Reaffirmed: 6/94, 6/99, 11/04

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3605 (June, 1989)

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

(Behandlung radioaktiv kontaminierter Gase in Kernkraftwerken mit Leichtwasserreaktoren)

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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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 the damage arising from the construction and operation of the facility (Sec. 7 para. 2 no. 3 Atomic Energy Act), in order to attain the protective goals specified in the Atomic Energy Act arid the Radiological Protection Ordinance and further concretized in the "Safety Criteria for Nuclear Power Plants" and in the "Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactor against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (Incident Guidelines)".

(2) To fulfill the licensing prerequisites pursuant to Sec. 7 of the Atomic Energy Act for the construction and operation of a plant, among other things, facilities are provided for the retention of solid, liquid and gaseous (including airborne) radioactive substances, for the handling and the controlled guidance of radioactive substances within the nuclear power plait as well as for the controlled discharge of radioactive substances via pathways intended for this purpose. The off-gas treatment systems are part of the facilities which, under Sec. 45 of the Radiological Protection Ordinance, the person responsible for radiological protection shall provide in order to keep as low as possible the radiation exposure of man resulting from the discharge of radioactive substances and to make sure that the specified limits are not exceeded.

(3) This safety standard on off-gas treatment systems contains requirements for the design, arrangement, construction and tests the fulfillment of which serves to attain in particular the following protective goals:

(a) to keep as low as possible, even below the limits specified in the Radiological Protection Ordinance, any radiation exposure or contamination of men, property or the environment while observing the state of the art and considering all circumstances of each individual case (Sec. 28 para. 1 no. 3 of the Radiological Protection Ordinance),

(b) to Make sure that any uncontrolled discharge of radioactive substances is prevented, that the activity discharged is as low as possible (Sec. 46 para. 1 items 1 and 2 of the Radiological Protection Ordinance) and that the maximum discharges of radioactive substances into the atmosphere as specified by the authority in accordance with Sec. 46 para. 2 of the Radiological Protection Ordinance are adhered to.

(4) The off-gas treatment systems have the following tasks:

(a) Reception and transport of radioactive off-gases from nuclear systems.

(b) Reduction of the content of radioactive substances in the off-gas as well as their controlled discharge into the atmosphere with the vent air.

In this connection, parts of the off-gas treatment systems have to fulfill additional tasks for the limitation of H_2 or O_2 concentrations.

(5) Activity measurements are of importance for the assessment of the functional safety of the off-gas treatment systems. Requirements to be met by measuring equipment used for this purpose are not contained in this safety standard, since they have been provided for in KTA 1503.1 in a higher level approach.

(6) Requirements to be met by fire protection systems are provided for in KTA 2101 in a higher level approach.

1 Scope

(1) This safety standard applies to systems for the collection, guidance and treatment of contaminated radioactive off-gases in nuclear power plants with pressurized water reactor, referred to as PWR below, and in nuclear power plants with boiling water reactor, referred to as BWR below. This standard also contains requirements for components and pipes of other systems which are linked to the off-gas treatment system to the extent that these requirements are related with the guidance of the off-gases.

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

(a) systems for the extraction of leakages of the containment vessel,

(b) systems for the post-incident measurement and limitation of the hydrogen concentration inside the containment vessel,

Note:
These are provided for in KTA 3406, Parts 1 and 2 which are presently being prepared.

(c) systems for the selective ventilation of compartments and/or groups of compartments (nuclear ventilation systems),

Note:
These are provided for in KTA 3601 which is presently being prepared.

(d) turbine condenser with extraction unit (PWR),

(e) turbine condenser with primary steam admission up to the off-gas extraction nozzle (BWR).

2 Definitions

2.1 Off-Gases in Nuclear Power Plants

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

2.2 Activity Retention Units

Activity retention units are units for the reduction of the content of radioactive admixtures in off-gas streams such as

- activated charcoal adsorbers,
- buffer tanks,
- iodine sorption filters,
- aerosol filters.

2.3 Delivery Equipment in Off-Gas Treatment Systems

Delivery equipment in off-gas treatment systems is equipment for the transport of off-gases, e.g. compressors, ventilators, pipes.

2.4 Off-Gas Treatment Systems

Off-gas treatment systems are systems for the collection and treatment of off-gases. They consist of facilities for the delivery, activity retention arid, possibly, recombination of hydrogen and oxygen.

