NEW WORK ITEM PROPOSAL	
Closing date for voting 2015-05-14	Reference number (to be given by the Secretariat)
Date of circulation 2015-02-14	**ISO/TC** 85 **/ SC** 2 **N** 1454
Secretariat AFNOR	☐ **Proposal for new PC**

A proposal for a new work item within the scope of an existing committee shall be submitted to the secretariat of that committee with a copy to the Central Secretariat and, in the case of a subcommittee, a copy to the secretariat of the parent technical committee. Proposals not within the scope of an existing committee shall be submitted to the secretariat of the ISO Technical Management Board.

The proposer of a new work item may be a member body of ISO, the secretariat itself, another technical committee or subcommittee, or organization in liaison, the Technical Management Board or one of the advisory groups, or the Secretary-General.

The proposal will be circulated to the P-members of the technical committee or subcommittee for voting, and to the O-members for information.

IMPORTANT NOTE: Proposals without adequate justification risk rejection or referral to originator.
Guidelines for proposing and justifying a new work item are contained **in Annex C of the ISO/IEC Directives, Part 1.**

☒ The proposer has considered the guidance given in the Annex C during the preparation of the NWIP.

Proposal (to be completed by the proposer)

Title of the proposed deliverable.
(in the case of an amendment, revision or a new part of an existing document, show the reference number and current title)

English title	Criteria for design and operation of containment systems for nuclear worksite and for nuclear installations under decommissioning
French title (if available)	Critères pour la conception et l'exploitation des systèmes de confinement des chantiers nucléaires et des installations nucléaires en démantèlement

Scope of the proposed deliverable.

The purpose of containment systems is to protect the workers, public and environment against the spread of radioactive contamination. The scope of the proposed project is to specify the applicable requirements concerning the design and use of containment systems that ensure safety and radioprotection functions in nuclear worksites and in nuclear installations under decommissioning to protect from radioactive contamination produced: aerosol or gas.

The requirements concerning design, commissioning, monitoring and operation of nuclear worksite and of installations under decommissioning will be covered.

Purpose and justification of the proposal*

The requirements for the design and use of ventilation and containment systems in nuclear reactors or in nuclear installations other than nuclear worksites and from nuclear installations under decommissioning are developed in other ISO standards.

But, the containment of nuclear worksites and nuclear installations under decommissioning are characterized by their temporary and evolving nature as function of operations to be performed and, because of these specificities, are not properly covered by other standards.

Furthermore, decommissioning is a relatively new activity for witch containment is one of the most important functions. Standardized requirements for worksite containment will help to ensure a high level of safety during decommissioning.

**The reason for requiring justification statements with approval or disapproval votes is primarily to collect input on market or stakeholder needs, and on market relevance of the proposal, to benefit the development of the proposed ISO standard(s). Any NSB vote in relation to a proposal for new work may result in significant commitments of resources by all parties (NSBs, committee leaders and delegates/experts) or may have significant implications for ISO's relevance in the global community. It is especially important that NSBs consider and express why they vote the way they do. In addition, it is felt that it would be useful for ISO and its committees to have documentation as to why the NSBs feel a proposal has market need and market relevance. Therefore, please ensure that your justifying statements with your approval or disapproval vote convey the reason(s) why your national consensus does or does not support the market need and/or global relevance of the proposal.*

If a draft is attached to this proposal,:

Please select from one of the following options (note that if no option is selected, the default will be the first option):

☒ Draft document will be registered as new project in the committee's work programme (stage 20.00)
☐ Draft document can be registered as a Working Draft (WD – stage 20.20)
☐ Draft document can be registered as a Committee Draft (CD – stage 30.00)
☐ Draft document can be registered as a Draft International Standard (DIS – stage 40.00)

Is this a Management Systems Standard (MSS)?

☐ Yes ☒ No

NOTE: if Yes, the NWIP along with the Justification study (see Annex SL of the Consolidated ISO Supplement) must be sent to the MSS Task Force secretariat (tmb@iso.org) for approval before the NWIP ballot can be launched.

Indication(s) of the preferred type or types of deliverable(s) to be produced under the proposal.

☒ International Standard ☐ Technical Specification ☐ Publicly Available Specification ☐ Technical Report

Proposed development track ☐ 1 (24 months) ☒ 2 (36 months - default) ☐ 3 (48 months)

Known patented items (see ISO/IEC Directives, Part 1 for important guidance)

☐ **Yes** ☒ **No** **If "Yes", provide full information as annex**

A statement from the proposer as to how the proposed work may relate to or impact on existing work, especially existing ISO and IEC deliverables. The proposer should explain how the work differs from apparently similar work, or explain how duplication and conflict will be minimized.

As said before, the requirements for the design and use of ventilation and containment systems in nuclear reactors or in nuclear installations are developed in other ISO standards.

But, the containment of nuclear worksites and nuclear installations under decommissioning are characterized by their temporary and evolving nature as function of operations to be performed and, because of these specificities, are not properly covered by other standards. The proposed work may be related to ISO 17873, but the scope proposed will cover only nuclear worksite and nuclear installations under decommissioning that are not covered by ISO 17873.

A listing of relevant existing documents at the international, regional and national levels.

ISO 17873 Nuclear facilities - Criteria for the design and operation of ventilation systems for nuclear installations other than nuclear reactors

A simple and concise statement identifying and describing relevant affected stakeholder categories (including small and medium sized enterprises) and how they will each benefit from or be impacted by the proposed deliverable(s) All entreprises involved in decommissioning activities, Safety authority. Standardized requirements for worksite containment will help entreprise involved in decommissioning to have an appropriate approach for worksite containment, and will help to ensure a high level of safety during decommissioning.	
Liaisons: **A listing of relevant external international organizations or internal parties (other ISO and/or IEC committees) to be engaged as liaisons in the development of the deliverable(s).**	**Joint/parallel work:** **Possible joint/parallel work with:** ☐ IEC (please specify committee ID) ☐ CEN (please specify committee ID) ☐ Other (please specify)
A listing of relevant countries which are not already P-members of the committee.	
Preparatory work (at a minimum an outline should be included with the proposal) ☒ A draft is attached ☐ An outline is attached ☐ An existing document to serve as initial basis The proposer or the proposer's organization is prepared to undertake the preparatory work required ☐ Yes ☐ No	
Proposed Project Leader (name and e-mail address) L. LAFANECHERE EDF/CIDEN 154 Avenue Thiers - CS 60018 69458 LYON CEDEX 06 - FRANCE	**Name of the Proposer** (include contact information) Laurence THOMAS ISO/TC85/SC2 Secretariat
Supplementary information relating to the proposal ☐ This proposal relates to a new ISO document; ☒ This proposal relates to the adoption as an active project of an item currently registered as a Preliminary Work Item; ☐ This proposal relates to the re-establishment of a cancelled project as an active project. Other:	

Annex(es) are included with this proposal (give details)

☒ PWI ISO 16647-(E)-Containment of nuclear worksite-decommissioning

ISO 16647

Nuclear Facilities

Criteria for design and operation of containment systems for nuclear worksite and for nuclear installations under decommissioning

Contents

1 Scope

The purpose of containment systems is to protect the workers, public and environment against the spread of radioactive contamination resulting from operations in nuclear worksites and from nuclear installations under decommissioning.

ISO 16647 specifies the applicable requirements concerning the design and use of containment systems that ensure safety and radioprotection functions in nuclear worksites and in nuclear installations under decommissioning to protect from radioactive contamination produced: aerosol or gas.

The containment of nuclear worksites and nuclear installations under decommissioning are characterized by their temporary and evolving nature as function of operations to be performed.

ISO 16647 apply to maintenance or upgrades worksites responding to above definition.

The requirements for the design and use of ventilation and containment systems in nuclear reactors or in nuclear installations other than nuclear worksites and from nuclear installations under decommissioning are developed in other ISO standards.

2 Normative references

The following Standards contain provisions that, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ISO...

3 Definitions

For the purpose of the present Standard, the following definitions apply.

3.1 Aerosol

Solid particles and liquid droplets of all dimensions in suspension in a gaseous fluid.

3.2 Barrier

Structural element, which defines the physical limits of a volume with a particular radiological environment and which prevents or limits releases of radioactive substances from this volume.

EXAMPLES: containment enclosure, shielded cell, filters.

3.3 Discharge stack

Duct (usually vertical) at the termination of a system, from which the air is discharged to atmosphere.

3.4 Air conditioning

Arrangements allowing the sustainment of a controlled atmosphere (temperature, humidity, pressure, dust levels, gas content, etc.) in a closed volume.

