Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3605 (2017-11)

Treatment of Radioactively Contaminated Gases in Nuclear Power Plants with Light Water Reactors

(Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasserreaktoren)

The previous versions of this safety standard were issued in 1989-06 and 2012-11

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KTA SAFETY STANDARD

November 2017	**Treatment of Radioactively Contaminated Gases in Nuclear Power Plants with Light Water Reactors**	KTA 3605

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Contents

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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, 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 objective to specify safety-related requirements, compliance of which provides the necessary precautions in accordance with the state of the art in science and technology against damage arising from the construction and operation of the facility (Sec. 7 para. 2 subpara. 3 Atomic Energy Act - AtG) in order to achieve the fundamental safety functions specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants as well as in the Interpretations of the Safety Requirements for Nuclear Power Plants.

(2) In fulfillment of the licensing prerequisites pursuant to Sec. 7 AtG for the construction and operation of the plant, facilities are provided, among other things, for retaining solid, liquid and gaseous radioactive substances within their designated enclosures, for handling and the controlled conveyance of radioactive substances within the plant as well as for the monitored discharge of radioactive substances via the designated paths. Concrete safety related requirements for these facilities are specified in safety standard series KTA 3600.

(3) The present safety standard regarding gaseous waste processing systems contains requirements for their design, arrangement, construction and tests, the fulfillment of which serves, in particular, to attain the following protective goals:

a) The amount of radioactive substances discharged with the exhaust air during specified normal operation shall be kept as low as possible in accordance with the radiation protection principles pursuant to StrlSchV.
b) The radiation exposure of the personnel caused by radioactive substances in the room air shall be kept as low as possible in accordance with the radiation protection principles pursuant to StrlSchV.

(4) The gaseous waste processing systems must perform the following tasks:

a) accepting and conveying radioactive gaseous waste from nuclear systems, and
b) reducing the content of radioactive substances in the gaseous waste as well as its controlled discharge into the atmosphere with the vent air.

In this context, parts of the gaseous waste processing systems must perform additional tasks regarding limiting the concentrations of hydrogen or oxygen.

(5) Activity measurements are important for assessing the functional safety of the gaseous waste processing systems. Requirements for the measuring equipment used for this purpose are not contained in the present safety standard; they are specified in safety standard KTA 1503.1.

(6) Requirements regarding fire protection are specified in safety standard KTA 2101, Parts 1, 2 and 3.

(7) Requirements regarding explosion protection are specified in safety standard KTA 2103.

1 Scope

(1) This safety standard applies to systems for the collection, conduction and processing of radioactively contaminated gaseous wastes in nuclear power plants with pressurized water reactors, PWR for short, and in nuclear power plants with boiling water reactors, BWR for short. This safety standard also contains requirements for components and pipes of other systems which are connected to the gaseous waste processing system in as far as these requirements concern the conduction of the gaseous wastes.

(2) The following systems do not fall within the scope of this safety standard:

a) Systems for the leakage extraction of the containment vessel,
b) Systems for measuring and limiting the hydrogen concentration inside the containment vessel after a design basis accident,
c) Systems for the selective ventilation of rooms and or room groups (nuclear air supply and ventilation systems),

   Note:
   Requirements for these systems are specified in safety standard KTA 3601.

d) Turbine condenser with its exhaust equipment (PWR),
e) Turbine condenser with primary steam admission out to the gaseous waste extraction nozzle (BWR).

2 Definitions

(1) Gaseous wastes in nuclear power plants

Gaseous wastes in nuclear power plants are gas mixtures from activity-containing systems; these gas mixtures may be contaminated by radioactive substances. They are primarily composed of nitrogen, oxygen, hydrogen, carbon dioxide, argon, xenon, krypton and steam.

(2) Activity retaining devices

Activity retaining devices are devices for reducing the content of radioactive admixtures in gaseous waste streams through, e.g.,

a) activated charcoal adsorbers,
b) buffer tanks,
c) iodine sorption filters, or
d) aerosol filters.

