Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3402 (2009-11)

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

(Schleusen am Reaktorsicherheitsbehälter von Kernkraftwerken - Personenschleusen -)

Previous version of this Safety Standard was issued 1976-11

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

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KTA SAFETY STANDARD

2009-11	Airlocks on the reactor containment of nuclear power plants - Personnel airlocks -	KTA 3402

CONTENTS

PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 50-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger No. 72a on May 12, 2010. Copies may be ordered through the Carl Heymanns Verlag KG, Luxemburger Str. 449, D-50939 Koeln (Telefax +49-221-94373-603).

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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.

Fundamentals

(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 facility (Sec. 7, para. 2, subpara. 3 Atomic Energy Act) in order to attain the protection goals specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and which are further detailed in the "Safety Criteria for Nuclear Power Plants" and in the "Guidelines for the Assessment of the Design of PWR Nuclear Power Plants against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (StrlSchV) - Incident Guidelines" (in the version published on 18th October.1983).

(2) In Criterion 8.2, "Design Bases of the Safety Enclosure", the Safety Criteria for Nuclear Power Plants require, 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 fluids, reaction forces and breakage. Safety standard KTA 3402 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 personnel airlocks on the reactor containment are met during plant operational lifetime, i.e. to

a) prevent inadmissible release of radioactive material into the environment also during transfer operations through the airlock,

b) make possible escape and rescue operations from the reactor containment,

c) prevent unauthorized access to the reactor containment by taking specific design and supplementary administrative measures.

1 Scope

This safety standard applies to personnel airlocks on reactor containments of nuclear power plants. This safety standard does not apply to airlocks which are exclusively intended for the transfer of equipment and material, but not for the transfer of personnel.

2 Definitions

(1) Manually operated airlock

An airlock whose movable parts can only be operated directly or indirectly by muscular power.

(2) Motor-operated airlock

An airlock the movable parts of which can be operated by a power other than muscular power, even though manual operation is additionally possible in the case of emergency.

(3) Personnel airlock

Any airlock authorized for the transfer of personnel even if it is intended for the transfer of equipment or material.

(4) 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.

(5) Airlock

For the purpose of this safety standard an airlock is a pressure-resistant and technically gas-tight 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.

(6) Airlock chamber

The space enclosed by the two airlock doors of the airlock body.

3 General requirements

Airlocks shall satisfy federal and state rules and regulations as well as the accident prevention regulations of the legal accident insurance corporations and shall be manufactured and operated to the generally recognized rules of technology.

As regards design, analysis, materials, manufacture, operation, tests and inspections the same requirements as for the reactor containment apply.

4 Basic requirements for personnel airlocks

4.1 Arrangement

Personnel airlocks shall be arranged such as to ensure escape from the reactor containment as rapidly as possible and with as little as possible radiation exposure of personnel. Besides radiation fields and contaminations consideration shall be given to the possibility of escape routes being blocked, e.g. by leaking out media such as water, steam or gases.

4.2 Access

The access routes to both sides of the airlocks shall always be kept free and be arranged such that the transport of injured persons on stretchers is also possible.

4.3 Minimum number

Each reactor containment shall be equipped with at least two airlocks which, in case of need, make escape from the reactor containment possible at any time.

4.4 Size

The airlock used to enter and leave the reactor containment during normal operation shall be sized such as to accommodate all persons simultaneously staying within the reactor containment.

At least two airlocks shall ensure the transport of one injured person by two persons carrying him on stretchers or other suitable means.

5 Interlocking system

5.1 Interlocking of airlock doors

An interlocking system shall ensure that each airlock door can only be opened if the second door and its related pressure balancing system are closed and sealed.

5.2 Cancellation of interlocking

The interlocking system shall be designed such as to make its cancellation possible, but also to prevent unauthorized or

unintentional cancellation of the system. Cancellation of the system is principally not permitted except for conditions allowable under safety aspects.

5.3 Renewed interlocking of the door

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 at least one complete functional cycle.

6 Pressure balancing

6.1 Pressure balancing systems

(1) For transfer operations 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.

(2) The pressure balancing systems to (1) shall remain free from icing even during incidents.

(3) The inlet openings of the pressure balancing systems to (1) shall be designed such as to avoid functional impairment of the pressure balancing systems by dirt accumulation.

6.2 Pressure balancing times

(1) The time during which the differential pressure on the airlock is reduced to half its value (half-value period) shall be used as characteristic value for pressure balancing.

(2) The pressure balancing systems to para. 6.1 (1) shall permit the setting of the time period required for pressure balancing.

(3) The settings possible as per (2) shall be safeguarded against unintentional maladjustment.

(4) The half-value period to be set for pressure balancing shall be as short as possible. In this respect, the physiologically allowable stress levels for the human body shall be taken into account.

Note:
It is assumed that pressure balancing approximates an exponential function and thus can sufficiently be characterized by its half-value period.

Until presence of sufficient knowledge on the allowable physiological stress limit of the human body the half-value period should be set to be not below 15 seconds. For safety purposes, the adjustment range should, however, extend down to 5 seconds as shortest half-value period.