3.5 Containment

Arrangement allowing users to maintain separate environments inside and outside an enclosure, blocking the movement between them of process materials and substances resulting from physical and chemical reactions which are potentially harmful to workers, the external environment, or to the handled products.

3.6 Dynamic containment

Action allowing, by maintaining a preferential air flow circulation, to limit back-flow between two areas or between the inside and outside of an enclosure, in order to prevent radioactive substances being released from a given physical volume.

3.7 Contamination

Presence of radioactive substances on or in a material or a human body or any place where they are undesirable or could be harmful.

3.8 Containment enclosure

Enclosure designed to prevent either the leakage of products contained in the pertinent internal environment into the external environment, or the penetration of substances from the external environment into the internal environment, or both simultaneously

3.9 Gas cleaning

Action (sometimes called “scrubbing”) that consists of decreasing the content of undesirable constituents in a fluid. Aerosol filtration and iodine trapping are examples of gas cleaning

3.10 Filtre

Conventional term used to designate a device intended to trap particles suspended in gases or to trap gases themselves.

3.11 DAC

DAC: Derived Air Concentration. It is the amount of contamination in air, which, if breathed for 2000 hours, would result in the annual limit of intake (ALI). The ALI has to be calculated using reference conversion factors given by ICRP (International Commission for Radiological Protection) for each radionuclide.

3.12 Airtight bag and ventilated airtight bag

An airtight bag is a flexible containment used to establish an enclosure around a contaminated item, allowing personnel to accomplish works or manipulations via gloved sleeves without contacting the contaminated environment.

The airtight bag may include inlet and extract ventilation in order to achieve an air velocity in leakage points or negative pressure within the containment.

3.13 Prefilter

Filter fitted upstream of the main air filters to minimize, by removal of large particles, the dust burden on the latter.

3.14 Negative pressure or depression

Pressure difference between the pressure of a given volume, which is maintained lower than the pressure in a reference volume or the external ambient pressure.

3.15 Containment system

System constituted by a coherent set of physical barriers and/or dynamic systems intended to confine radioactive substances in order to ensure the safety of the workers and the public and the protection of the environment.

3.16 Ventilation system

Totality of network components such as ducts, fans, filter units and other equipment, that ensures ventilation and gas cleaning functions as defined in the present document.

3.17 Air-change rate

Ratio between the ventilation air flow rate of a containment enclosure or a compartment, during normal operating conditions, and the volume of this containment enclosure or compartment.

3.18 Ventilation

Organization of air flow patterns within an installation.

4 Functions ensured by the containment

The containment of nuclear worksite and of nuclear installations under decommissioning (sometime in complement of existing containment of the installation) enables the improvement of safety, of the workers, general public and protection of environment. It plays the role of:

- *Safety and radioprotection,* by contributing to keep the workers, the general public and the environment free of contamination,
- Protection of equipment and rooms, maintaining the level of cleanliness to avoid any radiological releases of contamination.

Containment ensures as necessary the following functions:

- **Safety and radioprotection function**, by acting in a static and/or dynamic manner, the role of this function is to control the reject of radioactive products, in aerosol or gas form, in environment, and to protect workers, in particular those that do not have respiratory protection from volume radioactivity generated by activities.
- **Cleaning** of the atmosphere of the enclosure or room, by renewing the volumes of air within it, in order to minimise the risks associated with the corresponding atmosphere (for example, the elimination of any gas that can lead to an explosion hazard, flue gas evacuation).
- **Purification** (or gas cleaning) by conveying the collected gases including any dust, aerosols and volatile components, towards defined and controlled points for collection, processing and elimination if possible (by using filters, traps, etc.).
- **Radiological cleanliness** maintaining a level as low as possible the atmospheric and surface contamination of equipment and rooms.
- **Conditioning** of the atmosphere of considered volumes to ensure ambient conditions continually compatible with the proper functioning of the equipment.

5 Principles for radioactive substances containment

5.1 General principles

Containment systems shall ensure the safety and radioprotection functions defined in the previous clause, in all normal operation conditions of nuclear worksites and of nuclear installations under decommissioning. They shall also ensure some of these functions, during abnormal operating conditions, or accidental situations that are to be defined case by case

Before beginning any containment design, a hazard assessment shall be made so that actual targets will be adequately defined. Clause 5.2 below provides an outline of the hazard assessment process.

System designers of containment of materials and radioactive gases must also comply with all national regulations and all the most stringent requirements specified by the competent national authorities.

5.2 Risk assessment procedure

The design of an appropriate containment system requires preliminary analysis, taking into account:

- radiological hazards generated by materials and operations leading to the need to confine the rooms or work areas where hazardous substances are handled, including:
  - permissible levels of surface or airborne contamination inside the room or rooms where are contained confined enclosures,
  - requirements for contamination monitoring.
- existence of a sufficient margin between discharge permit limits and actual discharges generated in the existing or to be created ventilation systems,
- facility external risks to which the confined enclosures and ventilation systems can be exposed and that can be considered plausible on the installation (e.g. load drop , fire, flood , external explosion , earthquakes , wind and extreme temperatures, etc. .),
- must also be taken into account human activities deployed nearby facilities (co- operations),
- possible temporary unavailability of fluids or energy necessary for the proper functioning of the containment system (electricity , compressed air, neutral gases , cooling water , etc. .),
- non-radiological hazards associated with equipment and operations implemented in confined enclosures (e.g. sudden break of containment due to mechanical failure , sudden change in pressure , explosion, fire, corrosion , condensation, load drop) , which consequences may be resuspension of activity.

For each consideration, a risk assessment is to be carried out using the safety analysis methodology where the risk is defined as the combination of the consequences of the event and its estimated frequency. An alternative deterministic approach may also be carried out, based on incidental or accidental conservative situations.

Other factors to consider in the design of containment systems are:

- for the protection of the environment, it is necessary to take into account the need to reduce to a level as low as reasonably achievable, the amount of waste produced and radioactive release (liquid and gaseous),
- it is necessary to minimize as far as reasonably achievable, the level of contamination in the rooms or work areas,
- the impact on the existing installation of modifications of ventilation network, static containment, containment enclosure layout, etc... must be considered,
- physical and radiological state of the existing installation (e.g. for static confinement, cable, drains) must be considered,
- appropriate conditions of comfort should be provided to workers.

5.3 General requirements

The basic principle with regard to the prevention of the spread of the radioactive material is:

- in normal situations, to limit the release of radioactive material outside the facility, but also to maintain a level of contamination as low as reasonably achievable inside the nuclear worksite or the nuclear installation under decommissioning,
- in accidental situations, to limit to acceptable levels the radiological consequences for the environment, for workers.

The application of this principle leads to the provision of different containment systems between the environment and the radioactive substances. Each containment system and the associated devices are designed to suit the risks they are intended to control. The goal will be to maintain, in any case, the functionality of at least one stage of effective containment and filtration between the contaminated areas and the environment under all circumstances, including some accident situations, (such as a fall from a contaminated sample component) and in all cases to limit to acceptable levels the radiological consequences for workers and the environment.

The application of this principle generally requires knowing fairly precisely the following:

- nature, spectra and quantities of radioactive material (contamination and activation) at the equipment to be modify / dismantle and particularly in areas of cutting or volume reduction,
- the state of the installation (e.g. building's architecture and ventilation system of buildings and processes).
- tools and processes used for maintenance / dismantling / cleaning and resuspension factors related to activities to be realized,
- the sequence and procedures of operations to be performed to derive scenarios of accidental situations and their associated probability level.

For these input a conservative approach in the containment design may also be accepted.

5.4 Containment system

The objective of "**containment system(s)**" is to limit the spread of radioactive substances in accessible areas of work and prevent the spread of radioactive substances into the environment. Usually a double containment is in place, however according to radiological issues and to existing configurations, the implementation of three levels of containment or of a single containment may be an optimal configuration.

Two main configurations can be meet, other configurations must be considered on a case by case study:

- Case of a worksite containment located in an existing "containment system" (usually consisting of an "historic" nuclear ventilation system, but can also be set up for the needs of a particular worksite).
- Case of a worksite containment located beyond any "containment system".

5.4.1 Case of a worksite containment site located in an existing "containment system"

The goal of "**worksite containment**" is to avoid, to the extent possible, the release of radioactive materials from containment in areas accessible to unauthorized persons (radiologically).

It includes walls of containment, if necessary associated ventilation systems: ventilation ducts, filters installed in ducts or on-through, etc.

The design of the worksite containment must reflect the maximum amount of dispersible radioactive substances within the containment and the possible consequences of risks caused by industrial processe(s) implemented.

