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NON-DESTRUCTIVE TESTING—RADIOGRAPHY OF STEEL CASTINGS AND CLASSIFICATION OF QUALITY

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The following interests are represented on Committee MT/7:

Australian Nuclear Science and Technology Organisation
Australian Institute for Non-destructive Testing
Australian Pipeline Industry Association
Australian Welding Institute
Bureau of Steel Manufacturers of Australia
Confederation of Australian Industry
Department of Defence
Department of Industrial Relations and Employment, N.S.W.
Department of Labour, Victoria
Electricity Supply Association of Australia
Hawker de Havilland Ltd
Institute of Australian Foundrymen
Metal Trades Industry Association of Australia
National Association of Australian State Road Authorities
National Association of Testing Authorities, Australia
Pipeline Authority
Railways of Australia Committee
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NON-DESTRUCTIVE TESTING—RADIOGRAPHY OF STEEL CASTINGS AND CLASSIFICATION OF QUALITY

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PREFACE

This Standard was prepared under the direction of the Association's Committee on Non-destructive Testing of Metals and Materials by its subcommittee on radiation methods, to provide suitable methods for the radiography of steel castings. The Standard includes the use of X-ray and gamma-ray radiographic testing equipment under direct exposure conditions. It describes various test methods (using ionizing radiation) which may be specified by manufacturers of castings, inspecting authorities, or purchasers for the testing of steel castings.

The Standard contains detailed methods of test including recommended film types, appropriate IQI sensitivities and quality levels.

During the preparation of this Standard, cognizance was taken of the following documents:

BS 4080	Methods for Non-destructive Testing of Steel Castings.
ASTM A 609	Standard Specification for Longitudinal-beam Ultrasonic Inspection of Carbon and Low Alloy Steel Castings.
DIN 17245	Ferritic Steel Castings Creep Resistant at Elevated Temperatures.
Stahl-Eisen Prufblatt 1922	Ultra Schall Prufung Von Gusstucken Aus Ferritischen Stahl
ISO/TC 17/SC11	N 185—Draft Proposal for the Ultrasonic Inspection of Steel Castings.
	Atlas of Steel Casting Flaws as shown by Non-destructive Testing, The Steel Casting Research and Trades Association, Steel Founders Society of America.
BS79/80599	Draft Standard Inspection and Quality Limits for Steel Castings by Ultrasonic Means.
JIS G 0581	Methods of Radiographic Test and Classification of Radiography for Castings.

The subcommittee recommended that the approach taken in JIS G 0581 for classification of quality should be adopted for the Australian Standard and approval has been obtained from the Japanese Standards Association to use the information contained in Tables 3 to 11 of JIS G 0581. Examples have been added to assist users in assessment of discontinuities.

Guidelines for purchasers, designers and testing authorities have been included in an appendix. Because of the importance of technical competence and experience in radiography of castings, reference should be made to information on Testing Authorities given in Appendix A.

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FOREWORD

It is emphasized that diagnosis of the nature of discontinuities located by radiography can only be made by consideration of both metallurgical and radiographic factors. Consideration should therefore be given to the method of manufacture of the casting under test, and the type, position and probable distribution of any discontinuities likely to be present.

Soundness of castings depends on such factors as size, section, configuration, method of moulding and design of runner and riser systems. These factors and other aspects such as heat treatment, affect grain structure and location and orientation of possible discontinuities. These factors have to be considered when choosing the appropriate test method and sensitivity.

Radiographic sensitivity, in addition to consideration of surface condition or preparation prior to radiography, depends upon radiation energy (kilovolt or isotope spectrum), film/screen combination, scattered radiation control, exposure geometry (source-to-film distance and effective source size) and several less important parameters; usually, the highest sensitivity methods necessitate the use of X-ray. However, thickness limitations and accessibility may preclude the use of X-rays.

For hollow components it may be possible to use either single-wall or double-wall methods. Although radiographic sensitivity obtained with single-wall methods is generally superior to that obtained with double-wall methods, other factors such as diameter, thickness and accessibility may have a pronounced influence on the choice of a method.