(3) Conveying devices in gaseous waste processing systems

Conveying devices in gaseous waste processing systems are devices (e.g., steam blasters, compressors, ventilators) for transporting gaseous wastes.

(4) Gaseous waste processing systems

Gaseous waste processing systems are systems for the accumulation and treatment of gaseous wastes. They consist of facilities for the transport of gasses, for the activity retention and, if necessary, for the recombination of hydrogen and oxygen.

(5) Recombination equipment

Recombination equipment is equipment for reducing the concentration of hydrogen in gaseous wastes; it is comprised of a gas superheating or gas drying device, a catalytic recombiner and a condensing device.

(6) Retention time

The retention time of a gas component is the arithmetic mean weighted over the distribution frequency of the dwell time of this gas component in the gaseous waste processing system. It is dependent on the chemical and physical properties of the respective gas component.

(7) Pre-operational and operational evacuation facilities

Pre-operational and operational evacuation facilities are facilities for the evacuation of primary-steam-charged turbine condensers in BWR.

(8) Flammable mixture

A flammable mixture is a mixture of gases in which a combustion reaction will self-propagate as soon as an ignition source becomes effective.

3 System Design

3.1 Group Classification of Gaseous Wastes, Requirements for Gaseous Waste Processing Systems

(1) In order to reduce radioactive contamination, gaseous wastes from nuclear systems shall normally be treated in accordance with the respective group class of the gaseous wastes. The classification of the gaseous waste sources as gaseous waste groups A, B or C, and the respective requirements are listed in **Table 3-1** for PWRs and in **Table 3-2** for BWRs.

(2) With regard to activity retention, the requirements specified in **Table 3-1** shall be met for PWRs and those in **Table 3-2** for BWRs.

3.2 General Requirements

(1) Gaseous waste processing systems shall be gastight as specified in Section 3.8 or be under an underpressure with regard to the building atmosphere in order to keep the transfer of radioactive gases into the buildings at a minimum.

(2) Gaseous waste processing systems shall be designed, arranged, shielded and operated such that the radiation exposure of the personnel is kept at a minimum.

(3) The gaseous waste processing systems shall basically be designed and operated in such a way that no flammable mixtures can occur. This requirement may be deviated from, provided, the system components involved are designed for the possibility of a postulated spontaneous combustion reaction.

Notes:

(1) A mixture of $H_2/O_2/N_2$ is not flammable at atmospheric pressure if

a) the H_2 concentration is lower than or equal to 4 % by volume, or

b) the O_2 concentration is lower than or equal to 5 % by volume.

(2) Additional requirements for the design and operation of gaseous waste processing systems are specified in safety standard KTA 2103.

(4) The requirement specified under para. (3) may also be fulfilled by the process of dilution.

3.3 Conveying Devices

(1) If an underpressure can occur in connected components as a result of the mode of operation of the gaseous waste processing system (e.g., filling level changes, changes of pump suction pressure), the design of the conveying devices shall be based on the maximum underpressure that can occur.

(2) The underpressure may be limited by vacuum breakers which shall be arranged such that an isolation of the conveying devices can be excluded.

(3) If a conveying device serves the purpose of extracting seal leakages (e.g., stuffing box leakages) the leakage mass flow shall be limited by special devices in such a way that an overfeeding of downstream system parts is avoided.

(4) The leakage mass flow may be limited, e.g., by

a) restricting orifices at the leakage extraction locations, or

b) monitoring the temperature behind the leakage condensing device and closing the isolation valves as soon as specified threshold limits are reached.

(5) Devices shall be provided which enable the detection of seal leakages (e.g., in water or steam carrying systems, at sight glasses or temperature measuring points). Connecting several extraction points to one leakage detection unit is permissible, provided, this will not hinder the identification of the individual leakage.

(6) In order to achieve a continuous extraction of the gaseous waste generated in the turbine condenser of a BWR during power operation, the design shall provide redundant operational evacuation facilities. In this context, the changeover switching time shall be sufficiently short to prevent a shutdown of the turbine facility.

(7) If facilities are used for the pre-evacuation of a turbine condenser pressurized with primary steam, a flow rate increase may occur during changeover switching to the operational evacuation equipment. These flow rate increases shall be taken into account in the design of the evacuation unit and of the downstream system parts.