In this case, the goal of "**second level of containment (existing containment)**" historic confinement or create if necessary, is to prevent the release of radioactive contamination outside the building in the event of failure of worksite containment. It provides protection of the environment to an acceptable level. It comprises the walls of the containment system and the ventilation and air conditioning system associated.

A "**complementary containment**" located closer to the activities generating the spread of radioactive materials may be necessary depending on the radiological issue (airtight bag, ventilated airtight bag ...).

5.4.2 *Case of a worksite containment located beyond any "containment system"*

The goal of "**worksite containment**" is to prevent the release of radioactive contamination outside the building it provides protection of the environment to an acceptable level.

It includes walls of containment, if necessary associated ventilation systems: ventilation ducts, filters installed in ducts or on -through, etc.

The containment design must take into account the maximum amount of dispersible radioactive substances within the containment and the possible consequences of risks caused by industrial processe(s) implemented.

A "**complementary containment**" located closer activities generating the spread of radioactive material may be necessary. It must be implemented consistent with the safety requirements. It is generally recommended in installations with high risk of spreading radioactive material or in which high radiotoxicity materials are manipulated (ie plutonium).

5.4.3 *Summary of different levels of containment*

Table 1 below summarizes the composition of different containment levels, Figure 1 provides a block diagram.

Type	Nature containment
Worksite containment	Worksite containment usually consists of temporary walls: soft walls (vinyl), semi-rigid walls (polycarbonate) or rigid walls (metal or masonry). It can also be based on the existing rooms.
Additional containment (Closer to the source, if necessary)	Additional containment, closer to the source of contamination, implemented according to the radiological issue of the activity. It may consist of worksite containment or a closer containment (airtight bag, ventilated airtight bag...).
Existing containment (if necessary, historical or create)	Nuclear-type ventilation of buildings or rooms, or climatic shelters (sun, rain, wind, snow, extreme temperatures, cf. § 6.6)

Table 1 - Typical examples of different levels of containment

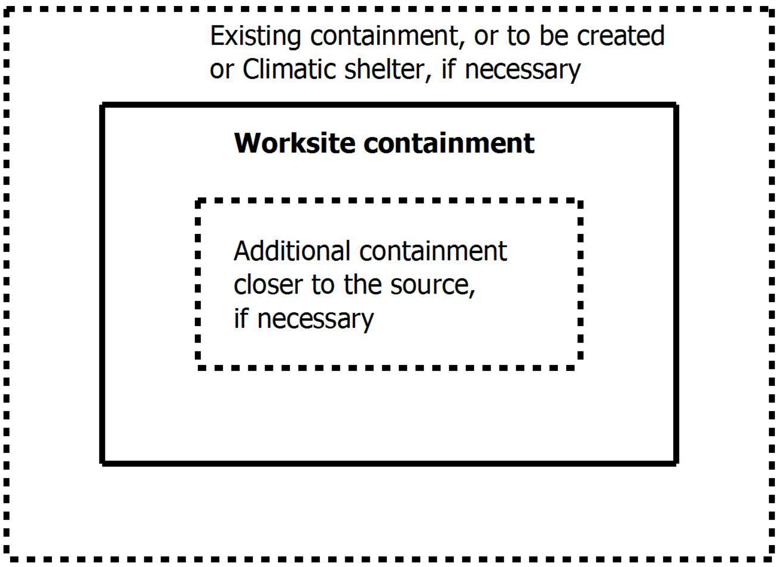


Figure 1: Schematic diagram of the composition of the different levels of containment.

The number of confinement required shall be determined by a risk assessment. To this end, the following factors must be considered: consequences and estimated frequency of potential accidents, amount of radioactivity, radiotoxicity and potential dispersibility (gas, liquid, solid) of the concerned materials.

In the definition of containment, the principle of containment of radioactive substances closer to the source of release is to be preferred. For this, additional measures may be implemented; these measures can reduce the requirements for static-dynamic containment or to make it useless, mainly include:

- capture at source (local air extraction, possibly with cover of the tool),
- depressurization of the circuit on which the intervention is performed,
- establishment of airtight bag or ventilated airtight bag (cf. § 6.5).

5.5 Static containment

An airtight enclosure containment is the most effective way to prevent the release of radioactive substances in the form of particles or gas medium. However, depending on the type of use required, a perfect seal is not possible (if some openings in containment are necessary for the transfer of materials and equipment, unsealed room in which is placed the containment etc.). In these cases, privileged air flow direction, calibrated air velocity or level of depression between each containment barrier direction must be maintained to create an air inflow to ensure the containment function.

5.6 Dynamic containment

The dynamic containment is complementary to the static confinement. It is based on the implementation of a dynamic barrier between inside and outside of containment: a privileged air flow direction, calibrated air velocity or level of depression. The idea is to keep the largest depression in areas where radioactive materials are present (process equipment, glove boxes or airlock), so that the air flows are directed from less contaminated to the most contaminated area.

This type of dynamic confinement is provided primarily by the ventilation system described in § 6.

5.7 Air clean-up modalities before release

Containment systems must not create unnecessary additional hazards and should be designed to limit the spread of radioactive substances within the installation. The modalities of air clean-up and release should help to limit the impact on the environment. To this end:

- The points of release and intake will be selected to avoid any possibility of local recycling of releases, or releases from another facility, and to limit their impact on the environment;
- The air cleaning devices must be designed and constructed in order to provide, if necessary, a suitable resistance to the various attacks, to fugitive or periodic mechanical constraints or to chemical origin aggression.

6 Methodology and recommendation for containment design

6.1 Classification of the installation into working areas

The areas in which work on radioactive materials takes place should be classified according to the degree of radioactive hazard they contain. The classification is usually set according to the direct radiation (external exposure), and the potential level of surface contamination and/or airborne contamination (internal exposure).

6.1.1 Containment area classification

In order to homogenize and to make consistent containment of nuclear worksites and of nuclear installations under decommissioning, a classification into containment areas, according to the normal or foreseeable accidental risk of spreading of contamination, can be defined.

Different systems of classification are used around the world. Most of them use a four-grade subdivision, called in the text below D1, D2, D3 and D4 area. The definitions of these four area are given in the following table. Appendix A provides an example of such a classification system.

Class	Expected normal and/or occasional contamination
D1	Area with a very low level of contamination in normal operation of containment. Only a low level of contamination is accepted in accidental circumstances
D2	Area with a low level of contamination in normal operation of containment. Only a moderate level of contamination is accepted in accidental circumstances.
D3	Area with a moderate level of contamination in normal operation of containment. A high level of contamination is accepted in accidental circumstances.
D4	Area with a high or very high level of contamination during normal operation of containment. A very high level of contamination is accepted in accidental circumstances.

Table 2 - Usual classification of containment areas

It is important to note that the notion of containment class area is always associated with operations and/or activities take into consideration during design phase and that will be realized in this containment. A significant change in the operation or of these activities (ie that significantly modifies resuspension in normal or accidental operation) must be followed by a check and possibly a modification of the design, operating conditions and monitoring of the containment area.

It may be necessary occasionally or for short periods, to change the classification of some areas or parts of areas, for example due to operational or maintenance requirements.

6.1.2 Radiological area classification

In the event of a radiation exposure hazard (external exposure), a complementary classification of the installation into radiological zones shall be made, according to the ICRP recommendations. The following radiological area designations are used if needed: unrestricted areas, supervised, controlled and forbidden areas.

6.2 Static containment design

Static containment is ensured by different means: soft walls (vinyl, shrinkable materials …), rigid walls (polycarbonate…), the walls of the building, the walls of the rooms containing radioactive substances, and/or the envelope of the process, etc. It may consist of a more or less complex combination of the aforementioned means (creating an opening for access to the process to dismantle for example).

The quality of its design, and especially its degree of leak-tightness, which is chosen according to the potential risk presented by the operations to achieve has a consequential influence on all the functions attributed to the ventilation systems that are associated with it, in particular the dynamic containment function

Following the same principles, it is generally true that good leak-tightness of a building or room can only be favorable for the overall safety of the installation, especially if failure of the dynamic confinement is considered possible.

The static containment shall be of optimum size to carry out the work safely, without risk of breaching the barrier and comfortably, whilst avoiding being too large, in order to restrict the spread of contamination and reduce waste.

The static containment must allow, if necessary, for at least separate work and undressing areas.

It is designed with consideration of decontamination, dismantling and disposal or reuse.

All static containments should have, if necessary, means of access for personnel, equipment and the removal of waste. Openings for these purpose need to be constructed to prevent contamination from escaping into surrounding environment.

