

Recommendations for

General principles of nuclear reactor instrumentation

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Co-operating organizations

The Nuclear Energy Industry Standards Committee, under whose supervision these recommendations were prepared, consists of representatives of the following Government departments and scientific and industrial organizations:

- Association of Consulting Engineers*
- British Electrical and Allied Manufacturers' Association
- British Insurance (Atomic Energy) Committee
- British Mechanical Engineering Confederation
- Department of Employment (H.M. Factory Inspectorate)
- Department of Trade and Industry*
- Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales*
- Institution of Chemical Engineers
- Institution of Electrical Engineers
- Institution of Mechanical Engineers
- Lloyd's Register of Shipping
- Scientific Instrument Manufacturers' Association of Great Britain
- United Kingdom Atomic Energy Authority*

The Government department and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of these recommendations:

- British Industrial Measuring and Control Apparatus Manufacturers' Association
- British Nuclear Design and Construction Limited
- British Nuclear Forum
- The Nuclear Power Group Limited

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The following BSI references relate to the work on these recommendations:
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Foreword

Adequate instrumentation, which gives the operator a knowledge of the state of the reactor or which initiates operation of the protective and control systems, is vital for safe and efficient operation.

These recommendations have been developed for use by designers, constructors, purchasers and users of nuclear power station instrumentation systems and equipment. They are concerned primarily with nuclear safety and reflect current British good practice.

These recommendations are based upon and meet the principles contained in IEC Publications 231 (1967) and 231 A (1969).

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

These recommendations give guidance on the provision of reactor instrumentation and recommend standards of good practice.

Items of instrumentation are not necessarily included in these recommendations unless they have a direct bearing on the overall safety and effective control of the reactor.

The design of area and effluent radioactivity monitoring systems are not included in these recommendations but should be given careful attention.

NOTE The titles of the British Standards referred to in the recommendations are listed on the inside back cover.

2 General requirements

2.1 Safe operation

The responsibility for safe operation of a reactor should be vested in the management chain of command.

Nevertheless, the instrumentation design should aim to ensure safe operation throughout the life of the reactor.

2.2 Instrumentation

The instrumentation should be such as to enable the operator to make an adequate assessment of the physical state and behaviour of the plant. Suitable warnings should be provided for indicating abnormal conditions.

2.3 Protection provided

The protection provided should be determined by the following considerations:

- 1) Correct action of the reactor protection system is required to avoid unacceptable hazards to the general public in case of accident. The reactor protection system design should take into account the consequence of failure: the degree of protection provided being determined by humanitarian, technical, economic and other considerations.
- 2) The reactor protection system should also protect the plant against faults which would otherwise damage it, and minimize the consequential radiation exposure of plant operatives.
- 3) An incident should normally be sensed by at least two independent parameters, one of which should, wherever possible, be a direct measurement of the parameter of greatest concern for that particular incident.

2.4 Sensors

2.4.1 Sensors should be selected with due regard for long and short term compatibility with environmental conditions, to minimize consequent measurement errors and physical deterioration.

2.4.2 Sensors may have to be sited under adverse flux and temperature conditions.

To avoid loss of performance, consideration should be given to the effects of prolonged irradiation on materials used within sensors. In particular, electrical insulation performance should not be degraded by the conditions.

Those parts of the system (both permanent and temporary) which are in contact with the coolant should be constructed from materials which are compatible with the coolant itself and with other materials within the circuit.

2.4.3 Since access is often limited or difficult, the number and disposition of the sensors should permit effective monitoring, allowing for failures which may occur during operation.

A sensor which projects into the coolant circuit should not interfere with any internal inspection work which may be required on the circuit and should be securely fixed.

2.4.4 Connections or joints should be avoided within the reactor. If necessary, they should not introduce significant measurement errors under steady state, transient or abnormal temperature conditions.

2.4.5 Hydrodynamic or aerodynamic effects should be considered when determining the position of sensors.

2.5 Control and safety systems

2.5.1 The reactor control system and the reactor safety system should be mutually independent, in the sense that a fault in one should not lead to incorrect action of the other. In all cases, safety action should have priority over control action.

2.5.2 The design of the reactor safety system should aim to ensure that no action or failure of the reactor control system can lead to a situation in which protection is not provided by the reactor safety system. In considering failure of the control system, combinations of failure should also be considered.

2.5.3 The design of the control system should ensure that no failure or combinations of failure of the safety system can result in the increase of reactivity by the control system.

2.6 Abnormal operating conditions

Where reactors have to be operated in conditions other than normal (for instance, commissioning), safety and control arrangements equivalent to those under normal operation should be preserved.