Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3409 (2022-11)

Airlocks on the reactor containment of nuclear power plants - Equipment airlocks -

(Schleusen am Reaktorsicherheitsbehälter von Kern-kraft-werken - Materialschleusen -)

Previous versions of this safety standard were issued in 1979-06 and 2009-11.

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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KTA SAFETY STANDARD

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Contents

Basic principles 5
1 Scope 5
2 Definitions 5
3 General requirements 5
4 Interlocking system 5
4.1 General 5
4.2 Purpose of interlocking system 5
4.3 Cancellation of interlocking 5
5 Pressure balancing system 5
6 Airlock operating equipment 5
6.1 Motor operation 5
6.2 Manual operation 6
7 Control panels 6
7.1 General 6
7.2 Arrangement 6
7.3 Display and control elements 6
7.4 Operating instructions 7
7.5 Effectiveness of control commands 7
7.6 Additional operating elements in the airlock chamber 7
8 Doors 7
8.1 Neutral position 7
8.2 Safeguarding against pressure differentials 7
8.3 Hazard zones 7
9 Movable transportation tracks 7
10 Sight glasses 7
11 Voice communication system 7
11.1 Direct connection to the control room 7
11.2 Voice communication system between the control panels 7
12 Access to the airlock 7
13 Equipment in the control room 7
13.1 Displays 7
13.2 Signal indication 7
13.3 Release of actuation 8
14 Design requirements 8
14.1 Design 8
14.2 Arrangement of airlock operating equipment 8
14.3 Hydraulic and pneumatic systems 8
14.4 Power supply lines 8
14.5 Decontamination 8
15 Inspection and documentation 8
15.1 Design approval 8
15.2 Initial inspection 8
15.3 In-service inspections 8
15.4 Documentation 8
16 Operation and maintenance 8
17 Personnel 8
Annex A: Regulations Referred to in this Safety Standard 8

Comments by the editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, the exceptions used, shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of this safety standard.

Basic principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety-related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against damage arising from the construction and operation of the plant (Sec. 7, para. (2), subpara. (3) Atomic Energy Act - AtG) in order to attain the protective goals specified in the AtG, the Radiation Protection Act (StrlSchG) and the Radiation Protection Ordinance (StrlSchV) as well as further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) and the Interpretations of the SiAnf.

(2) In the safety requirements for nuclear power plants, in requirement No. 3.6 "Requirements for containment" and in section 6 "Containment" of the Interpretation I-2 “Requirements for the design of the reactor coolant pressure boundary, the external systems as well as the containment”, inter alia, such a design of airlocks as to withstand maximum pressure and temperature loadings without the leakage rate on which design is based being exceeded or safety-relevant plant parts being destroyed. In addition, airlocks shall be protected against consequential damage caused by leaking out fluids, reaction forces and breakage. Safety standard KTA 3409 is intended to specify detailed measures which shall be taken to meet these requirements within the scope of its application.

(3) By fulfillment of the specifications laid down by this safety standard it will be ensured that the safety-relevant tasks of equipment airlocks on the reactor containment are met during plant operational lifetime.

1 Scope

This safety standard applies to equipment airlocks on primary reactor containments of nuclear power plants. This safety standard does not apply to airlocks which are permitted to be used for the transfer of personnel. Airlocks where the airlock body is not closed by movable doors, do not fall under the scope of this safety standard.

2 Definitions

(1) Equipment airlock

For the purpose of this safety standard, an equipment airlock is a pressure-resistant and technically gas-tight hollow body with two doors connected to the reactor containment, where the inner door connects the airlock chamber to the containment interior and the outer door connects the airlock chamber to the containment exterior. Equipment airlocks exclusively serve the transfer of material or equipment.

(2) Motor-operated airlock

An airlock the movable parts of which cannot be operated by muscular power even though manual operation is additionally possible in the case of operating trouble.

(3) Authorised inspector

For the purpose of this standard, this is the inspector charged by the licensing or supervising authority to perform inspections in accordance with § 20 of the Atomic Energy Act. The tests and inspections specified by this safety standard shall be performed on the basis of respective orders placed by the regulating authority.

(4) Airlock operating equipment

The operating equipment comprises all elements supporting the operation of the individual airlock components. The operating equipment comprises e.g. motor-operated or manually operated drive elements, moving, transfer and monitoring elements.

