



DPC: 25 / 30507923 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Interested committees:

Title: BS EN IEC 62241 Nuclear power plants - Human-machine interfaces - Alarm functions and presentation

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- iii) requires additional national guidance or information

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Responsible Committee Secretary: **Mr Andranik Ohanian (BSI)**

Direct tel:

E-mail: andranik.ohanian@bsigroup.com

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



45A/1579/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 62241 ED2

DATE OF CIRCULATION:

2025-01-10

CLOSING DATE FOR COMMENTS:

2025-04-04

SUPERSEDES DOCUMENTS:

45A/1558/RR

IEC SC 45A : INSTRUMENTATION, CONTROL AND ELECTRICAL POWER SYSTEMS OF NUCLEAR FACILITIES

SECRETARIAT:

France

SECRETARY:

Mr Alexander WIGG

OF INTEREST TO THE FOLLOWING COMMITTEES:

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

Safety

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Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Nuclear power plants - Human-machine interfaces - Alarm functions and presentation

NOTE FROM TC/SC OFFICERS:

Following resolution of comments on the working draft and based on the recommendation of working group 8 at the virtual meeting which took place on 13th December, in agreement with IEC SC45A Secretary, IEC 62241 ED2 CD is circulated to IEC National Committees for comment for a period of 12 weeks.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**NUCLEAR POWER PLANTS –
HUMAN-MACHINE INTERFACES –
ALARM FUNCTIONS AND PRESENTATION**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62241 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

The text of this standard is based on the following documents:

FDIS	Report on voting
45A/XXXX/FDIS	45A/XXXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This document supplements 8.7.2.4 of IEC 60964:2018.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- 167 • reconfirmed;
- 168 • withdrawn;
- 169 • replaced by a revised edition, or
- 170 • amended.

171

172

173

INTRODUCTION

174 **a) Technical background, main issues and organisation of the standard**

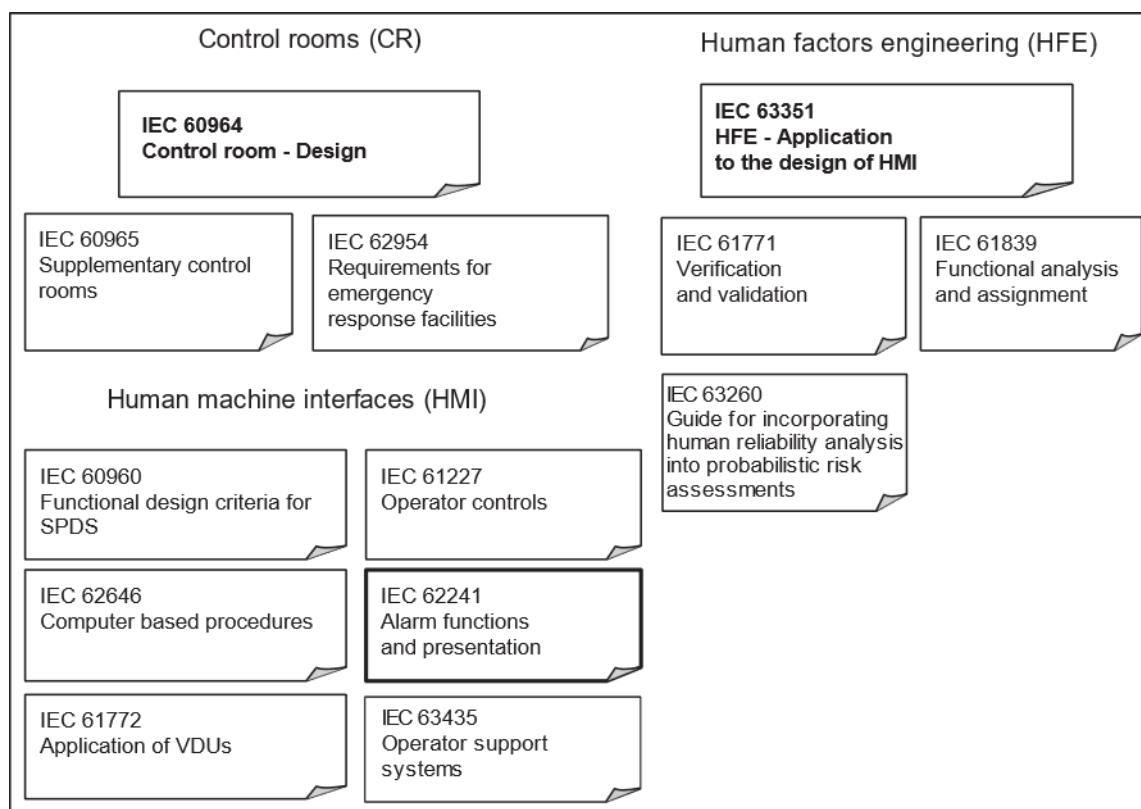
175 IEC 60964:2018 was developed to supply requirements relevant for the design of Control
176 Rooms (CR) of nuclear power plants. IEC 60964 is extensively used within the nuclear
177 industry, and alarm systems are addressed in clause 8.7.2.4. This document supplements
178 clause 8.7.2.4 of IEC 60964 by providing detailed requirements for alarm systems.