6.3 Opening of doors without pressure balancing

(1) It shall be possible to open each door prior to completion of pressure balancing if the existing pressure differential does not exceed 0.1 bar.

(2) The airlocks shall be designed such that the doors cannot fling open due to pressure differentials still prevailing.

7 Transfer priorities

(1) The following priorities are laid down for airlock transfer operations:

Persons in the airlock chamber have priority

over persons in the reactor containment

over persons in the containment exterior.

(2) The airlock users shall be permitted to decide whether and how they want to exercise their priority rights.

(3) It shall not be possible to make the priority of transfer ineffective by overriding the operating equipment.

(4) Contrary to the requirements of (1), (2) and (3) it shall be possible to manually stop and re-open each closing door as long as closing is not completed (see Sec. 10.3).

8 Operating equipment

8.1 Manually operated airlocks

(1) The operating equipment shall meet the requirements of 5.1 and 7 (1).

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

(3) The operating equipment shall automatically trip the pressure balancing process as per section 6.

(4) The operating equipment shall be designed such that the sequence of operation can be started, stopped, continued and be reversed at any time in due consideration of the respective priorities of transfer.

(5) That operating equipment which presses 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) Manual operating equipment shall be clearly and evidently identified and be labeled to be readily and durably visible.

8.2 Motor-operated airlocks

(1) The operating equipment shall meet the requirements of 5.1, 6.3 and 7 (1).

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

(3) The operating equipment shall automatically trip the pressure balancing process as per section 6. The door shall be allowed to open only if the pressure has been balanced to a sufficient extent.

(4) The operating equipment shall be designed such that the sequence of operation can be started, stopped, continued and be reversed at any time in due consideration of the respective priorities of transfer.

(5) That operating equipment which presses 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) Motor-operated airlocks shall be driven by means of pushbuttons with automatic return.

(7) The pushbuttons to (6) shall be designed such that priority of transfer to section 7 can be exercised by continued actuation of the respective pushbutton. During this interval all

control commands of subordinate priority shall remain ineffective.

(8) Each control station shall be provided with a break pushbutton to interrupt the respective operational sequence. The break pushbuttons shall be arranged accordingly in the priority sequence as per section 7.

(9) That control command shall be executed which has been the last to be effectively released.

(10) It is permitted to provide airlocks with movable transport tracks in the vicinity of the doors, which

a) in position, with the door open, provide the track,

b) upon retraction make closing of the door possible.

The transport tracks shall be secured in each of their final positions.

8.3 Manual emergency operation of motor-operated airlocks

(1) Each motor-operated airlock shall be manually operable in case of emergency. The manual force required for emergency actuation shall not exceed 200 N.

(2) The emergency drive shall provide all positive operations and interlocks required for motor operation as well as the priorities of transfer as per by 7 (1) and 7 (3).

(3) The emergency drive shall be operable from inside the airlock chamber and from the interior and exterior of the reactor containment.

(4) Brief and readily visible operating instructions shall durably be provided in the proximity of the control elements.

(5) The emergency drive shall be secured against unauthorized actuation from the exterior of the reactor containment.

9 Control panels

(1) The control elements of motor-operated airlocks shall be neatly comprised in the reactor containment, in the airlock chamber and in the containment exterior on a control panel each. The control panels shall be clearly and durably labeled and shall be readily visible and accessible.

(2) The control panels shall be arranged in proximity of the door such that when operating the controls the operator does not stay in the operating radius of either a door or a movable transport track.

(3) The control panels shall be equipped with display and control elements as per **Table 1**. Additional display and control elements should not be provided on the control panels. The control elements shall be distinctly set apart from each other and be arranged as evidently as possible. Furthermore, the display elements shall be evidently assigned to the control elements.

10 Doors

10.1 Position of doors

(1) While persons stay in the reactor containment, all airlocks that are not in use shall be in the locked position “Inner door open”.

(2) In the case of motor-operated airlocks the locked position to (1) shall be attained automatically by a proper operational sequence, and this independently of whether or not inward or outward transfer operations have been performed.

(3) Where no persons stay in the reactor containment, both airlock doors may be closed and sealed and both pressure balancing systems be closed. It shall, however, be ensured that during inward transfer of persons all airlocks are brought into the locked position “Inner door open”.

10.2 Operating area of doors

The door operating area shall be clearly marked and be kept free from obstacles and edges over which people may stumble.

10.3 Anti-squeeze protection

(1) As regards closing operations, the doors shall be provided with an anti-squeeze protection to BGR 232, section 4.5, where upon its actuation the door can be stopped by muscular power and pushed open against the closing direction. In the case of motor-operated airlocks the actuation of the anti-squeeze protection may also effect the movement of the door in the reverse direction as long as the anti-squeeze protection button is pressed.

(2) The doors and their surroundings should be designed such that an anti-squeeze protection in the direction of opening is not required.

(3) Where the requirement to (2) cannot be met, an anti-squeeze protection shall also be provided for the direction of opening and shall satisfy the requirements of (1) accordingly.