2.5 Recombination Units

Recombination units are units for the reduction of hydrogen concentrations in off-gases and consist of a gas drying facility and a catalytic recombiner.

2.6 Holdup Time

The holdup time of a gaseous component is the arithmetic mean, weighted over the distribution frequency, of the dwell time of this gas component in the off-gas treatment system. It depends on the chemical and physical properties of the gas component under review.

2.7 Pre-Evacuation and operational Evacuation Facilities

Pre-evacuation and operational evacuation facilities are facilities for the evacuation of turbine condensers to which primary steam is admitted.

2.8 Ignitable Mixture

An ignitable mixture is a mixture of gases in which a combustion reaction propagates as soon as an ignition source becomes effective.

3 System Design

3.1 Classification of off-Gases into Groups of Off-Gases and Requirements to be Met by the Off-Gas Treatment Systems

(1) In order to reduce the radioactive contamination, off-gases from nuclear systems should be treated m specific groups of off-gases. The classification of the off-gas sources as off-gas groups A, B and C, and the requirements which apply in this context, are specified in **Table 3-1** for PWRs and in Table and in **Table 3-2** for BWRs.

(2) As far as the activity retention is concerned, the requirements in accordance with **Table 3-1** shall be met for PWRs and in accordance with **Table 3-2** for BWRs.

3.2 General Requirements

(1) Off-gas treatment systems shall be gastight in accordance with Section 3.8, or have a negative pressure as compared with the atmosphere; of the building, in order to keep the entry of radioactive gases into buildings low.

(2) Off-gas treatment systems shall be designed, arranged, shielded and operated in such a way that the radiation exposure of the personnel is kept low (ALARA principle).

(3) Basically, the off-gas treatment systems shall be designed and operated in such a way that no ignitable mixtures will occur. Deviations from this principle are admissible if the system parts involved are designed to cope, with a postulated spontaneous combustion reaction.

Note:
An $H_2/O_2/N_2$ mixture is not ignitable at atmospheric pressure if the
H_2 concentration is lower than or equal to 4% volume fraction
or
O_2 concentration is lower than or equal to 5% volume fraction.

(4) Adherence to the requirement in para (3) above may also be achieved by dilution.

3.3 Delivery Equipment

(1) If a slight vacuum may occur in adjacent components as a result of the mode of operation of the system, such as changes in level or changes in pump suction pressure, the design shall be based on the maximum negative pressure that can occur.

(2) The slight vacuum may be limited by vacuum breakers which shall be arranged in such a way that an isolation can be excluded.

(3) If an item of delivery equipment serves the extraction of seal leakages such as stuffing box leakages, the leakage mass flow shall be limited by certain features in such a way that any overfeeding of downstream system parts is avoided.

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

(a) orifices at the locations of leakage

or

(b) monitoring the temperature behind the leakage condensate feature and closing the isolation valves as soon as preset limits are reached.

(5) Features shall be provided which permit the detection of seal leakage, such as eight glasses or temperature measuring points. The connection of several extraction points to one leakage detection unit is admissible, provided this will not prevent the detection of single leakages.

(6) In order to achieve a continuous extraction of the off-gases generated in the turbine condenser of a BWR during power operation, the operational evacuation facilities shall be redundant. In this context, the changeover time shall be so short that a shutdown of the turbine facility is prevented.

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

3.4 Recombination Units

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

(2) When using a catalytic recombiner, any coverage of the catalytic surface by water induction or by steam condensing on the catalyst should be prevented. This may be achieved, for example, by superheating or drying the gas stream.

(3) When using steam as a medium of dilution, the recombination unit shall fulfill the following additional requirements:

(a) Recombination units shall be designed and operated reliably. For this purpose, devices for superheating and the removal of condensate shall be provided.

(b) Monitoring systems shall be provided to permit the timely changeover to a redundant recombination unit in the case of malfunctions.

(c) To ensure the availability of the standby recombination unit, the catalyst shall be provided with a heater unit in the catalyst bed, in order to prevent condensation. The heater unit shall be in permanent operation during the standby time.

(d) Backflows of ignitable mixtures of gases into the redundant recombiner during a failure of the operating recombination unit shall be prevented. This may be effected, for example, by a continuous flushing of the redundant recombination unit with a mixture of steam and air.

(4) Devices shall be provided for the timely detection of any backpressure of water which may lead to a malfunction in the case of a disturbed removal of condensate.