Specific factors to be considered in determining the static containment included: maximum number of occupants, nature of activities, need for interim storage, and handling of materials equipment and/or waste, tools and equipment to be used. Furthermore, the time necessary for the planned activities to be realized can have an impact on the static containment conception.

The propose location for the static containment shall be considered to ensure that the design is not affected by local processes or activities and conversely the static containment does not inhibit any operations, or emergency access arrangement.

It is recommended that suitable clear windows be included in the walls of the static containment to enable other personnel to view what is going on inside without having to enter. The number and location of windows depends on the location, size and complexity of the static containment. The aim is, as far as reasonably practicable, to provide a view of all parts of the temporary containment.

The static containment can also be located in the external environment. Therefore, the design shall ensure, if necessary, that it is protected from prevailing weather conditions (sun, rain, wind, snow, high/low ambient temperatures), cf. §**Erreur ! Source du renvoi introuvable.**.

6.3 Dynamic containment design

Dynamic containment is usually realized by a ventilation system which provides in the confined area as appropriate:

- a privileged air flow direction from outside to inside the containment,
- calibrated air velocity from leakages and / or openings and / or a standard temporary opening,
- a level of depression in the containment.

Ventilation used can be a network of existing building or rooms ventilation, or a mobile ventilation set up to perform a specific activity.

Depressions between zones are necessary to create a required air flow in permanent or accidental openings that is not less than specified criteria for normal or degraded / accidental conditions. Depressions are maintained through control dampers, control valves, speed control, centrifugal fans, etc. The extraction air flows and eventually air intake may be adjusted to maintain the necessary depressions in the containment area.

To ensure the adequacy of this function in all operating conditions, criteria must be defined during the design, taking into account the influence of various factors, including :

- wind speed on the facades of the building (with accidental or temporary openings)
- uncertainties related to the operation of ventilation systems and their regulation (among others : the accuracy of the measurement systems , the response time of control equipments , the drift of the functional characteristics of components of the ventilation system (aging, clogging , degradation)
- different predictable short-term disturbances such as opening airlocks or changes in operating conditions of ventilation systems .
- temperature differences between local rooms and between rooms and the outside,
- conditions / intervention tools (pneumatic tools, ventilated suits , etc).

6.4 Static-Dynamic containment design

The overall approach to design static-dynamic containment of worksite containment site should follow the methodology of hazard assessment, type safety analysis presented in § 5. The static-dynamic containment selected must be adapted to the potential consequences of an event and its probability of occurrence. An alternative may consist of a deterministic approach based on incidental or accidental conservative situations.

The approach presented below focuses on obtaining a dynamic containment criterion, which must be adapted to radiological issues. Indeed, it is this criterion that guarantees that from the leakage of the containment an air flow direction is continuously maintained from not or less contaminated area to contaminated area with a margin suitable to radiological issues.

However, its achievement depends heavily on the design of static containment (air tightness level) and the air change rate. Optimizing the static-dynamic containment should also focus on these parameters.

It is important to note that by obtaining a dynamic containment criterion are also check: (1) a high level of static air tightness containment, and (2) a significant level of extraction air flow (high air change rate) without which the achievement of the dynamic criterion would not be possible.

On this basis, the static-dynamic criterion of containment may follow the approach outlined in the figure below.

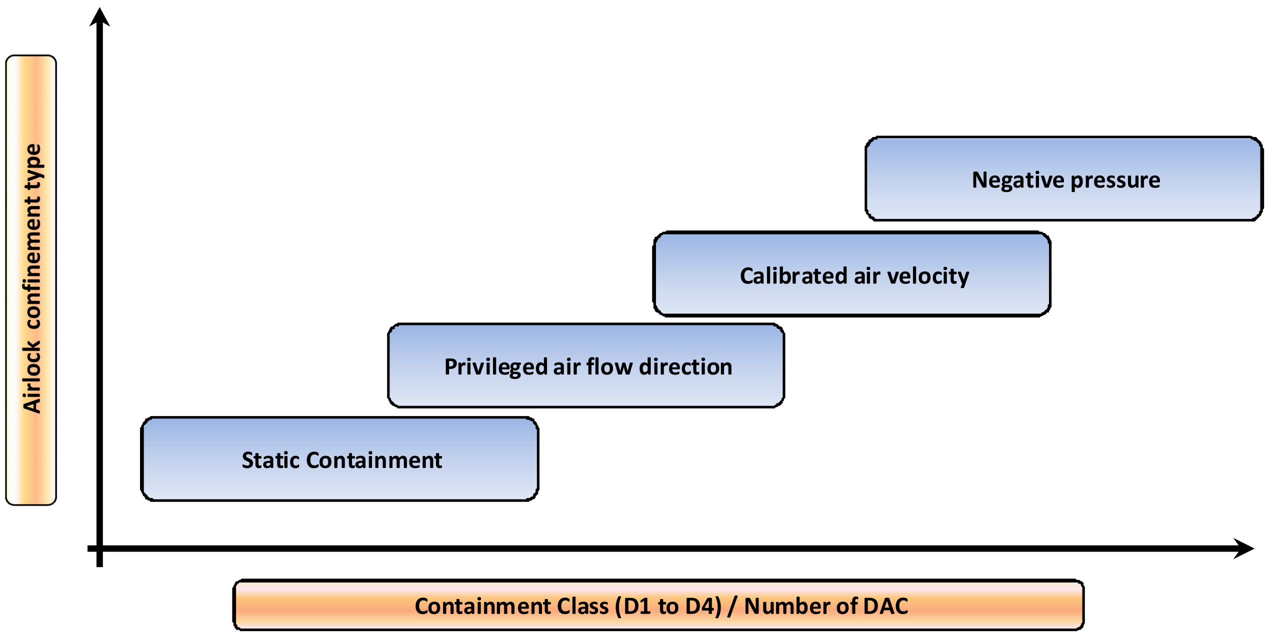


Figure 3: Static-dynamic containment criteria based on the radiological issue.

The static-dynamic criteria thus defined are necessary when activities with risk of dissemination are realized in the containment. Generally, out of spreading activities, the static worksite containment is enough, because adapted to residual risks, which may allow, for example:

- break depression for removal of waste from containment,
- stop worksite ventilation during out of workers hours and at each end of days work depending on the level of contamination and residual airborne contamination in the containment.

In cases where the source of release is not related to current activities (in the event of resuspension by evaporation, for example) the above principle does not apply. The input / output, and operation during out of workers hours must be considered on a case by case basis as function of radiological issues.

Dynamic criteria (privileged air flow direction, calibrated air velocity, depression levels) are needed in normal operation of worksite containment; they are the limits of loss of the containment. To meet these limits, the hydraulic ventilation system design should take into account a margin including normal fluctuations of ventilation.

Table 3 below provides, for indication, the usual values of dynamic containment criteria (privileged air flow direction, calibrated air velocities, depression level) in different containments based on their classification and on the number of level of containment implemented.

For the implementation of a single containment level, the dynamic containment criteria given are to be checked against the external containment atmospheric conditions.

If it is a containment level implemented in an existing containment, dynamic containment criteria are to be checked against the existing containment atmospheric conditions. In this case we value the existence of two levels of containment; this implies that there is few common mode of aggression of the two levels of containment. In addition, an indication of the dynamic containment criteria of the existing containment is also given for the implementation of confinement of class D3 and D4.

The use of at least two levels of containment is recommended for activities with high radiologic issue of type D4.

It should be noted however, that larger depressions might be required for glove boxes or containment enclosures. In certain circumstances, for example, where the effects of wind loading and thermal convection have to be considered, it may be necessary to enhance depressions (see § 6.6).

The dynamic criterion maintained between two adjacent areas with different classification should be selected to suit particular conditions of activities realized but in any case, it should be measurable during operation.

Nature of local or area	**Containment criterion**		**Containment class**
	If it is the only level of containment implemented	**If it is a second level of containment (1st level available)**	
Rooms free from contamination	Atmospheric pressure, or Slight overpressure	Atmospheric pressure, or Slight overpressure	unclassified
Areas with very low levels of airborne or surface contamination.	Static containment or Privileged air flow direction	No containment, or Static containment or Privileged air flow direction	D1
Areas with low airborne contamination	Calibrated air velocity (3)	No containment, or Static containment or Privileged air flow direction	D2
Areas with moderate airborne contamination	≥ 20 Pa (1)	Calibrated air velocity (2), (3) (and ≥ 20 Pa (1) for the 1st level of containment)	D3
Areas with high airborne contamination.	≥ 40 Pa (1) (It is recommended to implement at least two levels of containment)	Calibrated air velocity (2), (3) (and ≥ 20 Pa (1) for the 1st level of containment)	D4
Areas with very high airborne contamination.	to study case by case	to study case by case	D4*

(1) Compared with the reference external atmospheric pressure.