3 General requirements

For all parts of the equipment airlock required for safe and leak-tight sealing of the reactor containment against the outer atmosphere the same requirements as for the reactor containment shall apply as regards design, analysis, materials, manufacture, operation, tests and inspections. These requirements are supplemented by the requirements laid down in this safety standard, which result from the operation of the equipment airlock and the requirements for safety at workplace.

4 Interlocking system

4.1 General

The equipment airlock shall be provided with an interlocking system.

4.2 Purpose of interlocking system

The interlocking system shall ensure that each airlock can only be opened if the opposite door and its related pressure balancing system are closed and sealed. The interlocking system shall remain effective even in the case of failure of one or all auxiliary energies (e.g. electric, hydraulic or pneumatic power supply) and in the case of internal or external events.

4.3 Cancellation of interlocking

(1) The interlocking system shall be designed such as to make its cancellation possible and to prevent inadvertent cancellation of the system.

(2) Cancellation of the system is permitted only for conditions allowable under safety aspects.

Note:
Each cancellation of interlocking shall be subject to agreement by the supervising authority.

(3) Where, after cancellation of the interlocking system, this system has been directly rendered effective again, the proper functioning of the airlock including the signals transmitted to the control room shall be verified and documented by expert personnel of the licensee for least one complete functional cycle.

5 Pressure balancing system

Where the pressure in the reactor containment differs from that in the containment exterior, each door shall be provided with a pressure balancing system. Prior to opening the inner door it shall be possible to balance the pressure between the airlock chamber and the reactor containment, and prior to opening the outer door to balance the pressure between the airlock chamber and the containment exterior by using the respective pressure balancing system.

6 Airlock operating equipment

6.1 Motor operation

(1) The airlock operating equipment shall meet the requirements of section 4.2.

(2) The operating equipment shall actuate the pressure balancing system to section 5. The door shall be allowed to open only if the pressure has been balanced to such an extent that the door can be opened without danger (see section 8.2).

(3) The airlock operating equipment shall effect the positioning or retraction of any movable tracks as per section 9.

(4) The airlock operating equipment shall be designed such that an initiated functional sequence of operation can be

stopped or continued at any time. Reversal of the functional sequence of operation shall be possible.

(5) Those parts of the operating equipment which press the door against the seal during the sealing process shall be brought into a locked position on completion of sealing operation. It is not until this position has been reached that the door is considered to be closed, and this closed position shall be annunciated.

(6) The airlock operating equipment shall be designed such that each door is mechanically secured in its closed position.

(7) Motor-operated airlocks shall be driven by means of pushbuttons with automatic return. Upon release of the pushbutton the functional sequence of operation shall be interrupted.

(8) Each control station shall be provided with a break pushbutton to interrupt the respective functional sequence of operation.

(9) No danger shall arise from moving parts of the airlock operating equipment.

6.2 Manual operation

(1) The airlock operating equipment shall meet the requirements of 6.1 (1) to 6.1 (6) and 6.1 (9).

(2) Manual operating elements shall be clearly and evidently identified and be labeled to be readily and durably visible.

(3) All manual operating elements shall be secured against unauthorized actuation.

7 Control panels

7.1 General

Two control panels shall be provided to operate motor-operated equipment airlocks: one control panel inside the reactor containment and one outside the reactor containment.

7.2 Arrangement

The control panels shall be arranged such that the person operating the panel is outside the danger zone of the door to be moved, the pertinent transport track or any other moving part, but is able to overlook the total closing or opening operation of the respective door including any unsecured parts moving in the traffic area.

7.3 Display and control elements

(1) The control panels shall be equipped with display and control elements as per **Table 1**.

(2) The display and control elements shall be clearly arranged and be labeled to be readily and durably visible, and shall be readily accessible.

(3) Other display and control elements than those listed in **Table 1** should not be provided.

