
**Non-destructive testing — Thermal neutron
radiographic testing — General principles
and basic rules**

*Essais non destructifs — Essai de neutronographie thermique — Principes
généraux et règles de base*



Contents

Page

1	Scope	1
2	Background material	1
3	Neutron radiography method	1
4	Facilities	3
5	Neutron sources	3
6	Neutron collimators	4
7	Imaging methods and conversion screens	6
8	Film	7
9	Cassettes	7
10	Applications for thermal neutron radiography	8
11	Improved contrast	9
12	Image quality indicators	9
13	Neutron activation	9

Annexes

A (informative)	Glossary of terms related to neutron radiography	10
B (informative)	Thermal neutron linear attenuation coefficients using average scattering and thermal absorption cross sections for the naturally occurring elements	12
C (informative)	Bibliography	15

© ISO 1998

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

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 11537 was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiation methods*.

Annexes A, B and C of this International Standard are for information only.

Introduction

This International Standard is intended to provide guidelines for the production of neutron radiographs that possess consistent quality characteristics, and as an aid to the user in determining the suitability of thermal neutron radiographic inspection for a particular application.

Recommended practices are stated without detailed discussion of the technical background for the preference.

Non-destructive testing — Thermal neutron radiographic testing — General principles and basic rules

Radiation protection - Health warning

Exposure of any part of the human body to neutrons, X- or gamma rays can be injurious to health. It is therefore essential that whenever neutron radiographic equipment or radioactive sources are used, adequate precautions should be taken to protect the radiographer and any other person in the vicinity.

Limits for the safe levels of neutron, X- or gamma radiation as well as the recommended practice for radiation protection are those valid in different countries. If there are no official regulations or recommendations in a country, the latest recommendations of the International Commission on Radiological Protection should be applied.

1 Scope

This International Standard specifies the basic practices and conditions that are to be observed for thermal neutron radiography of materials and components for flaw detection. It is concerned with techniques using photosensitive film as a recording medium. However, it recognizes that alternative methods of imaging may be used more widely in the future. The scope includes neutron production and collimation methods, converter screen selection, radiographic film, neutron radiographic inspection techniques and the type of material to be inspected. This practice is generally applicable to specific material combinations, processes and techniques.

2 Background material

A glossary of terms relating to neutron radiography is presented in annex A. Attenuation of neutrons in matter is presented in annex B.

3 Neutron radiography method

Neutron radiography and X-radiography share some similarities but produce different results when applied to the same object. Neutrons replace X-rays as the penetrating beam of radiation whose intensity is modulated by an object, resulting in a film image of the features of the object. Since the absorption characteristics of materials for X-rays and neutrons are very different, the two techniques generally tend to complement one another. Neutron and X-ray attenuation coefficients, presented in figure 1 as a function of atomic number, are a measure of this difference.