(2) Compared to the existing containment atmosphere.

(3) e.g. air velocity > 1 m / s in a ϕ 100 mm calibrated orifice.

Table 3 - Indicative guide values for usual depressions.

6.5 Airtight bag and ventilated airtight bag

Airtight bag or ventilated airtight bag can be used for nuclear worksite and dismantling. They are generally used for : sampling (radiological inventory), or single activity , or in locations where the installation of a worksite containment remains difficult.

For the use of airtight bag or ventilated airtight bag, it is necessary be consistent with the approach and requirements on static- dynamic containment previously defined.

However, calculating a number of equivalent DAC in small volumes of various sizes cannot correctly quantify the " radiological toxicity", therefore no containment class are usually associated directly to an airtight bag or ventilated airtight bag.

As for worksite containment (cf. § 5.4), two main configurations are possible:

Case 1: Use in an existing containment system:

The use airtight bag or ventilated airtight bag within existing containment system can limit the airborne contamination in the containment.

Limit of their use results from the consideration of a new accident situation which involves the deterioration of bag. In this case, the resulting airborne contamination in the existing system of containment must remain compatible with the accidental limit allowed in this containment.

Case 2: Use beyond any containment system :

In this case, the airtight bag or ventilated airtight bag realize the safety containment function.

To define their limit of use, one can use the following methodology:

- one considers the worksite containment that should be implemented to achieve these activities, this allow to calculate the number of equivalent DAC of the activities.
- one limit their use at for low radiological issues, that is to say, use instead of worksite containments D1 or D2 class.
- Exceptionally, airtight bag or ventilated airtight bag may also be used for higher radiological issues when gain is obtained compared to the use of an airlock containment in terms of radiation received (e.g., work in a dosing location for personnel involved...), or security (e.g., work at height ...). Formal analyses then justify their use.

For associated operating and monitoring requirements associated to airtight bag or ventilated airtight, they arise from those defined for worksite containment of type D1 or D2 as appropriate (monitoring of a static or dynamic criterion cf. § 7).

6.6 Protection against weather: sun, rain, wind, snow and extreme temperatures

An outer containment is subject to weather conditions, adequate protection against the elements (sun, rain, wind, snow and extreme temperatures) may be required depending on the duration of use of containment.

It is recommended that the functions of protection against weather and radiobiological containment are structurally separated.

Wind effects on containment can create temporary dynamic leakages by creating a comparable level of depression or even higher level than the depression level kept in worksite containment on the walls on the opposite side of the wind.

In the case of extreme weather conditions (strong wind ...) a "**climatic shelter**" can be set up only playing a role to "stop the wind effects" on the walls of the worksite containment which will keep in containment function by respecting dynamic worksite containment criteria previously defined.

6.7 Air-change rate

The number of air changes will be determined by the conventional ventilation requirements necessary to cater for fresh air, removal of odors, potential asphyxiants, vapors and heat, etc. In addition, the air change rates may be determined by the radiological requirement to maintain correct depression and air flows between areas, and to allow efficient air monitoring where this is required.

In most cases, for areas subject to classification for radiological release, the air change rate must be at least one volume per hour. However, modifications are possible case by case, in particular for large volume containment, or according to the radiological issue (particularly for low airborne contamination during normal operation).

Similarly, higher air change rate may be selected, depending on the airborne contamination or on activities realized (especially if for dusty work), or on rooms function (airlock, change rooms, workshop...).

As an indication, the air change rate commonly used in worksite containments are in the range from 1 to 30 depending on the radiological issue, volumes of containment implemented and on type of tools used.

However In areas which have a potential for airborne activity, increasing the air change rate may not result in a significant reduction of airborne activity levels local to the operator. Excessive flow rates should be avoided, since they can cause levitation of contamination and hence increased airborne activity levels. However, increased flow can reduce the average concentration in the area as a whole. Distribution of the clean air at the operator level (positioning of extraction air) are important et must be optimized as function of radiological issue and of activities to be realized

Finally, the air change rate are adapted to the processes in the work area: for example, using hot spots cutting techniques such as plasma torch may require high air change rate, not based on radiological criteria, but to maintain the thermal conditions in the room and to reduce flue gas generated.

6.8 Air inlet filtration and Air-transfer between containment system

Installing an inlet air network for worksite containments is generally not necessary (air inlets being made by leakages from the containment). Similarly, air transfer from worksite containment to another is rarely used.

However, for the following two cases:

- air inlet in a worksite containment by air inlet ventilation network,
- air transfer from rooms to another,

If it is necessary to implement air inlet systems or air transfer between containments, the recommendations below may be applied:

The air lock alone may supply sufficient fresh air for a small or simple worksite containment. However, for larger or poorly located worksite containment, additional air inlet may be required. These air inlets should be provided with filtration as presented in annex A to prevent back flow of potential contaminated air.

For worksite equipped with air inlet (air inlet ventilation network) equipment Air should enter the building through industrial grade filters to reduce the quantity of dust and impurities in the inlet air, which would otherwise find its way to the HEPA filters in the extraction network. The air may be treated to maintain the designed environmental conditions.

Similarly, consideration should be given to supplying air adjoining to the operator work station, in order to direct the flow from the operator location to the extraction points where radioactive contamination will potentially be released.

Depending on the safety requirements, the air inlet of containment areas shall be equipped with adapted filtration unit to provide protection against the backflow in case of loss of extraction air in these areas. The definition of this filtration must take into account the radiological issue in containment and ventilation extraction system configuration (configuration with or without backflow risk). These inlet airs may be necessary for containment with high air change rate.

Finally, for the calculation of containment classes, recommendations below should be taken into account:

The transfer of air without filtration from containment to another with same containment class can affect activity airborne contamination in normal operation which must be taken into account for determining the containment class of the containment.

Similarly, the transfer of air from a containment area to another, with or without filtration, in the case of gaseous radioelement can have a significant impact on the airborne activity in normal operation, which must be taken into account for determining the containment class of the containment.

6.9 Air clean-up system design

6.9.1 Areas not classified under radiological dispersal

Areas that have not been classified for radiological dispersal should normally not be filtered (they can be filtered for industrial cleanliness of the installation). Appropriate air treatment should be foreseen only when the corresponding rooms are occupied by workers or contain electric or electronic material. The extract air can be exhausted locally without filtration

6.9.2 Areas classified under the radiological release

In general, the air extracted from D1 or D2 areas via a ductwork to the discharge duct or stack the extraction system comprises includes at least, one HEPA filtration stage before release.

Compared to D2 areas, the level of contamination of the air extracted from D3 areas can be such that a level of additional HEPA filtration can be required before final discharge to the stack.

Containments for D4 areas, which contain usually loose radioactive materials, a proportion of which is airborne, require special consideration. The activity extracted from these facilities will be directly proportional to both the airborne contamination concentration and the extract air flow rate. As a general rule, several HEPA filtration stages are recommended to provide the necessary clean up for these extracts

For the design of air clean-up systems , the following recommendations should be considered:

- HEPA filtration before discharge is the Last Filtration Level (LFL).
- The filters shall be installed on the suction side of the fan.
- The implementation of a prefilter upstream HEPA filters is recommended for all activities generating a significant amount of dust.
- The implementation of spark arrestor upstream of the first stage of filtration is recommended for all worksites, with the spark risks of (hot cuts).
- Specific air cleaning systems should be implemented in case of a significant inventory of nuclides for which HEPA filters are not efficient (iodine, tritium, carbon, cesium gaseous form ...).

It should be noted, in this context, that the level of activity in relation to operator access is not directly relevant to the need for discharge filtration; which is rather a process of optimization in terms of radioactive risks for the environment; this latter requirement arises more from the need to keep discharges as low as reasonably practicable.

Mobile Filtration Unit can be used, MFU generally consist of fan and fan motor, filtration units, isolation damper, control, instrumentation and alarms all mounted on a base frame.

6.10 Connection to any existing ventilation networks

Worksite containments have usually a temporary and changing nature, for these reasons, the connection of their ventilation systems to existing ventilation systems ("historical" ventilation or ventilation implemented for a particular worksite) should be considered on a case by case basis.

Two main configurations can be met and are detailed in the following chapters, other configurations must be considered on a case by case:

- Worksite containment located in a building, room or enclosure equipped with nuclear ventilation.

- Worksite containment located beyond any nuclear ventilation (in a building, room or an enclosure without any nuclear ventilation system or outdoor).