3.4 Recombination Equipment

(1) Recombination equipment the short-term failure of which would require a shutdown of the nuclear power plant for safety reasons shall be designed to be redundant.

(2) When using a catalytic recombiner, a covering of the catalytic surface by inflow of water or by steam condensing on the catalyst shall normally be prevented. This may be achieved, e.g., by superheating or drying the gas stream.

(3) The various operationally relevant influences on the catalyzer, such as necessary dwell times to ensure a proper reaction, wear resistance, permissible maximum flow velocities, necessary distance from the dew point, and the permissible as well as optimal operating temperatures, shall be taken into account. The radiation resistance of the catalyst may be verified by its proven service life or by laboratory experiments.

(4) With regard to a sustained functional capability, the recombination equipment shall be designed such that

a) the dwell times are sufficiently long, and

b) the frictional wear of the catalyst material caused by mechanical loads is limited (e.g., by inserting metal sheets as flow directors and thereby preventing a redistribution).

(5) When using steam as a dilution medium, the recombination equipment shall fulfill the following additional requirements:

a) Recombination equipment shall be designed and operated with special regard to reliability. In this context, devices for superheating and for removing condensate shall be provided. In order to ensure a stable and effective catalytic reaction, the amount of diluting steam shall be chosen such that a sufficiently high operating temperature and a sufficiently large dewpoint distance are achieved.

   Note:

   At atmospheric operating pressures a reaction temperature of 300 °C is recommended.

b) Monitoring systems shall be provided that will enable a timely changeover switching to a redundant recombination equipment in the case of malfunctions.

c) To ensure the availability of the standby recombination equipment, the catalyst bed shall be provided with a heater unit in order to prevent condensation on the catalyst. During standby, this heater unit shall be kept in permanent operation.

d) A backflow of inflammable gas mixtures into the redundant catalytic recombiner during failure of the operating recombination equipment shall be prevented. This may be achieved, e.g., by a continuous flushing of the redundant recombination equipment with an air and steam flow.

(6) Monitoring systems shall be provided for the timely detection of any water backpressure endangering the functionality in the case of malfunction of the condensate removing device.

3.5 Gas Proportioning Devices and Concentration Measuring Equipment

(1) Permanently installed concentration measuring equipment shall be designed such that a reliable operation is ensured despite fluctuations of gas concentration, humidity and operating pressure. Requirements regarding integrity of the particular system section shall also be applied to the respective concentration measuring equipment.

(2) When using proportioning devices for H_2 and O_2 it shall be ensured that

a) any gas injection is performed only after the concentration of the respective gas in the gaseous waste stream has been measured, and only if this concentration is also monitored during the injection process,

b) a simultaneous injection of H_2 and O_2 is avoided, and

c) injection is automatically interrupted whenever impermissible H_2 and O_2 concentrations are detected in the gaseous waste stream (cf. Section 3.2, para. (3)).

3.6 Activity Retaining Devices

(1) The retention times for the noble gases xenon and krypton during constant power operation shall be at least as listed in **Tables 3-1** and **3-2**.

Note:
The retention time is influenced by the moisture of the activated charcoal. This shall be taken into account when adjusting the moisture of the gas stream.

(2) When determining the retention characteristics of the activated charcoal, the factors influencing the relevant holdup characteristics (e.g., humidity, temperature, operating pressure and flow velocity) shall be accounted for in the design. The radiation resistance of the activated charcoal may be verified by a proven service life or by laboratory experiments.

(3) The operating temperature of the activated charcoal shall normally be below 50 °C.

(4) The material characteristics of activated charcoal with regard to its ultimate strength should be such that the grain size distribution is not significantly changed by a mechanical or pneumatic transport.

(5) The self-ignition temperature of the activated charcoal shall normally not be lower than 300 °C.

(6) Measures shall be taken that will prevent the occurrence of a fire, that will ensure a timely fire detection and that will limit the extent of the fire (e.g., suitable gas concentration measurement, sampling equipment, temperature measurement).