	Location			Remarks			
	Control panel in outer space	Control panel in reactor containment	Control panel in airlock chamber	Type of control elements	Colour of elements	Additional requirements for effectiveness [2]	Requirements as per para.
Display elements [1]	Inner door closed	Inner door closed			White		
	Inner door open	Inner door open			White		
	Outer door closed	Outer door closed			White		
	Outer door open	Outer door open			White		
	Actuation released	Actuation released			Green		13.3.1 13.3.2
Control elements	Open outer door	Open inner door		Pushbutton	Black	Release from control room and key-operated switch [3]	7.5.1
	Close outer door	Close inner door		Pushbutton	Black	Key-operated switch [3]	7.5.2
	Close inner door			Pushbutton under lead- seal cap	Black	Release from control room and key-operated switch [3]	7.5.2
			Open outer door	Pushbutton under lead- seal cap	Black		7.6.2
	Stop	Stop	Stop	Mushroom-type pushbutton	Red		7.6.1

[1] The display elements “Open” and “Closed” indicate the final completion of the respective functional sequence.
[2] The effectiveness of a control command additionally depends on the interlocking system to section 4.
[3] The key-operated switches shall be arranged on the respective control panel and shall be operable with the same key.

Table 1: Display and control elements for equipment airlocks

7.4 Operating instructions

Brief and readily visible operating and safety instructions shall be durably attached on the control panels to include specific notes on

a) the prohibition of transfer of personnel,

b) keeping free the radius of operation of movable parts.

7.5 Effectiveness of control commands

7.5.1 Opening of airlock doors

The effectiveness of the control command “Open door” shall be restricted to the respective door to be controlled. The command “Open door” shall only become effective if

a) its actuation has been released from the control room,

b) the key-operated switch of the respective control panel has been switched on, and

c) the opposite door is closed.

7.5.2 Closing of airlock doors

The effectiveness of the control command “Close door” shall be restricted to the respective door to be controlled. Such a command shall only become effective if the key-operated switch on the control panel assigned to the respective door has been switched on. In addition, a pushbutton “Close inner door” under a lead-seal cap shall be provided on the control panel on the outside of the reactor containment to cover special situations. This pushbutton shall only become effective if

a) its actuation has been released from the control room and

b) the key-operated switch of the control panel on the outside of the reactor containment has been switched on.

7.6 Additional operating elements in the airlock chamber

(1) Stop pushbuttons shall be provided in the airlock chamber, one near the inner door and one near the outer door at readily visible and accessible safe locations. The actuation of one of these stop pushbuttons shall interrupt movement of both doors; the initiation of movement in the correspondingly opposite direction shall, however, be further possible.

(2) An emergency pushbutton “Open outer door” shall be provided in the airlock chamber under a lead-seal cap. The effectiveness of this pushbutton shall meet the interlocking requirements as per 4.2. The release or blocking of functions from the control room shall not be possible. The actuation of this pushbutton shall be annunciated by an optical and acoustic signal in the control room [see cl. 13.2 (2)].

8 Doors

8.1 Neutral position

Where no transfer operations through the lock are effected, both airlock doors shall be closed and sealed as well as both pressure balancing systems be closed.

8.2 Safeguarding against pressure differentials

The airlocks shall be designed such that the doors will not fling open due to pressure differentials still prevailing.

8.3 Hazard zones

The hazard zones of doors and transportation tracks shall be clearly marked (see section 9). Shear and squeeze locations on other movable parts shall be made safe in hazard zones within reach of personnel (see DIN EN ISO 13587).

9 Movable transportation tracks

In the vicinity of each door, airlocks may be equipped with transportation tracks which

a) when in position with the door opened, provide the track,

b) when retracted make closing of the door possible.

The positions of the transportation tracks shall be secured in each of these final positions.

10 Sight glasses

Inside and outside the reactor containment each airlock shall be provided with a sight glass each of at least 150 mm clear opening. The sight glasses shall be arranged such that the airlock chamber can be sufficiently viewed. The sight glasses shall be protected against breakage and meet the requirements of 14.1.

11 Voice communication system

11.1 Direct connection to the control room

Each control panel shall be provided with a direct connection to the control room telephone system. A further direct connection to the control room telephone system shall be provided in the airlock chamber.

11.2 Voice communication system between the control panels

Between the control panel inside and outside the reactor containment a voice communication system shall be provided which the control room can join in at any time.

12 Access to the airlock

The opening action of and access to the airlock shall be monitored. In the case of equipment transfer the accompanying personnel shall be allowed to enter the airlock, but transfer through the airlock of personnel is prohibited. The respective open door shall not be closed until the accompanying personnel have left the airlock again. Unauthorized opening and entering the airlock shall be prevented by design measures and operating instructions.

Note:
In special cases the equipment airlock may be used, upon opening of both airlock doors, as transfer passage at reactor shutdown under plant-specific conditions to be laid down (section 4.3).

13 Equipment in the control room

13.1 Displays

The respective end position of all airlock doors shall be displayed in the control room.