6.10.1 Worksite containment located in a building, room or enclosure equipped with a nuclear ventilation

In this case, it is recommended not to connect the worksite containment to the existing ventilation network. The air is discharged after filtration, close to the existing ventilation network extraction, to be carry on to the discharge stack after HEPA filtration by the last filtration level (LFL). This configuration offers the features below:

- The ventilation network is not disturbed by the implementation of the worksite.
- This configuration provides flexibility and simplicity of implementation,

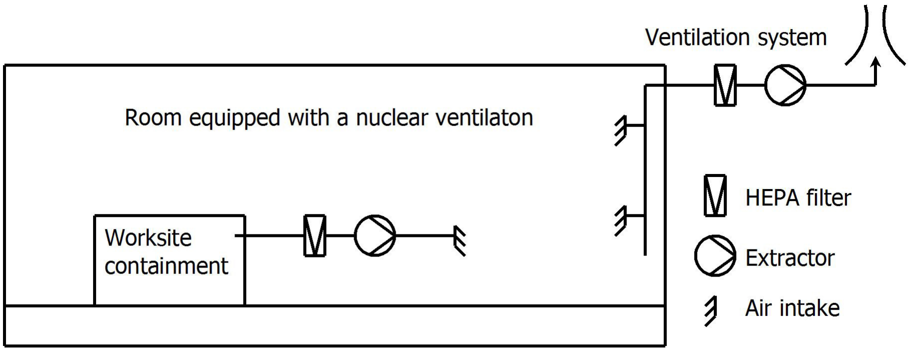


Figure 4: Worksite containment not connected and located in a room equipped with a nuclear ventilation.

The connection to the existing ventilation system is possible and should be preferred based radiological issues of activities performed, presence in significant amounts of radioelement in gaseous form (unfiltered), and on acceptable radiological conditions in the area where is located the worksite containment.

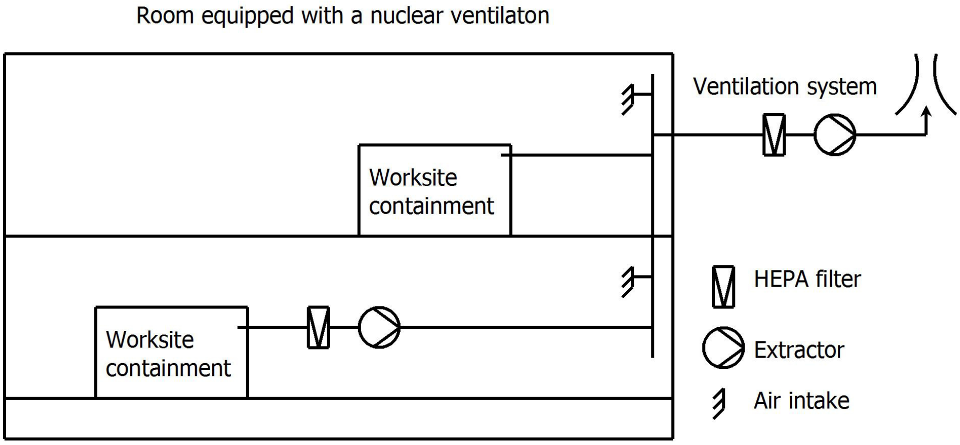


Figure 5: Worksite containment connected and located in a room equipped with a nuclear ventilation

6.10.2 Worksite containment beyond any nuclear ventilation

In this case, it is recommended to connect the worksite containment to a ventilation network system in the vicinity, if any. The air is discharged by the worksite containment, after optional filtration, in the existing extraction of existing ventilation system, to be carry on to the discharge stack after HEPA filtration by the last filtration level (LFL).

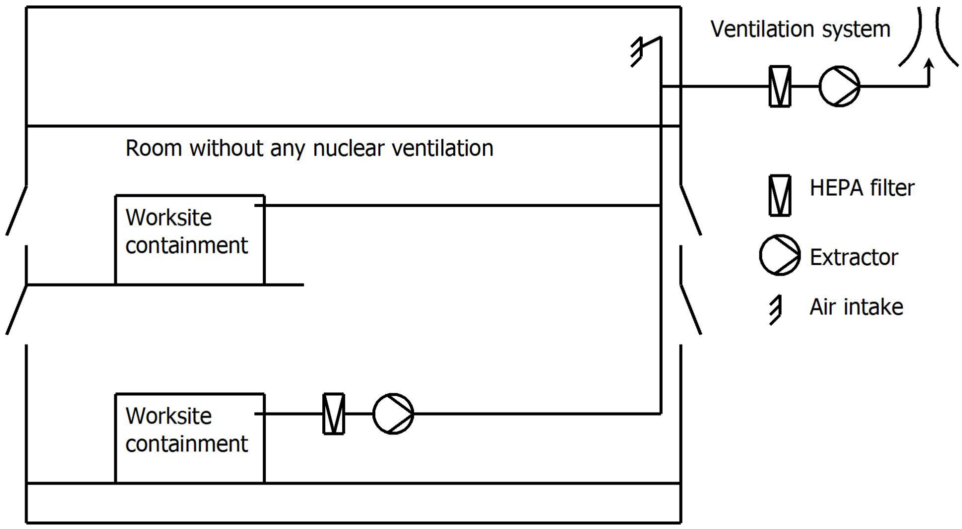


Figure 6: Worksite containment connected and located in a room without nuclear ventilation.

Non connection to existing ventilation system is possible if there is a major technical problem for connection, or the lack of nuclear ventilation system.

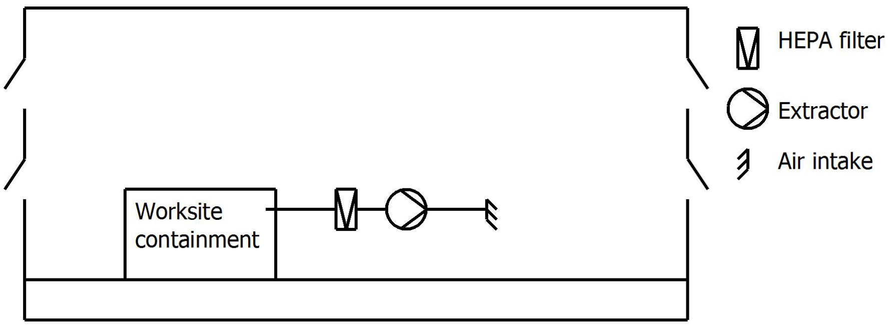


Figure 7: Worksite containment not connected and located in a local without any nuclear ventilation.

6.10.3 Additional recommendations

For the possible connection to existing ventilation networks ("historical" ventilation or ventilation implemented for a specific activity to be performed), the following recommendations should be considered:

If the worksite containment is not connected to the existing ventilation networks:

- attention should be paid to radioelement for which HEPA filters are ineffective (iodine, tritium , carbon, cesium gaseous form ...). Indeed, discharges at worksite containment output must be compatible with the radioprotection constraints and the allowed radiological conditions the area where is located the discharge of the worksite containment.

If the worksite containment is connected to existing ventilation networks:

- special attention should be paid to the non- disturbance of the ventilation system because of this connection, including the possible degradation of other rooms containment ventilated by the existing ventilation network (for a worksite ventilation with mobile fan in operation and, if needed, mobile fan stopped).
- Similarly, for worksite connected to the general ventilation and using à mobile fan, the risk of backflow in case of an unscheduled stop of general ventilation should be studied and, if necessary, procedures or palliative measures must be implemented.

6.11 Recommended ventilation configuration as function of containment class

In addition to the classification into containment area classes, and in accordance with the previous requirements, it is possible to establish basic rules for the overall design of specific equipment for worksite containments.

Annex A provides a good example of configuration for worksite containment based on the normal as well as the potential accident contamination levels. This annex is not a requirement but only a guide that should be modified according to the safety analysis.

6.12 Worksite containment usually used

Several major types of airlock are usually implemented :

- The soft walls airlock, made with layers of polyethylene or PVC (vinyl) attached by adhesives or rivet on a tubular steel structure. The soft walls airlock is the lightest and is quick and easy to install.
- The airlock with thermo shrinkable material mounted on a structure of carbon or steel which generally allows complex shapes.
- The semi-rigid walls airlock made of translucent and interchangeable polycarbonate modular panels. Links inter panels are usually made by an inner and an outer rail bracket.
- The rigid airlocks, using metal panels (black painted steel, galvanized steel, stainless steel) freestanding or attached in civil engineering. Even masonry airlocks are possible.

Are also used: airtight bag and ventilated airtight bag glove bags.