(7) For operating conditions with only a brief increase of the gas flow (e.g., shift gas operation), the retention time to be achieved by the design of the activity retaining device shall be at least 80 % of the respective values listed in **Tables 3-1** and **3-2**.

(8) The gas velocity shall be selected such that a liquefaction of the fixed-bed is prevented.

(9) In the case of an intermittently operated buffer tank, the gaseous waste discharge shall be controlled in order to prevent any impermissible discharge of activity. This may be effected by, e.g.,

a) preventing a simultaneous opening of the inlet and outlet valves, or

b) closing the outlet valves as soon as the operational limits for the activity discharge are reached.

(10) It shall be ensured that the permissible operating overpressure in a buffer tank is not exceeded. This can be achieved, e.g., by a limitation of the gaseous waste injection.

(11) The use of iodine sorption filters is subject to the respective requirements applying to the systems for the selective ventilation of rooms and room groups (cf. safety standard KTA 3601). The requirements regarding retention of methyl iodide shall be met as listed in **Tables 3-1** and **3-2.**

(12) Aerosols shall be filtered out by high-efficiency particulate air filters of at least Filter Class E12 in accordance with DIN EN 1822-1. The use of high-efficiency particulate air filters is subject to the respective requirements applying to the systems for the selective ventilation of rooms and room groups.

3.7 Sampling Equipment

(1) Sampling equipment shall be designed and arranged in such a way that representative gaseous waste samples can be taken for checking the efficiency of the procedures employed.

(2) The sampling equipment shall be provided downstream directly after the recombination equipment as well as in front of and downstream directly after the activity retaining devices.

3.8 Leak Tightness of Systems

(1) The leak rate of system sections subjected to underpressure during operation shall be sufficiently low such that the gaseous waste stream will not increase far enough to interfere with plant operation. This requirement shall be considered as being fulfilled if the leak tightness of this system section is verified within the scope of the system pressure test.

(2) The leak rate of system sections subjected to overpressure during operation shall be sufficiently low such that the integral leak rate, L, for the sum of the sections under overpressure will not exceed the following limit values:

a) Gaseous waste group A:
L smaller than or equal to 10^{-3} hPa $dm^3 s^{-1}$,

b) Gaseous waste group B:
L smaller than or equal to 10^{-1} hPa $dm^3 s^{-1}$.

(3) Systems containing gaseous wastes of gaseous waste group C shall be subject to the same leak tightness requirements that apply to systems for the selective ventilation of rooms and room groups (cf. safety standard KTA 3601).

(4) The following tests shall be used to verify that the permissible leak rate of system parts operated under overpressure is not exceeded:

a) Test by the pressure decay method or the sustained pressure method with a gaseous medium, or

b) Helium leak test for gaseous waste group A, and bubble formation test (e.g., Nekal test) for gaseous waste groups B and C.

4 Arrangement and Design

4.1 Arrangement

(1) The arrangement of the gaseous waste processing systems shall be subject to the corresponding requirements of safety standard KTA 1301.1.

(2) System parts, the functional capability of which would be significantly affected by water (e.g., recombination equipment and activity retaining devices), shall be protected against inflow of water from possible malfunctions. This protection may be provided, e.g., by an appropriate arrangement of the system parts or by additional features such as float valves, level-controlled isolating valves or fluid level monitors.

4.2 Design and Construction

(1) Those system sections subject to the requirement specified under Section 3.8, para. (2), item a), shall normally be designed and constructed for high leak tightness (e.g., welds, bellow- or diaphragm-type valves, canned motors, shaft penetrations with mechanical seals).

(2) In the case of such components for handling bulk materials which may get contaminated during regular operation, preventive measures shall be taken against room air contamination when bulk materials are unloaded. The protection against room air contamination can be ensured, e.g., by using service bags, proportioning devices or exhaust devices

Note:

Using operating media (e.g., drying gels or catalysts) with a low chloride content can be a preventive measure against damage of downstream systems.