179 This document applies to the design of new main control rooms of nuclear power plants
180 conforming to IEC 60964, where work is initiated after the publication of this standard. It
181 serves as a reference for upgrading and modernizing existing control rooms.

182 **b) Situation of the current standard in the structure of the IEC SC 45A standard series**

183 IEC 62241 will be directly referenced by the third edition of IEC 60964 and is the third level
184 document specifically tackling the topic of alarm systems.

185 Figure 1 shows the set of IEC SC 45A standards that collectively give requirements for control
186 rooms, human-machine interfaces (HMI) and human factors engineering (HFE).



187

188 **Figure 1 – IEC SC 45A standards addressing control rooms, HMI and HFE**

189 The documents shown on the left of the figure below the “IEC 60964” box constitute the
190 existing set of control room (CR) and human-machine interface (HMI) design related
191 standards and those on the right of the figure below the “IEC 63351” box constitute the HFE
192 related standards.

193 It is noted that IEC 61771 and IEC 61839 are still in connection with IEC 60964 and an update
194 is under processing by WG 8. After the final update this can be adapted based on the relevant
195 content.

196 For more details on the structure of the IEC SC 45A series of standards, see item d) of this
197 introduction.

198 **c) Recommendations and limitations regarding the application of this standard**

199 It is important to note that this document establishes no additional functional requirements for
200 safety systems.

201 To ensure that the standard will continue to be relevant in future years, the emphasis has
202 been placed on issues of principle, rather than specific technologies.

203 **d) Description of the structure of the IEC SC 45A series of standards and relationships** 204 **with other IEC documents and other bodies documents (IAEA, ISO)**

205 The IEC SC 45A standard series comprises a consistent set of documents organised in a
206 hierarchy of four levels. The top-level documents of the IEC SC 45A standard series are
207 IEC 61513 and IEC 63046, covering respectively general requirements for instrumentation
208 and control (I&C) systems and general requirements for electrical power systems of NPPs.
209 IEC 61513 and IEC 63046 adopt an overall system life-cycle framework and constitute, along
210 with the relevant second-level standards, the nuclear implementation of the basic safety
211 series IEC 61508.

212 IEC 61513 and IEC 63046 refer directly to other IEC SC 45A standards for general
213 requirements for specific topics, such as categorization of functions and classification of
214 systems, qualification, separation, defence against common cause failure, control room
215 design, electromagnetic compatibility, human factors engineering, cybersecurity,
216 programmable digital item and hardware aspects for programmable digital systems,
217 coordination of safety and cybersecurity requirements and management of ageing.

218 At a third level, IEC SC 45A standards not directly referenced by IEC 61513 or by IEC 63046
219 are standards related to specific requirements for specific equipment, technical methods, or
220 activities. Usually, these documents refer to second-level documents for general requirements
221 and can be used on their own.

222 A fourth level extending the IEC SC 45A standard series, corresponds to the Technical
223 Reports which are not normative.

