AS 2981—2008

Australian Standard®

High voltage a.c. switchgear and controlgear—Vacuum interrupters—High voltage testing—Protection of personnel from x-ray emission

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The following are represented on Committee EL-007:

- Australian British Chamber of Commerce
- Australian Electrical and Electronic Manufacturers Association
- Australian Railway Association
- Energy Networks Association
- Engineers Australia
- Testing interests

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High voltage a.c. switchgear and controlgear—Vacuum interrupters—High voltage testing—Protection of personnel from x-ray emission

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PREFACE

This Standard was reviewed by the Standards Australia Committee EL-007, Power Switchgear to supersede AS 2981—1987.

This Standard is republished from AS 2981—1987 without technical alterations.

Referenced documents have been updated.

The objective of this Standard is to provide testing conditions and procedures to keep the emission of X-rays as affecting personnel to acceptable limits in the carrying out of high voltage testing on vacuum interrupters and switchgear incorporating vacuum interrupters. The Standard covers factory testing, on-site commissioning, in-service testing and specifies that a chain of responsibility be established for the implementation of these procedures.

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FOREWORD

When a high voltage is applied across electrodes in a vacuum, X-ray emission may occur. Such a situation exists across the open contacts of a high voltage vacuum interrupter and the introduction of these interrupters has generated a need to consider the possible production of X-rays across the open contacts.

For vacuum interrupters with rated voltages up to 36 kV (the highest rating presently in general use) the X-ray output is virtually undetectable when they are operating at their rated voltage. Although a small but finite X-ray output occurs under test conditions when a higher voltage is applied, the radiation levels are generally well below those accepted as limits for exposure of members of the general public under AS 2243.4, *Safety in laboratories*, Part 4: *Ionizing radiations*. This Standard lays down simple procedures and precautions which should be observed in certain instances and in particular at higher test voltages, to ensure that safe conditions are maintained for testing personnel.

The emission of X-rays from electrodes in vacuum occurs when electrons in the electrical field are accelerated to a sufficiently high level of kinetic energy and then impinge on electrode material. This emission mechanism is exhibited by X-ray tubes, where free electrons are produced by thermal electron emission. In vacuum interrupters the free electrons can be produced by field emission.

The X-ray flux is a function of the emission current and the applied voltage, and the penetrating power of the X-rays increases rapidly with voltage. On the other hand, the radiation intensity at a location under any given operating condition decreases approximately as the square of the distance from the source. For vacuum interrupters and switchgear incorporating vacuum interrupters, much of the emission produced at the higher test voltages is absorbed by the shielding provided by the interrupter envelope and the metal enclosure of the switchgear. Because of this, in most cases all that is necessary is that the test voltage should be applied with the operator at the normal electrically safe distance.

X-rays can be generated only when a high voltage is applied across the open contacts. There is no residual emission after the test voltage is removed, nor is there any generation of X-rays from a closed interrupter when high voltage is applied to earth or between phases.

STANDARDS AUSTRALIA

Australian Standard

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1 SCOPE AND GENERAL

1.1 Scope

This Standard sets out the conditions for carrying out high voltage tests on vacuum interrupters and switchgear incorporating vacuum interrupters for the protection of personnel from X-ray emission. The Standard covers factory testing, on-site commissioning and in-service testing.

It outlines situations where such precautions may be necessary, and establishes methods by which measurement of X-ray emission may be made.

1.2 Referenced document

The following Standard is referred to in this Standard:

AS
2243 Safety in laboratories
2243.4 Part 4: Ionizing radiations

2 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

2.1 Absorbed dose

The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The SI unit of absorbed dose is the gray (Gy).

2.2 Dose equivalent

Product of absorbed dose and quality factor (QF).

NOTE: For the purpose of this Standard, as emissions are exclusively X-rays, QF = 1 and the dose equivalent is equal to the absorbed dose as measured. The SI unit of dose equivalent is the sievert (Sv). It replaces the ‘rem’ with 1 Sv = 100 rem.

2.3 Exposure time

The duration for which high voltage capable of generating X-rays is applied across the open contacts of a vacuum interrupter.

2.4 Shielding

Provision around a source of a protective barrier of appropriate material, thickness and shape to attenuate X-ray emission.

2.5 Source

The open contacts of a vacuum interrupter from which X-ray emission occurs when high voltage is applied across the gap.