5 Instrumentation and Control Systems

(1) Equipment shall be provided with which control tasks for the prevention of impermissible operating conditions can be performed at short notice, either automatically or by remote control from a permanently manned control station. The measuring values and alarm signals required for these control tasks shall be displayed in this control station.

(2) As far as systems for the processing of gaseous waste group A are concerned, the measuring values necessary for assessing of the respective functions and the alarm signals shall normally be displayed in the main control room of the power plant. In addition, the main control room shall normally also be provided with equipment for remotely controlling the tasks outlined in para. (1).

(3) Measures for limiting the concentrations of H_2 and O_2 (e.g., by dilution or recombination) shall be monitored continuously by measuring equipment.

(4) If proportioning devices for H_2 and O_2 are provided, the O_2 concentration shall additionally be measured directly downstream from the proportioning devices. The injection of H_2 and O_2 shall be adjusted such that an occurrence of impermissible concentrations is prevented.

(5) Threshold values shall be specified in order to meet the requirement under Section 3.2, para. (3). These threshold values shall be monitored independently from the control system. An alarm signal shall be issued as soon as a threshold value is exceeded.

(6) Depending on the system concept, one of the following measures shall be taken as soon as a threshold value is exceeded:

a) If the system concept is based on the condensation of the dilution medium, it is required that the startup of the redundant recombination equipment and the isolation of the failed recombination equipment are initiated automatically.

b) If the system concept is based on a proportioning device, it shall be ensured that the requirement under Section 3.2, para. (3), is met by taking appropriate measures. This can be achieved, e.g., by decreasing the hydrogen injection or increasing the nitrogen injection. In this context, opening of a bypass to the recombination equipment is only permissible if it is ensured that the requirement under Section 3.2, para. (3), stays fulfilled.

(7) Devices for monitoring the extraction on the turbine condenser of a BWR (e.g., the measurement of the gaseous waste volume stream downstream directly after the catalytic recombiner) shall be designed to be redundant.

(8) In the case of a failed conveying device, it shall be possible to automatically put a redundant conveying device into operation.

(9) In the vicinity of the recombination equipment, temperature measurements shall be provided

a) upstream before the catalytic recombiner,

b) inside the catalytic recombiner, and

c) downstream after the catalytic recombiner.

(10) If the dilution medium is condensed after having passed through the recombination equipment, the recombination equipment shall be cleared for operation only after a minimum temperature has been reached.

(11) For the functional check of the draining and superheating devices installed upstream of the catalytic recombiner, the outlet temperature of, or the energy supply to the superheater shall be monitored as well as the function of the condensate removing device. Alarm signals shall be issued when specified limit values are reached.

(12) If the temperature measured directly downstream of the recombination equipment exceeds a specified limit, an alarm signal shall be issued.

(13) In the case of gas retention through adsorption by means of activated charcoal, the following parameters shall be monitored:

a) gas moisture directly upstream of the activity retaining device,

b) pressure in the vicinity of the adsorbers, and

c) temperature in the first adsorber of the adsorption device.

Alarm signals shall be issued when specified limit values are reached.

(14) In the case of gas retention by means of buffer tanks, the following parameters shall be monitored:

a) the pressure in the individual storage groups,

b) the storage duration, and

c) the gaseous waste amount discharged to vent air.

Alarm signals shall be issued when specified limit values are reached.

6 Tests

6.1 Commissioning Tests

Prior to the initial operation of the system, the tests specified in **Tables 6-1** and **6-2** shall be performed, as far as possible, under operating conditions.

6.2 In-Service Inspections

In-service inspections shall be performed as listed in **Table 6-2**

6.3 Integrity Tests

Integrity tests are not dealt with in the present safety standard.

Note:

Such tests are within the scope of safety standard series KTA 3200.

6.4 Documentation

The documentation of the tests shall be carried out in accordance with the requirements specified in safety standard KTA 1404..