224 The IEC SC 45A standards series consistently implement and details the safety and
225 cybersecurity principles and basic aspects provided in the relevant IAEA safety standards and
226 in the relevant documents of the IAEA nuclear security series (NSS). In particular this
227 includes the IAEA requirements SSR-2/1, establishing safety requirements related to the
228 design of nuclear power plants (NPPs), the IAEA safety guide SSG-30 dealing with the safety
229 classification of structures, systems and components in NPPs, the IAEA safety guide SSG-39
230 dealing with the design of instrumentation and control systems for NPPs, the IAEA safety
231 guide SSG-34 dealing with the design of electrical power systems for NPPs, the IAEA safety
232 guide SSG-51 dealing with human factors engineering in the design of NPPs, the
233 implementing guide NSS 42-G and technical guidance NSS 17-T for computer security at
234 nuclear facilities. The safety and cyber security terminology and definitions used by SC 45A
235 standards are consistent with those used by the IAEA.

236 IEC 61513 and IEC 63046 refer to ISO 9001 as well as to IAEA GSR part 2 and IAEA GS-G-
237 3.1 and IAEA GS-G-3.5 for topics related to quality assurance (QA).

238 At level 2, regarding nuclear security, IEC 62645 is the entry document for the IEC SC 45A
239 security standards. It builds upon the valid high-level principles and main concepts of the
240 generic security standards, in particular ISO/IEC 27001 and ISO/IEC 27002; it adapts them
241 and completes them to fit the nuclear context and coordinates with the IEC 62443 series. At
242 level 2, IEC 60964 is the entry document for the IEC SC 45A control rooms standards,
243 IEC 63351 is the entry document for the human factors engineering standards and IEC 62342
244 is the entry document for the ageing management standards.

245 Note 1: IEC TR 63400 provides a more comprehensive description of the overall structure of the IEC SC 45A
246 standards series and of its relationship with other standards bodies and standards.

247

248

NUCLEAR POWER PLANTS – HUMAN-MACHINE INTERFACES – ALARM FUNCTIONS AND PRESENTATION

1 Scope

This document provides the functional requirements for the alarm systems in the main control room of nuclear power plants. It gives definitions of the terms used for alarm functions. It also establishes the human factors requirements and the design guidelines for alarm presentation for the main control room of nuclear power plants.

NOTE The alarm functions can be implemented in a dedicated system (alarm system) or preferably be an integrated part of the main control room HMI (Human-Machine Interface) system.

It specifies the alarm functions including those for the selection and definition of original alarm signals, alarm signal processing (e.g., event sequence processing, static and dynamic prioritisation), alarm display processing (e.g., alarm suppression) and the use of associated display devices (e.g., Visual Display Unit (VDU), conventional alarm fascia, mural display), with acknowledge and reset sequences, and other related matters.

Under abnormal conditions or plant transient conditions in the nuclear power plant, many alarms occur simultaneously. For this reason, the alarm functions of the main control room of nuclear power plants require special considerations for human factors engineering and system configuration, to avoid operator misunderstandings and to provide the operator with adequate information. Therefore, the scope includes special alarm functions based on human factors for monitoring and operation of nuclear power plants. It does not cover specific alarm systems, such as the fire alarm and security alarm systems.

The purpose of this document is to establish a common international understanding of the underlying functional design basis of alarm systems for control rooms, covering the corresponding functional requirements, the human factors requirements and design guidelines for the alarm functions and alarm presentation for the main control room of nuclear power plants.

This document therefore aims to give guidance to reduce problems which have been experienced in the past: omission of important alarms, delay in detecting important alarms, increased workload that may affect the performance of other operational activities, inattention to frequently activated alarms known as 'nuisance alarms,' and confusion associated with the misunderstanding of the relationships among alarms and of the importance of alarms.

2 Normative references

The following referenced documents are necessary 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.

IEC 61226, *Nuclear power plants – Instrumentation, control and electrical power systems important to safety – Categorization of functions and classification of systems*

IEC 61771, *Nuclear power plants – Main control room – Verification and validation of design*

IEC 61839, *Nuclear power plants – Design of control rooms – Functional analysis and assignment*

IEC 63351, *Nuclear facilities – Human factors engineering – Application to the design of human-machine interfaces*

295 3 Terms and definitions

296 For the purposes of this document, the terms and definitions given in IEC 60964, as well as
297 the following definitions, apply.

298 NOTE When the same term is defined in IEC 60964 and in this standard, the definition given in this standard
299 applies.