3.5 Gas Dosing Units

When using H_2 and O_2 dosing units it shall be ensured that

(a) any gas feeding is effected only after the concentration of the respective gas in the off-gas stream has been measured, and this concentration is also monitored during the feeding process,

b) any simultaneous feeding of H_2 and O_2 is avoided, and

c) feeding is automatically interrupted as soon as the H_2 and O_2 concentrations in the off-gas stream as specified, in Section 3.2 (3) have been reached.

3.6 Activity Retention Units

(1) The holdup times for the noble gases xenon and krypton during constant power operation shall attain the values specified in **Tables 3-1** and **3-2**.

Note:
The holdup time is influenced by the moisture of the activated charcoal. This shall be taken into consideration when setting the moisture of the gas stream.

(2) In the case of special modes of operation, such as short-term increases in the flow rate, the holdup time shall attain at least 80% of the values specified in **Tables 3-1** and **3-2**.

(3) The gas flow velocity shall be set in such a way that any fluidization of the solid bed is prevented.

(4) The operating temperature of the activated charcoal should be below 50 °C.

(5) If an intermittent operation of buffer tanks is used, the off-gas discharge shall be monitored so as to prevent any inadmissible discharge of activity. This may be effected e.g. by

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

or

(b) closing the outlet valves ass soon as the activity discharge limits have been reached.

(6) It shall be made sure that the admissible operating gage pressure in any buffer tank is not exceeded. This can be achieved, for example, by a limitation of the off-gas feeding.

(7) When using iodine sorption filters, the requirements which apply shall be the same as those to be met by systems for the selective ventilation of rooms and room groups (see DIN 25 414). The requirements for the retention of methyl iodide shall be as specified in **Tables 3-1** and **3-2**.

(8) Aerosol filtering shall be done by means of Class R or S filters in accordance with DIN 24 184. When using aerosol filters, the requirements which apply shall be the same as those to be met by systems for the selective ventilation of rooms and room groups.

3.7 Sampling Units

(1) Sampling units shall be designed and arranged in such a way that representative off-gas samples can be taken in order to check the efficiency of the processes employed.

(2) The sampling units shall be provided behind recombination units as well as in front of and behind activity retention units.

3.8 Leak Tightness of Systems

(1) System sections to which a slight vacuum is applied during operation shall have such a low leak rate that the off-gas stream will not be increased in such a way as to interfere with operation. This leak tightness requirement shall be considered to have been fulfilled by the demonstrated leak tightness within the scope of the, system pressure test.

(2) System sections to which an gage pressure is applied during operation shall not exceed the following integral leak rates L with respect to the sum of the sections under gage pressure, in order to limit compartment air activities:

(a) Off-gas group A: L smaller than or equal to 10^{-3} hPa dm^3s^{-1},

(b) Off-gas group B: L smaller than or equal to 10^{-1} hPa dm^3s^{-1}.

(3) The leak tightness requirements for the systems serving the selective ventilation of rooms and room groups shall apply to off-gases included, in off-gas group C (see DIN 25 414).

(4) In the case of system parts to which gage pressure is applied, adherence to the admissible leak rate limits shall be demonstrated by

(a) the pressure decay method or the pressurizing method using a gaseous fluid

or

(b) an He or halogen leak test for group A, and a foam test such as the Nekal leak test, for groups B and C.

4 Arrangement and Design

4.1 Arrangement

(1) The requirements of KTA 1301.1 shall apply to the arrangement of the system.

(2) System parts the functionability of which is materially affected by the, influence of water (e.g. recombination units and activity retention units) shall be protected against the induction of water resulting from malfunctions. This protection may be provided, for example, by an appropriate arrangement of the system parts or by additional features such as float valves, levelcontrolled isolating valves or level monitors.

4.2 Design

(1) For system sections which are subject to the requirement in accordance with Section 3.8 (2) item a the designs to be provided should have a high leak tightness effect, such as welds, bellows or diaphragm type valves, canned motors or shaft penetrations with floating ring type shaft seals.

(2) In the case of components for the reception of bulk materials which may get contaminated during operation, precautions shall be taken against compartment air contamination when these bulk materials are unloaded. The protection to be taken against compartment air contamination may be ensured by using equipment such as maintenance bags, dosing units or extraction units.