Gaseous Waste Group	Gaseous Waste Source [1]	Requirements Regarding Activity Retention	Examples of Gaseous Waste Processing Systems	General System Allocation
A	- Coolant degassing - Coolant treatment - Coolant storage tanks - Volume control surge tanks - Plant drainage - Reactor pressure vessel flushing - Pressurizer relief tank	Retention times: Xe ≥ 40 d Kr ≥ 40 h Retention of aerosolbound substances and iodine: cf. footnote [2]	- Activated charcoal ad-sorbers or - Buffer tanks with iodine and aerosol filters - Conveying device - Recombination equipment - Gas proportioning device	Gaseous waste system
B	- Stuffing boxes of the primary coolant systems - Sample collection vessels for continuous sampling of primary coolant	Retention times: Xe ≥ 8 d Kr ≥ 0.5 h Retention of aerosolbound substances and iodine: cf. footnote [2]	- Activated charcoal ad-sorbers or - Buffer tanks with iodine and aerosol filters - Conveying device - Gas proportioning device	For conceptional reasons processing occurs in the gaseous waste system of gaseous waste group A
C	- Waste water and concentrate tanks - Waste water evaporation facility - Sampling from coolant treatment system	Retention of aerosolbound substances and iodine: Methyl iodide ≥ 90 % Aerosol filters of Filter Class E12 in accordance with DIN EN 1822-1	- Iodine and aerosol filters - Conveying device	System air filter unit
	- Concentrate treatment system	Retention of aerosolbound substances and iodine in case of negligible iodine activities Aerosol filters of Filter Class E12 in accordance with DIN EN 1822-1 cf. footnote [3]	- Aerosol filters - Conveying device	Vent air system

[1] Gaseous waste sources may also be allocated to a gaseous waste group involving higher requirements.

[2] When achieving the retention times for xenon and krypton specified for gaseous waste groups A and B, the associated design of the adsorber bed is bound to result in an almost complete retention of iodine and aerosolbound substances; thus, a specification of separate requirements in this context is not necessary.

[3] Because of the preceding long storage time of the concentrates, an iodine retention is usually not necessary.

N o t e :

The classification of the gaseous wastes is based on the following aspects (characteristic features):

Gaseous waste group A: Gaseous wastes which contain, apart from the activities of iodine and aerosolbound substances, the major amount of noble gas activities from the systems containing the primary coolant.

Gaseous waste group B: Gaseous wastes which contain, apart from the activities of iodine and aerosol activities, only a fraction of the noble gas activities of gaseous waste group A and only relevant amounts of short-lived noble gas isotopes and, in addition, is diluted by considerable amounts of leakage air.

Gaseous waste group C: Gaseous wastes for which no noble gas retention is necessary.

Table 3-1: Group classification of gaseous waste sources and requirements for the gaseous waste processing systems of PWR plants

Gaseous Waste Group	***Gaseous Waste Source***[1)]	***Requirements Regarding Activity Retention***	***Examples of Gaseous Waste Processing Systems***	***General System Allocation***
A	- Turbine condenser - Reactor pressure vessel flushing	Retention times: Xe ≥ 40 d Kr ≥ 40 h Retention of aerosolbound substances and iodine: cf. footnote [2)]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Conveying device - Recombination equipment	Gaseous waste system
B	- Stuffing boxes - Plant drainage vessels - Continuous reactor coolant sampling - Reactor coolant purification	Retention times: Xe ≥ 8 d Kr ≥ 0.5 h Retention of aerosolbound substances and iodine: cf. footnote [2)]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Conveying device	Stuffing box exhaust system
C	- Waste water and concentrate storage tanks - Waste water evaporation facility	Retention of aerosolbound substances and iodine: Methyl iodide ≥ 90 % Aerosol filters of Filter Class E12 in accordance with DIN EN 1822-1	- Iodine and aerosol filters - Conveying device	Nuclear vessel exhaust and vent air system
	- Concentrate treatment facility	Retention of aerosolbound substances and iodine in case of negligible iodine activities Aerosol filters of Filter Class E12 in accordance with DIN EN 1822-1 cf. footnote [3)]	- Aerosol filters - Conveying device	Vent air system

[1)] Gaseous waste sources may also be allocated to a gaseous waste group involving higher requirements.