It is difficult to know, a priori, the allowed dynamic criteria for a type of airlock. Indeed, the design of an airlock depends substantially of:

- dimensions of the airlock, frames and stiffening that is implemented,
- local conditions and installation constraints,
- duration of use.

The choice of materials used for the construction of worksite containments are determined by a number of factors. This includes: duration of use and environmental conditions (exposure to wind, rain, sun, snow, high/low temperatures).

Therefore, the necessary hydraulic conditions in worksite containment (privileged air flow direction, calibrated air velocity, level of depression) apply regardless of the type of airlock used and of its ability to withstand harder conditions.

Finally, the mechanical design of the airlock must take into account a margin on dynamic criteria used in normal operation to ensure its solidity in all circumstances, including during the phases of commissioning, adjustment and potential evolution of the ventilation configuration (especially when connecting the worksite containment to an area with high depression).

7 Recommendations concerning commissioning, monitoring and operation of containment

Worksite containment and purification system, as well as associated monitoring and control equipment, shall be subject to commissioning and, test during operation In addition, a clear set of commissioning, monitoring and operating procedures must be developed.

Confinement can be considered "in operation" when activities involving resuspension of activity are regularly implemented or will soon be implemented or when a source of spread of activity is present in the containment.

The achievement of commissioning tests (cf. § 7.1), is a prerequisite to consider a containment "in operation".

Containment may be considered "out of operation" when no activity involving resuspension of activity is regularly implemented or will soon be implemented and that there is no of spread of activity present in the containment.

Radiological decommissioning is a prerequisite to consider containment "out of operation".

Operation (see § 7.3) and monitoring (see § 7.2) requirements are necessary when the containment is considered "in operation. Confinement can be considered "out of operation" for a long time.

7.1 Pre-commissioning inspection

Before operation of worksite containment, compliance must be validated by commissioning test that must be formalized by a test record.

These verifications shall be realized in all the functional regimes: manual, automatic, etc. and operated from the different control consoles, if any. During these tests, a number of system adjustments and measurements will be made, including the adjustment of the extraction air, and air supply, if any, and eventually air flow from containment, the pre-setting of control and monitoring loops, ...

These tests focus on the following:

- a visual inspection of static containment as well as taps and ventilation ducts, to ensure they were built correctly and that the air tightness is effective,
- Visually check the correct installation of filters, prefilters , spark arrestor if implemented.

  This good control must be realized and formalized for each replacement or removal of materials.
- efficiency testing of HEPA filters, if required, and of other possible treatment means,
- verification of dynamic criterion to be maintained in the worksite containment (privileged air flow direction, calibrated air velocity, level of depression ...)
- verification of proper operation of audible and / or visual alarm and of automated monitoring of dynamic criteria to be maintained, if any,
- When the worksite containment is connected to the existing ventilation network:
  - verification for affected rooms, that the required air flow conditions are always satisfied in different operational situations.
  - verification, if significant rate increase general ventilation flow rate, that pressure drop of HEPA filters LFL on existing ventilation network remain below replacement level.

Acceptance tests shall be undertaken in conditions as representative as possible of the operational conditions specified for the design of the ventilation systems.

Commissioning test may also include the simulation of some failures of equipment (to simulate abnormal operating rates of the containment systems, extractor fans out of order, unintended closing of a valve, etc.) leading to a degraded situation.

In the event of significant change or if the worksite containment has been put "out of operation" for a long duration, the above elements that may have been modified must be retested.

7.2 Monitoring of the containment

The aim of monitoring and monitoring system is to verify the continued proper performance of the worksite containment system, and when necessary to identify possible corrective actions.

7.2.1 Monitoring of static containment

Regular visual inspection of the physical condition of the walls of static containment and of taps and ventilation ducts is recommended and should be formalized.

7.2.2 Monitoring of dynamic containment

Dynamic containment should be monitored during operation.

Monitoring devices:

Depending on the radiological issue of the containment, it is recommended to equip the containment system with the following specific devices :

  - differential pressure indicator or of air velocity, and/or flow rate measurement or similar device to provide indication that the ventilation system is providing an adequate dynamic containment.
  - in addition, radioactivity detectors shall be installed. Techniques required for the sampling, monitoring and achievement of these measurements are described in ISO 2889.
  - An audible and/or visual warning in case of loss of required dynamic criteria to provide local warning to personnel working within worksite containment.
- Flow measurements in the main ventilation ducts.

Monitoring during operation:

Monitoring during operation and its frequency should be adjusted to the radiological issue of the worksite implemented and to the dynamic criterion monitored, it is recommended as function of the dynamic criterion to be check, to realize:

- a periodic record of that extraction flow rate in effective in the containment,
- a periodic record of the air velocity at leakages of the containment or in an calibrated orifice (or equivalent measure),
- a periodic record of the negative pressure in the containment,
- a periodic control of audible and / or visual alarm systems of the containment.

This monitoring during operation should be formalized, in the form of a test record, including the date and time of the test.

The monitoring systems of dynamic criterion required for the worksite containment will be design to avoid untimely tripping, especially during the opening and closing of airlock doors, and during phases of waste packages handling.

In case of non -respect of the monitored criteria, operating procedures must specify the actions to be taken before the worksite reprise (for example: ongoing work should be stopped, the reason of the defect must be research, and corrective actions must be realized. If the defect cannot be corrected at the earliest, the worksite must be secured and evacuated. Return to normal operating conditions allows resumption of work).

In the design of containment systems for highly contaminated areas, direct evidence must be available to the operator, by means of pressure gauges or flow indicators, that the required negative pressure differences are being maintained between such areas and the operating areas.

7.2.3 Purification systems monitoring

It is recommended to equip the purification system of the following specific devices, which may be subject to periodic monitoring.

Monitoring of filters pressure drop:

Indication of the status of all filters by measuring the pressure drop at each filtration stage in order to avoid any media filter break by excessive clogging , acceptance criteria are based on the manufacturer's specifications,

Depending on the risk of clogging, these filters must be either, periodically monitored with record the pressure drop with precision the date and time of recording or, continuously monitored with an alarm (visual and / or audible), at the worksite level, in case of exceeding the pressure drop replacement value.

When reaching the pressure drop replacement value, filters must be replaced as soon as possible.

Several limit values may be defined, with different consequences, for example: stop of activities generating dust, stop of the ventilation...

Monitoring of HEPA filters efficiency:

It is recommended to equip the ventilation system with specific devices that allow accurate measurement of HEPA filters constituting the Last Filtration Level (LFL) or of filter that are not LFL depending on radiological issue of activities implemented, this is of considerable importance, since the safety justification for the operation of the facility will be based on the verification of the criteria, particularly with respect to the radiological protection of personnel and of the environment,

Note: the level of filtration LFL is usually on the existing ventilation system and not at the worksite containment.

Under containment safety, HEPA filters of worksite ventilations that discharge in a room without nuclear ventilation (filters LFL) must be efficiency tested when filters are implemented, at each filter replacement, and periodically.

For HEPA filters that are not constituting the Last Filtration Level that discharge in a room with nuclear ventilation, efficiency periodic testing may be necessary depending on the radiological issue during normal operation and during accidental situations of the worksite implemented.

Efficacy in situ testing of HEPA filters must be made under the terms of ISO 17170.

Filters dose rate monitoring:

Measurement of dose rates filters, the objective this monitoring is to limit the operators dose rate during the filters replacement. The frequency of tests and acceptance criteria are set according to the radiological issue.

For the monitoring of the filters dose rate, depending on the radiological issue, it is recommended:

- To follow up the activity of filter that may be heavily contaminated,
- To provide, where appropriate, means of protection to limit the dose rate (implementation of shield for example).

7.3 Containment operation

Fans stop of worksite containments:

For worksite whose ventilation is not connected to the existing ventilation, all worksite fans can be stopped out of hours of work and at each daily end of work (in order to limit fire risk).

For worksite whose ventilation is connected to the existing ventilation, several options are possible:

- Stop fans of worksite containments out of hours of work. It is necessary in this case to ensure that the disruption of the existing ventilation related to the stop of worksite fans are acceptable (this can be achieved through ventilation design and checked during commissioning).
- Left fans of worksite containment in continuous operation (it should be compatible or made compatible with fire studies in the perimeter of the worksite).

In addition, it is necessary for these configurations, to ensure the worksite fan to stop in case of loss of existing ventilation (in and out of work hours) by means of design (automatism) or exploitation (operator action)

Where worksite containment is stopped (end of daily work), the stop of the containment ventilation is possible, if it meets the criteria of radiological cleanliness to be defined.