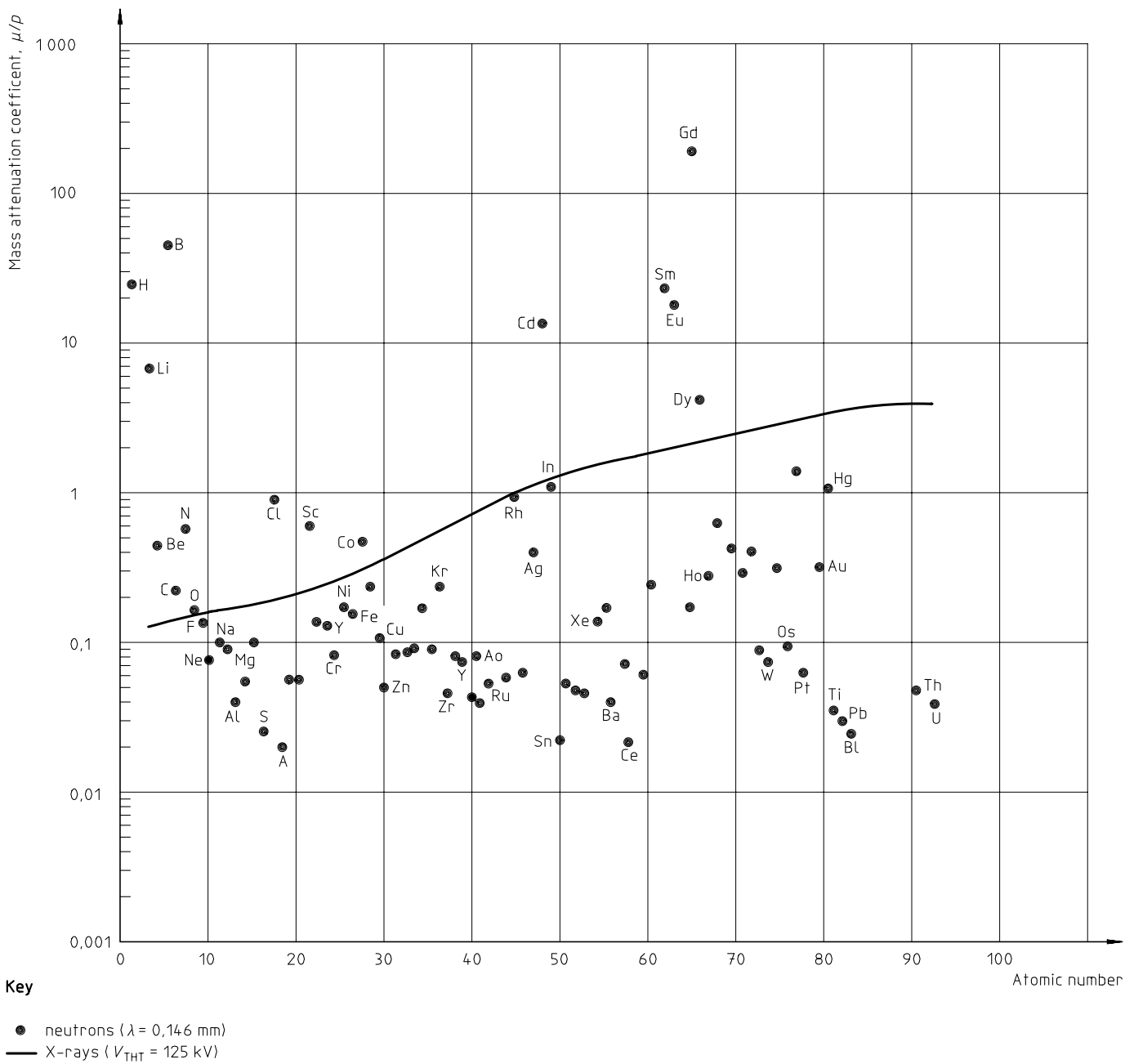
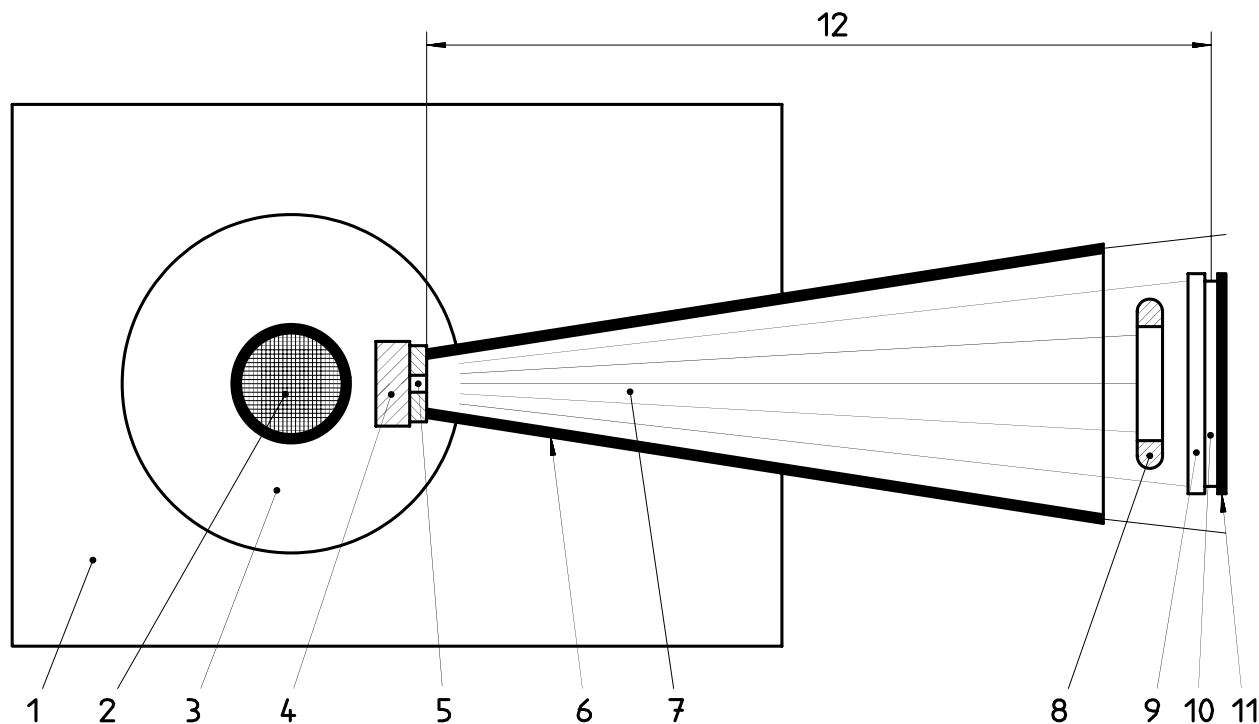


Figure 1 — A comparison of mass attenuation coefficients for thermal neutrons and X-rays

4 Facilities

A neutron radiography facility typically includes a source of thermal neutrons, a neutron beam collimator, a conversion screen, film and an exposure cassette. A schematic diagram of a representative neutron radiography facility is shown in figure 2.



Key

1	Shielding	7	Divergent neutron beam
2	Neutron source	8	Object
3	Moderator	9	Film
4	Gamma filter	10	Emulsion
5	Aperture - diameter (D)	11	Conversion screen
6	Collimator	12	Length (L)

Figure 2 — Typical neutron radiography facility with divergent collimator

5 Neutron sources

Neutron sources suitable for thermal neutron radiography can be classified into three general categories:

- radioactive isotopes;
- sealed tubes and accelerators of particles; and
- nuclear reactors.

Each of these sources produces high-energy neutrons that require moderation (slowing down) to thermal energies. This can be accomplished by surrounding the neutron source with beryllium, graphite, water, oil, plastic or some other moderator material.