[2)] When achieving the retention times for xenon and krypton specified for gaseous waste groups A and B, the associated design of the adsorber bed is bound to result in an almost complete retention of iodine and aerosolbound substances; thus, a specification of separate requirements in this context is not necessary.

[3)] Because of the preceding long storage time of the concentrates, an iodine retention is usually not necessary.

N o t e :

The classification of the gaseous wastes is based on the following aspects (characteristic features):

Gaseous waste group A: Gaseous wastes which contain, apart from the activities of iodine and aerosolbound substances, the major amount of noble gas activities from the systems containing the primary coolant.

Gaseous waste group B: Gaseous wastes which contain, apart from the activities of iodine and aerosol activities, only a fraction of the noble gas activities of gaseous waste group A and only relevant amounts of short-lived noble gas isotopes and, in addition, is diluted by considerable amounts of leakage air.

Gaseous waste group C: Gaseous wastes for which no noble gas retention is necessary.

Table 3-2: Group classification of gaseous waste sources and requirements for the gaseous waste processing systems of BWR plants

Tests - in as far as the respective components are present in the reactor type		***Tester***	
		Plant expert (e.g., manufacturer or licensee)	***Proper authority or authorized expert***
1	**Recombination equipment**		
1.1	Adherence to the safety-related operating data of the recombination devices	X	X
1.2	Function of the gas driers by verification of the specific residual moisture	X	X
1.3	Function of the catalytic combustion of the catalytic recombiner via the residual H_2 concentration	X	X
1.4	Threshold limit setting and annunciation of temperature behind the catalytic recombiner > max	X	X
2	**Activity retaining device**		
2.1	In the case of adsorptive retention by means of activated charcoal: functional check by means of retention time measurement under design conditions [1)]	X	X
2.2	In the case of gas storage by means of buffer tanks: demonstration of sufficient storage capacity under design conditions	X	X
2.3	Gaseous waste group A		
2.3.1	Leak-free condition of filter elements by means of oil thread test	X	X
2.3.2	Differential pressure measurement in the installed condition	X	X
2.4	Threshold limits		
2.4.1	Throughput of activity retaining devices > max	X	X
2.4.2	Humidity upstream directly before activity retaining devices > max	X	
2.4.3	Pressure of activity retaining devices < min	X	
3	**Conveying devices and flushing-gas streams**		
3.1	Function of the conveying devices and check of the inert gas streams	X	X
3.2	Threshold limit setting of flushing-gas streams	X	
4	**Calibration of measuring equipment**		
4.1	Measurements of humidity	X	
5	**System leak tightness (cf. Section 3.8)**	X	X

[1)] The retention time corresponds to the mean dwell time of the marker substance (e.g. test nuclide Kr-85) in the activated charcoal columns. In this context, it is permissible that the measuring conditions (pressure, temperature, throughput) deviate from the design conditions, provided, the dependency of the dynamic adsorption coefficient on pressure, temperature and gas flow velocity is known with respect to the kind of activated charcoal from laboratory tests, and these results can be used to calculate the retention time for the design conditions. Furthermore, the ratio of the dynamic adsorption coefficient of xenon and that of the test-nuclide gas shall be known.

Table 6-1: Commissioning tests with respect to gaseous waste treatment systems (During commissioning, the tests listed in **Table 6-2** shall also be performed)