NOTE: Where alternatives exist, the exact method should be agreed on between customer and contractor if not covered by the product or application Standard.

Non-destructive testing methods are mutually complementary; it is emphasized that the results of one test should be considered in relation to those obtained by another method. Accordingly differing interpretations may be required to be reassessed by alternative methods.

STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard

NON-DESTRUCTIVE TESTING—RADIOGRAPHY OF STEEL CASTINGS AND CLASSIFICATION OF QUALITY

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This Standard sets out methods for film radiography of whole or specified areas of steel castings and defines six quality classes of steel castings based on size and number of discontinuities observed in radiographs.

NOTES:

1. Information to be supplied with the enquiry and order is given in Appendix A.
2. Any repair welding carried out is deemed to be part of the casting.

1.2 APPLICATION. Radiographic methods described in this Standard determine size and nature but not necessarily depth of discontinuities in castings. Each radiographic method can yield a radiograph with a range of sensitivities depending upon section thickness.

For convenience in the assessment of integrity of castings, discontinuities in castings have been graded into severity indexes which vary according to type of discontinuity. However, acceptance criteria or quality classes for discontinuities are normally specified in relevant product Standards or determined by agreement between the contracting parties after due consideration of size, configuration, and service requirements of the casting (see Appendix A).

1.3 REFERENCED DOCUMENTS. The following Standards are referred to in this Standard:

AS 1929	Non-destructive Testing—Glossary of Terms.
AS 2177.2	Radiography of Welded Butt Joints in Metal Part 2: Image Quality Indicators (IQI) and Recommendations for their Use.
AS 2243.4	Safety in Laboratories Part 4: Ionizing Radiations.
AS 2574	Non-destructive Testing—Ultrasonic Testing of Steel Castings and Classification of Quality.

1.4 TEST METHOD DESIGNATION. Radiographic methods are designated in accordance with the following scheme (see also Table 3.1):

(a) By a prefix letter 'C' to signify testing of a casting.

(b) By a second letter to indicate source of ionizing radiation, as follows:

G—Gamma ray source.
M—Mega electron-volt source.
X—X-ray source.

(c) By the numeral 0, 1, 2, 3, or 4 to indicate film type (see Appendix F).

(d) By the suffix letter 'F' to indicate the use of fluorometallic screens.

Examples of designation: CM, CX1, CXF, CG2.

1.5 DEFINITIONS. For the purpose of this Standard, the definitions given in AS 1929 and those below apply.

1.5.1 Air lock—a cavity formed by the entrapment of air during pouring and solidification.

1.5.2 Blowhole—a gas cavity, generally 1.5 mm in diameter.

1.5.3 Chaplet—a metal support for holding cores in place within sand moulds.

1.5.4 Chill—a metal insert imbedded in the surface of a sand mould or core or placed in a mould cavity to increase the cooling rate at that point.

1.5.5 Crack—stress induced fracture of metal after solidification.

1.5.6 Filamentary shrinkage—a form of shrinkage in which cavities are branching and interconnected.

NOTE: Microshrinkage is a very fine form of filamentary shrinkage.

1.5.7 Gas porosity—discrete cavities formed by the entrapment of gas from the reaction of metal with the mould or a core, or during solidification.

1.5.8 Hot tear—metal separations, frequently discontinuous and ragged, formed by restraint of metal during solidification.

1.5.9 Inclusion—exogenous material entrapped in the casting during solidification.

1.5.10 Macroshrinkage—large shrinkage cavity or cavities caused by contraction during solidification.

1.6 SAFETY PRECAUTIONS. Exposure of any part of the human body to ionizing radiation can be injurious. It is therefore essential that when X-ray equipment or radioactive sources are being used, adequate precautions shall be taken to protect testing personnel and any other persons in the vicinity.

NOTE: The use of radioactive substances and irradiating apparatus is controlled by various Statutory Regulations. Reference should also be made to the 'Code of Practice for the Control and Safe Handling of Sealed Radioactive Sources used in Industrial Radiography' issued by the National Health and Medical Research Council.

Reference should also be made to AS 2243.4.