7.4 Containment disassembly

When the requirement for à worksite containment has finished decontamination, dismantling and disposal (or storage for reuse) of the structure and equipments shall be undertaken in a controlled manner.

The cleaning should include the inside surfaces of the worksite containment as well as all equipment either contained or used within it.

During airlock disassembly, arrangement to avoid any spread of contamination (e.g. keep extraction flow during disassembly or stick contamination before removing the airlock) must be implemented.

Where the facility ventilation system has provide the ventilation extraction for the worksite containment, either via an installed worksite containment connection or a modification to the installed system, the system may need to be return to its reference design arrangement. This may require the blanking of open ports, re-instatement of modified ductwork and/or the rebalancing of the ventilation system.

8 Considerations about other risk than radiological risks related to confinement

The following other risks are discussed because of their interaction on the containment:

- Release of toxic gases or vapors,
- …

Appendix A
(for information)

Example of containment classification based on radiological hazard - Recommendations on associated ventilation systems configuration

A.1 Classification of containments

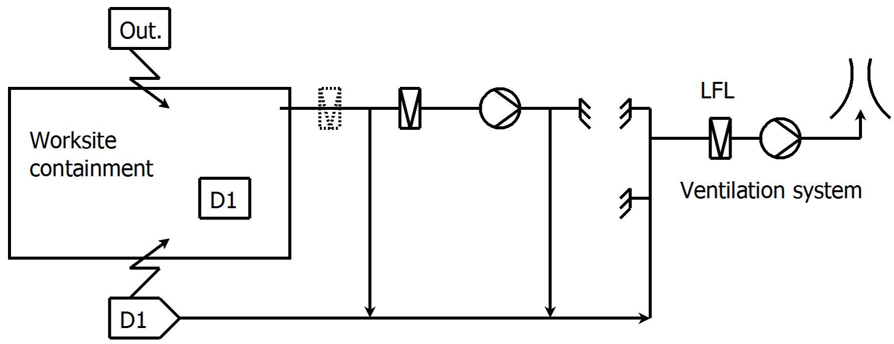
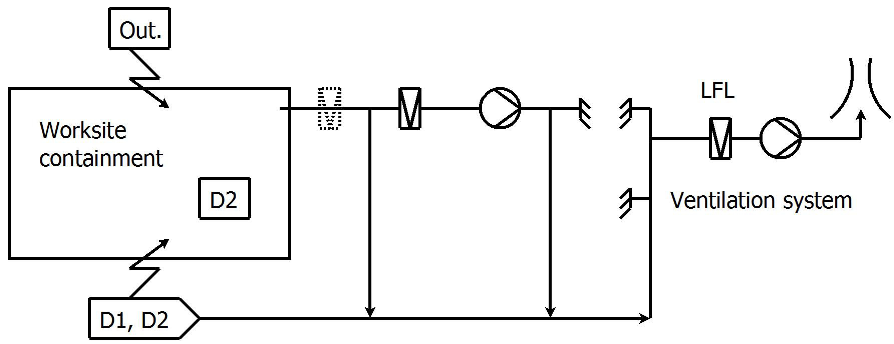
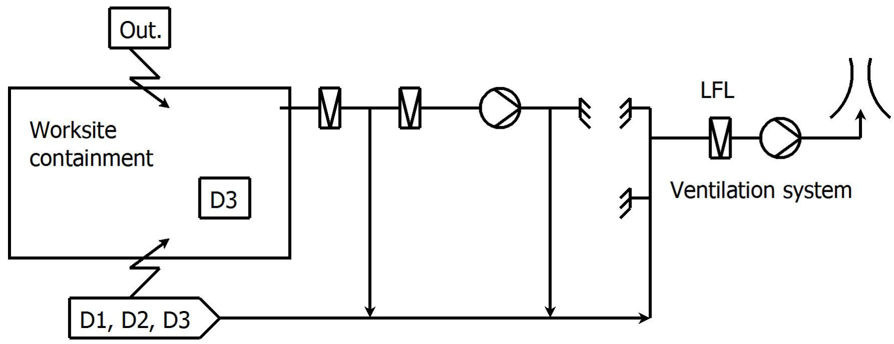
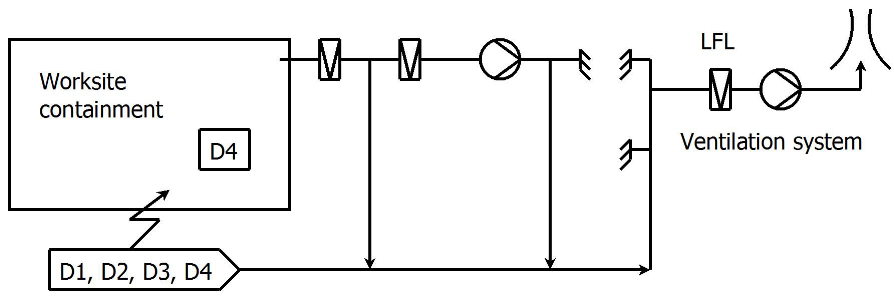
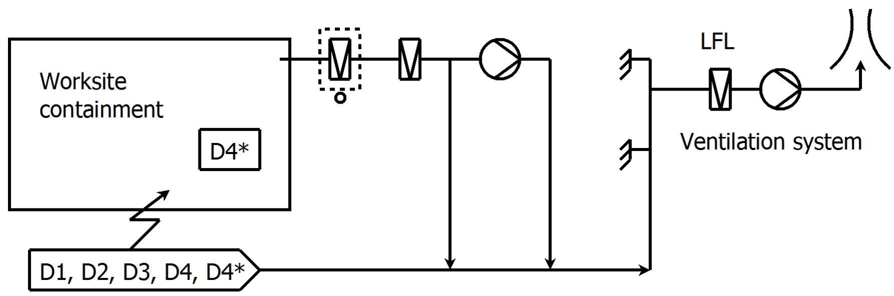
Table A.1 below gives an example of containment classification, according to the expected or potential level of airborne contamination compared to the DAC.

Expected normal permanent contamination (Pc)	Potential accidental contamination (Ac)	Containment classification
≤ 1/10	≤ 1	D1
≤ 1	≤ 80	D2
≤ 80	≤ 4 000	D3
≤ 4 000	≥ 4 000	D4
> 4 000	>> 4 000	D4*

Table A.1 - Example of containments classification, according to airborne contamination.

A.2 Recommended equipments associated with containment classes

Table A.2 below indicate the equipment recommended for each containment class and associated filtration systems.

Containment class and Foreseen radioactive Contamination		**Organization of containment systems and filtration unit**
D1	Cp : Very low Ca : Low	
D2	Cp: Low Ca : Moderate	
D3	Cp : Moderate Ca : High	
D4	Cp : High Ca : Very high	
D4*	Cp : Very high Ca : Very high	

Containment class and Foreseen radioactive Contamination	Organization of containment systems and filtration unit
legend: Cp: Permanent Contamination Ca: Accidental Contamination	

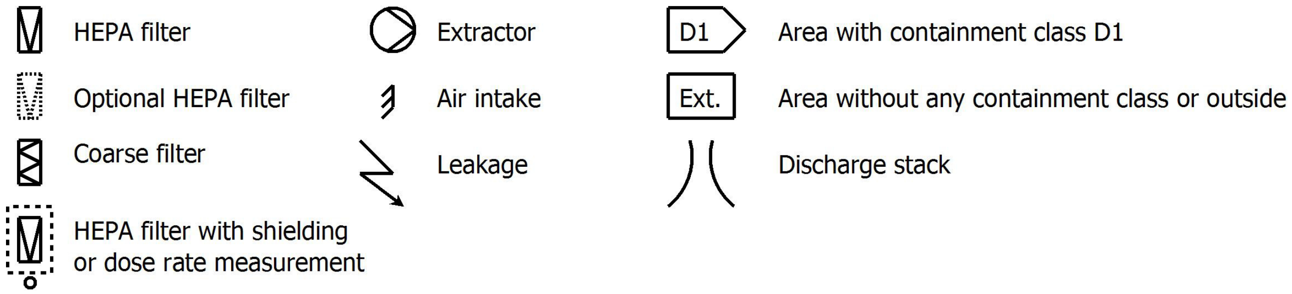


Table A.2 - Recommended associated equipment according to the containment classes.

Comments on Table A.2 figures:

If other gases (iodine, tritium, etc) have to be trapped, additional gas absorbers, iodine traps or detritiation devices shall be installed, complementing the HEPA filters.

Bibliography

ISO 16170 in situ test method for very high efficiency filter systems in industrial facilities.

ISO 2889 RP measures