Tests - in as far as the respective components are present in the reactor type		Tester	
		Plant expert (e.g., manufacturer or licensee)	***Proper authority or authorized expert***
		Testing intervals in years	
1	**Recombination devices**		
1.1	Setting and activation of the limit value monitor		
1.1.1	Fluid level in preheater > max (also, the heating steam side)	B 1)	B 1)
1.1.2	Temperature before the catalytic recombiner < min	1	1
1.1.3	Temperature inside the catalytic recombiner < min	1	1
1.1.4	Temperature after the catalytic recombiner > max	1	1
1.2	Changeover switching of the recombination device to a bypass or to a redundant train (in the case of a BWR, this may be replaced by a simulation test of the conductive path)	B 1)	B 1)
1.3	Threshold limit of the concentration of H_2 and O_2 (setting, alarms and signal path)	½	1
1.4	Limitation and isolation of H_2 and O_2 injection	1	1
2	**Activity retaining device**		
2.1	In the case of adsorptive retention by means of activated charcoal: Determination of the holdup time of a suitable noble gas nuclide (e.g., krypton-85m, krypton-87, krypton-88 or alternative argon-41 in the case of PWR) by comparing the activity concentration in front of and behind the first column and calculating the resulting dwell time for xenon by applying the ratio of the corresponding dynamic coefficients of adsorption. The dwell time thus determined shall be linearly extrapolated to the entire activated charcoal section of the activity retaining device. Alternatively, in case of an insufficient plant-specific activity concentration: Functional check of the activity retaining device by evaluating the relevant operating conditions.	B 1)	B 1)
2.2	In the case of storage by means of buffer tanks: Function of the outlet valves on the buffer tanks	B 1)	B 1)
2.3	Gaseous waste group C: Iodine sorption filtering	in accordance with safety standard KTA 3601	
2.4	Gaseous waste group C: Aerosol filtering	in accordance with safety standard KTA 3601	
2.5	Setting and activation of the limit value monitors		
2.5.1	Pressure, buffer tanks > max	1	1
2.5.2	Temperature of pre-adsorber and activated charcoal column > max	1	1
2.5.3	Activity concentration > max	½	1
3	**Calibration of measuring equipment**		
3.1	H_2 measurement	¼	1
3.2	O_2 measurement	1	1
4	**Conveying equipment and flushing gas streams**		
4.1	Setting of the throughput threshold limits	B 1)	B 1)
4.2	Changeover switching of gaseous waste compressors	1	1
4.3	Changeover switching of the steam jet air ejectors (may be replaced by a simulation test of the conductive path)	B 1)	B 1)

1) B = during operation phase between consecutive refuelings

Table 6-2: In-service inspections of gaseous waste treatment systems
(These tests shall also be performed during commissioning)

Appendix

Regulations Referred to in this Safety Standard

(Regulations referred to in this safety standard are valid only in the versions 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 – AtG) of December 23, 1959, revised version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Article 2, Sec. 2. of the Act of July 20, 2017 (BGBl. I, p. 2808)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance – StrlSchV) of July 20, 2001 (BGBl. I, p. 1714; 2002 I, p. 1459), most recently in accordance with Article 10 changed by Article 6 of the Act of Janu-ary 27, 2017 (BGBl. I, p. 114, 1222)
SiAnf	(2015-03)	Safety Requirements for Nuclear Power Plants (SiAnf) of 22 November 2012 (BAnz AT 24.01.2013 B3), revised version of 3 March 2015 (BAnz AT 30.03.2015 B2).
Interpretations	(2015-03)	Interpretations of the "Safety Requirements for Nuclear Power Plants of 22 November 2012" (BAnz AT 24.01.2013 B3), revised version of 3 March 2015 (BAnz AT 30.03.2015 B2)
KTA 1301.1	(2017-11)	Radiation protection considerations for plant personnel in the design and operation of nuclear power plants; Part 1: Design
KTA 1404	(2013-11)	Documentation during the construction and operation of nuclear power plants
KTA 1503.1	(2016-11)	Surveilling the release of gaseous and aerosol-bound radioactive substances; Part 1: Surveilling the release of radioactive substances with the stack exhaust air during specified normal operation
KTA 2101.1	(2015-12)	Fire protection in nuclear power plants; Part 1: Basic requirements
KTA 2101.2	(2015-12)	Fire protection in nuclear power plants; Part 2: Fire protection of structural plant components
KTA 2101.3	(2015-12)	Fire protection in nuclear power plants; Part 3: Fire protection of mechanical and electrical plant components
KTA 2103	(2015-11)	Explosion protection in nuclear power plants with light water reactors (General and case-specific requirements)
KTA 3601	(2017-11)	Ventilation systems in nuclear power plants
DIN EN 1822-1	(2011-01)	High efficiency air filters (EPA, HEPA and ULPA) - Part 1: Classification, performance testing, marking; German version EN 1822-1:2009