11 Unauthorized access to the reactor containment

(1) Uncontrolled or unauthorized access to the airlocks from the containment exterior is prohibited. Despite all measures taken unhindered rapid escape from the reactor containment shall be possible at any time in case of danger.

(2) In the case of motor-operated airlocks, and separately for each airlock, it shall be possible, from the control room, to switch on or off the control voltage required for opening the outer door from the containment exterior.

(3) Where transfer operations through the airlock are supervised by a guard it is permitted to transfer the switch-on/off operations as per (2) from the control room to this guard.

(4) In the case of manually operated airlocks the requirements as per (1) may e.g. be met by arranging another door between the outer door and the containment exterior, which can be opened from the outer door without restrictions, however from the containment exterior only with a special key or upon controlled release from the control room.

	Control panel located in			Colour of display elements
	Outer space	Airlock chamber	Reactor containment	
Display elements	Inner door open	Inner door open	Inner door open	White
	Inner door closed	Inner door closed	Inner door closed	White
	Outer door open	Outer door open	Outer door open	White
	Outer door closed	Outer door closed	Outer door closed	White
	Actuation released			Green
Control elements				Type of control element
	Outer door open (only effective upon release of actuation)			Pushbutton black
		Outer door open		Mushroom button black
		Inner door closed		Pushbutton black
			Inner door open	Mushroom button black
	Stop	Stop	Stop	Mushroom button red

Table 1: Control panels

12 Additional safety equipment

12.1 Telephones

Each airlock chamber shall be provided with a telephone extension which either connects directly or through dialling with the control room, and with a direct connection to the control room telephone system.

12.2 Sight glasses

Each airlock door shall be provided with a sight glass of at least 150 mm clear opening at a height of approximately 1.5 m. This sight glass shall meet the requirements of 14 (1). The sight glass in the outer door should be removable from the containment exterior.

12.3 Emergency access

It shall be possible to provide emergency access from the outer space to the airlock chamber. To this end, the airlock shall be provided with a manhole that can be opened from the containment exterior, or it shall be ensured that the outer door can be opened with the aid of tools within relatively short period of time. The emergency access shall only be opened if the inner door and its related pressure balancing system are closed.

12.4 Maintained emergency lighting

The airlocks shall be provided with maintained emergency lighting. The illuminance in the airlock and near the operating equipment shall be at least 30 lx.

13 Equipment in the control room

(1) The respective position of all airlock doors shall be displayed in the control room.

(2) 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 or cancellation of door interlocking to section 5.2.

(3) In the containment exterior a secured button for the release of control panel actuation shall be provided for each motor-operated airlock.

(4) Motor-operated airlocks which can be brought into the locked position “Both doors closed” [see 10.1 (3)], shall be provided with a secured operating button (e.g. key-operated switch) with which they can be brought into this position.

(5) Where transfer through the airlock is supervised by a guard it is permitted to transfer the actuation possibilities as per (3) from the control room to this guard.

14 Design requirements

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

Deformations resulting from such loadings shall not lead to functional impairment of the mechanical parts of the airlock.

(2) All parts of the operating equipment not necessarily required in the airlock chamber or reactor containment shall be provided in the containment exterior.

(3) Hydraulic and/or pneumatic systems shall be designed such as to safely withstand external pressure loadings even in case of incidents and in no case to cause inadmissible leakage from the reactor containment.

(4) Type testing shall be performed on the electrical components of the operating equipment to verify that their functional capability is ensured under incident conditions.

(5) In traffic areas, the energy supply and control lines as well as hydraulic and pneumatic systems shall be safeguarded against unintentional mechanical damage.

(6) In case of need, the energy for controls, motor drive and lighting shall be supplied by the emergency power system.

(7) 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 test shall be performed in the presence of the authorised inspector prior to commissioning the airlock. Functional testing under design pressure as well as the pressure test may be performed along with the pressure test of the reactor containment.

15.3 In-service inspections

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

15.4 Documentation

All tests and inspections shall be documented.

16 Operation and maintenance

Short instructions for airlock operation and maintenance instructions shall be established for the handling, operation and maintenance of airlocks.

17 Training of personnel

Before starting airlock operation the personnel intended for work to be done in the reactor containment shall be trained to become familiar with the operation of each personnel airlock also with regard to functional disturbances. This training shall be repeated at maximum intervals of 12 months and successful training shall be verified by an examination.

Annex A

Regulations Referred to in this 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.)

Atomgesetz (AtG)		Act on the Peaceful Use of Atomic Energy and the Protection against its Hazards (Atomic Energy Act) dated 23 December 1959 (BGBl. I, p. 814) as published on 15 July 1985 (BGBl. I, 1985, No. 4, p. 1565), at last amended by Article 1 of the law dated 17 March 2009 (BGBl. I, 2009, No. 15, p. 556)
BGR 232		Regulations of the accident insurance corporations for safety and health at work; BR rules “Power operated windows, doors and gates” dated April 1989, editorially revised edition 2003
KTA 3401.4	(1991-06)	Steel Containment Vessels; Part 4: In-service Inspections