5 Instrumentation and Control Systems

(1) Equipment shall be available which can be used to effect control maneuvers at short notice for the prevention of inadmissible operating conditions, either automatically or by remote control from a permanently staffed control room. The data measured and annunciated for this purpose shall be displayed in this control room.

(2) As far as systems for the treatment of group A, off-gases are concerned, the data measured for the assessment of the respective function and the annunciations should be displayed in the main control room of the power plant. In addition, equipment should be available which can also be used for remotely controlled maneuvers relating to these systems, as outlined in para. (1) above, from the main control room of the power plant.

(3) Measures for the limitation of H_2 and O_2 such as dilution or recombination shah be monitored continuously by measuring equipment.

(4) Behind the recombination unit,

- the H_2 concentration

or

- the O_2 and H_2 concentrations

shall be measured.

If H_2 and O_2 dosing equipment is available, the H_2 and 02 concentrations shall also be monitored in front of the recombination unit.

(5) Intervention levels shall be specified for adherence to the requirement in accordance with Section 3.2 (3). An annunciation shall be effected as soon as an intervention level is exceeded.

(6) If the dilution medium is condensed after having passed through the recombination unit, the data allocated to the intervention levels shall be measured behind the recombiner.

(7) If the dilution medium is not condensed after having passed through the recombination unit, the data allocated to the intervention levels shall be measured in front of the recombiner.

(8) Depending on the concept of the system, the following measures shall be taken. as soon as the intervention levels have been exceeded:

(a) In the case of an equipment concept in accordance with para. (6), redundant recombination units shall be put into operation automatically, and the disturbed recombination unit shall be isolated automatically.

(b) In the case of equipment in accordance with para. (7), adherence to the requirement in accordance with Section 3.2 (3) shall be ensured by appropriate measures. This can be achieved for example, by decreased hydrogen supply or increased nitrogen feeding. In this context, the opening of a bypass to the recombination unit is only admissible if it is ensured that the requirement in accordance with Section 3.2 (3) is met.

(9) Features which serve the monitoring of the extraction on the turbine condenser of a BWR, such as the off-gas volume flow measurement behind the recombiner, shall be redundant.

(10) In the case of a failure of the delivery unit, it shall be possible to put a redundant delivery unit into operation automatically.

(11) In the area of the recombination units, temperature measurements shall be provided

in front of the recombiner,

inside the recombiner, and

behind the recombiner.

(12) If the dilution medium is condensed after having passed the recombination unit, clearance for operation of the latter shall not be given until a minimum temperature has been reached.

(13) In order to check the functions of the drainage and superheating units installed in front of the recombiner, either the superheater outlet temperature or the energy supply of the superheater unit as well as the function of the condensate removal unit shall be monitored. Annunciations shall be made as soon as given limits are reached.

(14) If the temperature measured behind the recombination unit exceeds a given limit, an annunciation shall be made.

(15) In the case of an adsorptive holdup of the gas by means of activated charcoal, the following state variables shall be monitored:

(a) gas moisture in front of the activity retention system,

(b) pressure in the area of the adsorbers, and

(c) temperature in the first adsorber of the adsorption unit.

Annunications shall be made as soon as given limits are reached.

(16) In the case of gas holdup by means of buffer tanks, the following state variables shall be monitored:

(a) the pressure in the various storage groups,

(b) the storage time, and

(c) the off-gas amount discharged to vent air.

Annunications shall be made as soon as given limits are reached.

6 Tests

6.1 Commissioning Tests

Prior to the first operation of the plant, the tests specified in **Tables 6-1** and **6-2** shall be performed, if possible, in operating conditions.

6.2 In-Service Inspections

In-service inspections shall be performed in accordance with **Table 6-2**.

6.3 Integrity Tests

Integrity tests are not part of this standard.

Note:
Such tests are covered by KTA series 3200.

6.4 Documentation

The documentation of the tests shall be carried out in accordance with the requirements laid down in KTA 1401.