300 3.1

301 alarm

302 item of diagnostic, prognostic, or guidance information, which is used to alert the operator and
303 to draw his or her attention to a process or system deviation

304 NOTE Specific information provided by alarms includes the existence of an anomaly for which corrective action
305 might be needed, the cause and potential consequences of the anomaly, the overall plant status, corrective action
306 to the anomaly, and feedback of corrective actions.

307 Two types of deviation may be recognised:

- 308 – unplanned – undesirable process deviations and equipment faults;
- 309 – planned – deviations in process conditions or equipment status that are the expected response to but could be
310 indicative of undesirable plant conditions.

311 3.2

312 alarm acknowledgement

313 action, which operators are required to carry out to show that they have recognized an alarm
314 presented to them

315 3.3

316 alarm avalanche

317 condition where a large number of alarms appear within a short time at a rate exceeding the
318 operator's capacity to take them into account

319 3.4

320 alarm coding

321 method of highlighting an object of concern visually or audibly, with the intention of drawing
322 the operator's attention to the object

323 3.5

324 alarm control

325 set of alarm presentation control functions, which support the operators in recognizing alarm
326 status correctly and in a timely manner

327 NOTE Alarm acknowledgement, silence, and reset are typical examples of alarm control.

328 3.6

329 alarm display processing

330 alarm signal processing functions or mechanisms, which are used in controlling or enhancing
331 alarm presentation, for example, grouped alarms, alarm suppression

332 NOTE The alarm display processing operates on the alarms identified by the alarm signal processing (q.v.) logic.

333 3.7

334 alarm fascia

335 alarm display consisting of a set of alarm tiles

336 3.8

337 alarm reduction or filtering

338 alarm signal processing function or mechanism which has the aim of reducing the number of
339 alarms for operator attention

340 NOTE Filtering or reduction are generic terms.

341 **3.9**
342 **alarm generation**
343 alarm signal processing function or mechanism, which is used to generate an alarm based on
344 a logical combination of pre-defined alarm signals and non-alarm binary signals (e.g.,
345 component status signals)

346 NOTE See also under alarm signal processing logic.

347 **3.10**
348 **alarm legend**
349 caption identifying an alarm

350 **3.11**
351 **alarm message**
352 alarm phrase identifying an alarm, which is used typically in VDU-based alarm displays

353 NOTE It may be associated with supplemental information such as the time of alarm activation, the threshold, and
354 the trend of a corresponding process. It is also used to mean a string of speech-based audible announcements,
355 representing an alarm, which may be associated with guidance or other supplemental information.

356 **3.12**
357 **alarm prioritisation**
358 alarm signal processing function or mechanism, which categorizes alarms into groups of
359 different priorities of importance

360 NOTE The priority may be defined beforehand or determined dynamically from plant conditions. See also under
361 alarm signal processing (q.v.) logic.

362 **3.13**
363 **alarm recording**
364 method ensuring that the identity and time of appearance and clearing of each alarm and
365 alarm signal can be available for off-line study and analysis, using a permanent record such
366 as printout or long-term magnetic or optical recording

367 **3.14**
368 **alarm response procedure**
369 procedure describing how operators should respond to alarms

370 **3.15**
371 **alarm signal**
372 binary signal taken into the alarm system, which is processed to provide an alarm. These
373 signals may be raw signals from the plant or from the I&C systems

374 **3.16**
375 **alarm signal processing**
376 logic or mechanisms which operate on the alarm signals (q.v.), before alarms are identified
377 and passed to alarm display processing (q.v.) to be displayed to operators

378 NOTE Alarm signal processing may be used to validate alarm signals, generate alarms, reduce alarms, or
379 prioritise alarms.

380 **3.17**
381 **alarm signal validation**
382 alarm signal processing function or mechanism, which determines whether an alarm signal is
383 correctly representing a corresponding process or system status

384 **3.18**
385 **alarm silence**
386 action, which is made to stop an audible cue or warning associated with an alarm

387 NOTE Action, which is made to stop alerting (i.e., both visual and audible signals), is implemented by alarm
388 acknowledgement. Alarm silence may directly be used to stop alerting as alarm acknowledgement.

