12, *Coatings on metal fasteners – Part 12: Requirements for imperial fasteners*

BS ISO 965-4, *ISO general purpose metric screw threads – Tolerances – Part 4: Limits of sizes for hot-dip galvanized external screw threads to mate with internal screw threads tapped with tolerance position H or G after galvanizing*

Other publications

[1] ECC Directive 2000/53/EC of 18th September 2000 on End of Life Vehicles

[2] End of Life Vehicles, Amendment of Annex II by Commission Decision of 27th June 2002 (Document No. C(2002) 2238)

[3] The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96).

3) Referred to in the Introduction only.

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