13.2 Signal indication

(1) Optical and acoustic signals shall be indicated in the control room if both doors of an airlock are not closed. This shall be independent of whether it is caused by airlock malfunction indication or cancellation of door interlocking to section 4.3.

(2) Optical and acoustic alarm signals shall be indicated in the control room if the emergency pushbutton in the airlock chamber [see cl. 7.6 (2)] has been activated.

13.3 Release of actuation

(1) For each motor-operated airlock a secured operating element shall be provided for the release of the control panels.

(2) Where transfer through the airlock is supervised by a guard it is permitted to transfer the actuation possibilities as per (1) from the control room to this guard. It shall, however, be possible at any time to cancel this release from the control room.

14 Design requirements

14.1 Design

As regards mechanical strength, temperature and radiation resistance as well as airlock leak-tightness, the air lock, each of its doors and all structural parts required to maintain leak-tightness shall be designed to withstand the consequences of an incident in the reactor containment as well as of external impact loadings (e.g. earthquake, blast waves, aircraft crash) to the same standards as for the reactor containment.

14.2 Arrangement of airlock operating equipment

All parts of the operating equipment not necessarily required in the airlock chamber or reactor containment shall be provided outside the reactor containment.

14.3 Hydraulic and pneumatic systems

Hydraulic and pneumatic systems shall be designed such as to safely withstand external pressure and temperature loadings even in case of incidents and in no case to cause inadmissible leakage from the reactor containment. External pressure loadings shall specifically be taken into account for seals of these systems the sealing effectiveness of which depends on the direction of pressure loading.

14.4 Power supply lines

In traffic areas, the power supply and control lines as well as hydraulic and pneumatic system lines shall be protected against unintentional mechanical damage.

14.5 Decontamination

When designing the airlock care shall be taken to ensure that it can be decontaminated.

15 Inspection and documentation

15.1 Design approval

Strength calculations, drawings and fabrication documents shall be submitted to the authorised inspector for design approval.

15.2 Initial inspection

Prior to commissioning airlocks shall be subjected to an initial inspection consisting of a final inspection, pressure test and acceptance test where the authorized inspector shall be involved. In addition, a leak-tightness and functional test shall be performed in the presence of the authorised inspector prior to commissioning the airlock.

15.3 In-service inspections

The requirements of KTA 3401.4 apply to in-service inspections.

15.4 Documentation

All tests and inspections, maintenance work and repairs shall be documented.

16 Operation and maintenance

Instructions for airlock operation and maintenance shall be established.

17 Personnel

Only specifically trained personnel having been made familiar with the airlock shall be charged with equipment airlock operations.

Appendix A

Regulations Referred to in the Present Safety Standard

(Regulations referred to in this safety standard are valid only in the version cited below. Regulations which are referred to within these regulations are valid only in the version that was valid when the latter regulations were established or issued.)

AtG		Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) Atomic Energy Act in the version promulgated on July 15, 1985 (BGBl. I, p. 1565), most recently changed by article 1 of the act dated December 4, 2022 (BGBl. I, p. 2153)
StrSchG		Act on the Protection against the Harmful Effect of Ionising Radiation (Radiation Protection Act - StrlSchG) Radiation Protection Act of June 27, 2017 (BGBl. I, p. 1966), most recently changed by the promulgation of January 3, 2022 (BGBl. I, p. 15)
StrlSchV		Ordinance on the Protection against the Harmful Effects of Ionising Radiation (Radiation Protection Ordinance - StrlSchV) Radiation Protection Ordinance of November 29, 2018 (BGBl. I, p. 2034, 2036), most recently changed by article 1 of the ordinance dated October, 2021 (BGBl. I p. 4645)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) of November 22, 2012, amended version of March 3, 2015 (BAnz AT 30.03.2015 B2), most recently changed as promulgated by BMUV on February 25, 2022 (BAnz AT 15.03.2022 B3)
Interpretions of SiAnf	(2015-03)	Interpretations of the safety requirements for nuclear power plants of November 22, 2012, of November 29, 2013 (BAnz AT 10.12.2013 B4), changed on March 3, 2015 (Banz AT of March 30, 2015 B3)
KTA 3401.4	(2022-11)	Steel Containment Vessels; Part 4: In-service Inspections
DIN EN ISO 13857	(2020-04)	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2019); German version EN ISO 13857:2019