389 **3.19**
390 **alarm suppression**
391 alarm presentation function, which switches off the illumination or prevents display of the
392 messages of alarms with no current operational significance

393 NOTE The state of suppressed alarms can still be determined by other means.

394 **3.20**
395 **alarm system**
396 system designed to alert the operators to the existence of an anomaly (i.e., a system or
397 process deviation), for which corrective action might be needed

398 NOTE Normally, an alarm system is an integral part of I&C systems, especially computerized I&C systems, but it
399 may also be a separate set of equipment as found in hardwired I&C systems.

400 **3.21**
401 **alarm threshold**
402 process value or system state, which is used as a reference for activating an alarm signal

403 NOTE Also called alarm limit or alarm setpoint.

404 **3.22**
405 **alarm tile**
406 alarm display unit which consists of an engraved legend shown on a tile and lit from behind
407 when its alarm condition is present

408 **3.23**
409 **alerting**
410 act of warning by means of visual and audible signals, which is intended to draw the
411 operators' attention

412 **3.24**
413 **dark-board**
414 for alarm display, a design goal that, for normal healthy plant conditions, no alarms are shown

415 **3.25**
416 **discrepancy indicator**
417 display in which an indicator switch or a switch controlling an equipment item shows an
418 illumination when the state is different from the last state ordered by that switch or shown by
419 that switch

420 **3.26**
421 **dynamic alarm coding**
422 alarm display processing function or mechanism, which is used to dynamically change alarm
423 coding (e.g. alarm presentation colour)

424 NOTE Lighting an alarm window with different colours in accordance with dynamically determined priorities is an
425 example of dynamic display coding.

426 **3.27**
427 **first-up alarm**
428 alarm which indicates the first initiation triggering an associated set of alarms

429 NOTE Often used for the first signal causing the actuation of the reactor protection system or safety systems.
430 Also known as 'first-out' alarm.

431 **3.28**
432 **grouped alarm**
433 alarm, which is defined as a logical combination of several alarms

434 NOTE Usually simple 'OR' logic is used to generate a grouped alarm. Sometimes called a 'shared alarm.'

435 **3.29**
436 **grouping**
437 group of alarms in terms of physical or functional properties

438 NOTE Laying out a group of alarms in a certain place in a distinctive manner is an example of physical grouping.

439 **3.30**
440 **navigation**
441 function, which supports the operators in locating the position of desired information in a
442 VDU-based information system, and also in guiding the selection of displays

443 **3.31**
444 **nuisance alarm**
445 alarm which repeatedly cycles between the alarmed and cleared states and leads to control
446 room distraction or annoyance

447 NOTE Also called a 'repeating alarm.'

448 **3.32**
449 **reflash**
450 action of flashing an alarm legend or of presenting it again with a flashing symbol on a VDU,
451 when it has been activated again after it has cleared, or to indicate that a grouped alarm is
452 reactivated by a new alarm

453 **3.33**
454 **reset**
455 alarm control function, which is used to return the alarm system to a pre-defined state by
456 removing cleared alarms from display

457 **3.34**
458 **ringback**
459 alarm presentation function, which is used to indicate that an alarm condition has been
460 cleared

461 **3.35**
462 **standing alarm**
463 alarm which is present and has been acknowledged

464 **3.36**
465 **telop**
466 short message or a symbol, often with a numerical content, presented at the foot or heading
467 line of a VDU display to direct the user to another display or to inform the user of some
468 information such as the number of outstanding alarms

469 **4 Background explanations**

470 **4.1 Problems of alarm systems**

471 Poor alarm system design is known to sometimes cause human factors problems, which may
472 be critical to plant availability and safety. Typical human factors problems involve the
473 following:

- 474 – omission of important alarms;
- 475 – delay in detecting important alarms;
- 476 – increased workload that may affect the performance of other operational activities;
- 477 – inattention to frequently activated alarms;
- 478 – confusion associated with the misunderstanding of the relationships between alarms and
- 479 of the importance of each alarm;
- 480 – delay in presentation of alarms when the operators know a plant change has occurred,
- 481 causing loss of operator belief in the integrity of the alarms.

482 It is known that the following are the major causes of these human factors problems:

- 483 – A large number of alarms are activated in a transient, and operators cannot acknowledge
- 484 them immediately. This problem is known as 'alarm avalanche'. In addition, many of these