1	2	3	4	5
Off-Gas Group	Off-Gas Sources [1]	Requirements to be Met by Retention	Examples of Off-Gas Treatment Units	Usual System Allocation
A	- Coolant degassing - Coolant treatment - Coolant storage tanks - Volume control surge tanks - Plant drainage - Reactor pressure vessel flushing - Pressurizer relief tanks	Holdup times: Xe ≥ 40 d Kr ≥ 40 h Retention of aerosols and iodine, see [2]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Delivery equipment - Recombination unit - Gas dosing unit	Off-gas system
B	- Stuffing boxes of primary coolant systems - Sample collection tanks for continuous primary coolant sampling	Holdup times: Xe ≥ 8 h Kr ≥ 0.5 h Retention of aerosols and iodine, see [2]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Delivery equipment - Gas dosing unit	For reasons of concept, treatment in the off-gas system of off-gas group A
C	- Waste water and concentrate tanks - Waste water evaporation unit - Sampling from coolant processing and treatment systems	Retention of aerosols and iodine Methyl iodide ≥ 90% Class S aerosol filters in accordance with DIN 24 184	- Iodine and aerosol filters - Delivery equipment	System air filter unit
	- Concentrate treatment system	Retention of aerosols and iodine with negligible iodine activities Class R or S aerosol filters in accordance with DIN 24 184, see [3]	- Aerosol filters - Delivery equipment	Vent air system

[1] Off-gas sources may also be allocated to an off-gas group involving higher requirements.

[2] When realizing the xenon and krypton holdup times specified in Groups A and B, the associated design of the adsorber bed is bound to result in an almost complete retention of iodine and aerosols, so that any specification of separate requirements in this context can be waived.

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

Note:
The allocation of the off-gases is based on the following aspects (characteristic features):

Off-gas group A: Off-gas which contains, apart from iodine and aerosol activities, the major amount of noble gas activities from the systems in contact with primary coolant.

Off-gas group B: Off-gas whose amount of noble gas activities, apart from iodine and aerosol activities, is only a fraction of those of group A and which only contains relevant amounts of short-lived noble gas isotopes and, in addition, is diluted by considerable amounts of leak air.

Off-gas group C: Off-gas where no noble gas holdup is required.

Table 3-1: Allocation of off-gas sources to off-gas groups and requirements for the gas treatment systems of PWR plants

1	2	3	4	5
Off-Gas Group	Off-Gas Sources [1]	Requirements to be Met by Retention	Examples of Off-Gas Treatment Units	Usual System Allocation
A	- Turbine condenser - Reactor pressure vessel flushing	Holdup times: Xe ≥ 40 d Kr ≥ 40 h Retention of aerosols and iodine, see [2]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Delivery equipment - Recombination unit	Off-gas system
B	- Stuffing boxes - Plant drainage tanks - Continuos primary coolant sampling - Primary coolant purification	Holdup times: Xe ≥ 8 h Kr ≥ 0.5 h Retention of aerosols and iodine, see [2]	- Activated charcoal adsorbers or - Buffer tanks with iodine and aerosol filters - Delivery equipment	Gland leak-off system
C	- Waste water and concentrate tanks - Waste water evaporation unit	Retention of aerosols and iodine Methyl iodide ≥ 90% Class S aerosol filters in accordance with DIN 24 184	- Iodine and aerosol filters - Delivery equipment	Nuclear vessel extraction and vent air system
	- Concentrate treatment system	Retention of aerosols and iodine with negligible iodine activities Class R or S aerosol filters in accordance with DIN 24 184, see [3]	- Aerosol filters - Delivery equipment	Vent air system

[1] Off-gas sources may also be allocated to an off-gas group involving higher requirements.

[2] When realizing the xenon and krypton holdup times specified in Groups A and B, the associated design of the adsorber bed is bound to result in an almost complete retention of iodine and aerosols, so that any specification of separate requirements in this context can be waived.

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

Note:
The allocation of the off-gases is based on the following aspects (characteristic features):

Off-gas group A: Off-gas which contains, apart from iodine and aerosol activities, the major amount of noble gas activities from the systems in contact with primary coolant.

Off-gas group B: Off-gas whose amount of noble gas activities, apart from iodine and aerosol activities, is only a fraction of those of group A and which only contains relevant amounts of short-lived noble gas isotopes and, in addition, is diluted by considerable amounts of leak air.

Off-gas group C: Off-gas where no noble gas holdup is required.

Table 3-2: Allocation of off-gas sources to off-gas groups and requirements far the gas treatment systems of BWR plants

Test - to the extent available in the reactor type concerned		Tester	
		Expert (e.g. manufacturer's or licensee's)	Authorized Expert as appointed by the authority
1	Recombination		
1.1	Adherence to the safety-related operating data of the superheating/drying units in front of the recombiner, the recombiner bed heaters as well as the condensation unit behind the recombiner	x	x
1.2	Function of the gas driers by demonstration of the specific residual moisture	x	x
1.3	Function of the catalytic combustion of the recombiner via H_2 concentration comparison	x	x
1.4	Limit setting and annunciation of temperature behind the recombiner > max	x	x
2	Activity retention equipment		
2.1	In the case of adsorptive holdup by means of activated charcoal: functional check by means of retention time measurement [1)] under design conditions	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	Off-gas group A aerosol filtering		
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 built-in condition	x	x
2.4	Limits		
2.4.1	Throughput of activity retention units > max	x	x
2.4.2	Moisture in front of activity retention units > max	x	
2.4.3	Pressure of activity retention units < min	x	x
3	Delivery equipment and flushing gas flows		
3.1	Function of the delivery equipment and checking of the inert gas flows	x	x
3.2	Limit setting of flushing gas flows	x	x
4	Calibration of measuring equipment		
4.1	Measurements of moisture	x	
5	System tightness in accordance with Section 3.8	x	x

[1)] *Note:*

The holdup 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, the measuring conditions (pressure, temperature, throughput) may deviate from the design conditions if 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 so that this can be used to calculate the holdup time for the design conditions. Furthermore, the ratio of the dynamic adsorption coefficients of xenon and of the test nuclide gas shall be known.

Table 6-1: Commissioning tests [2)] with respect to off-gas treatment systems

[2)] During commissioning, the tests contained in **Table 6-2** shall be performed in addition.

Test - to the extent available in the reactor type concerned		Tester	
		Expert (e.g. manufacturer's or licensee's)	Authorized Expert as appointed by the authority
		Testing intervals in years	
1	Recombination units		
1.1	Setting and activation of the limit comparators		
1.1.1	Preheater level > max (also on heating steam side)	B [1)]	B [1)]
1.1.2	Temperature in front of the recombiner < min	1	1
1.1.3	Temperature in the recombiner < min	1	1
1.1.4	Temperature in the recombiner > max	1	1
1.2	Changeover of the recombination unit to bypass or standby train	B [1)]	B [1)]
1.3	Limits of H_2 and O_2 concentrations (setting, annunciation and signal path)	1/2	1
1.4	Limitation and isolation of H_2 and O_2 feeding	1	1
2	Activity retention equipment		
2.1	In the case of adsorptive holdup by means of activated charcoal: determination of the holdup time of a calibrated noble gas nuclide, such as krypton 87, by comparison of the activity concentration in front of and behind the first column and calculation of the resulting dwell tithe for xenon using the ratio between the corresponding dynamic coefficients of adsorption. The dwell time thus determined shall be subjected to a linear conversion to the entire activated charcoal section of the activity retention unit. Alternatively: Functional check of the retention unit by means of a determination of the relevant operating conditions in the case of an insufficient plant-specific activity concentration	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	Off-gas group C iodine sorption filtering	In accordance with DIN 25 414, Sec. 10.4.4.2	
2.4	Off-gas group C aerosol filtering	In accordance with DIN 25 414, Sec. 10.4.4.1	
2.5	Setting and activation of the limit comparators		
2.5.1	Pressure, buffer tanks > max	1	1
2.5.2	Temperature, pre-adsorber, activated charcoal column > max	1	1
2.5.3	Activity concentration > max	1/2	1
3	Calibration of measuring equipment		
3.1	H_2 measurements	1/4	1
3.2	O_2 measurements	1	1
4	Delivery equipment and flushing gas flows		
4.1	Setting of the throughput limits	B [1)]	B [1)]
4.2	Activation of switching as a result of throughput < min	B [1)]	B [1)]
4.3	Changeover of off-gas compressors	1	1
4.4	Changeover of the steam jet air ejectors	B [1)]	B [1)]
[1)] B = in the operating phase between two refueling actions			

Table 6-2: In-service inspections [2)] of off-gas treatment systems

[2)] These inspections shall also be performed during commissioning.

Appendix A

Regulations Referred to in this Safety Standard

(Regulations referred to are only valid in the versions cited below)

KTA 1301.1	(11/84)	Radiological Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants, Part 1: Design
KTA 1401	(02/80)	General Requirements for Quality Assurance
DIN 24 184	(10/74)	Type Testing of Aerosol Filters
DIN 25 414	(06/83)	Ventilation Systems at Nuclear Power Plant