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To the Minister of the Environment
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**DATE** 16 April 2013
**REFERENCE** CGM/130416-01
**Subject** Advice on: Containment measures for activities involving the use of GM arthropods under conditions of 'contained use'

Dear Minister,

COGEM and the GMO Office had a study carried out on containment measures to prevent the escape of GM arthropods from laboratories and animal housing. On the basis of the research report COGEM's advice is as follows.

**Summary**
In the Netherlands research using genetically modified (GM) arthropods takes place in laboratories, breeding units or greenhouses. Because arthropods have a wide variety of properties and greatly differ from one another in their behaviour, COGEM is of the opinion that for activities involving the use of GM arthropods it is not possible to specify standard safety levels with associated containment measures in the Genetically Modified Organisms Regulation (*Regeling GGO*), such as those which have been set in the Netherlands for activities involving the use of GM micro-organisms, etc. It will have to be determined on a case-by-case basis what containment measures should be taken to prevent escape.
In this advisory report COGEM offers guidelines for containment measures for GM arthropods. The report provides a basic set of procedures and design guidelines based on the present containment measures for activities involving GM *Drosophila melanogaster* (the fruit fly) which may serve as a starting point in preventing the escape of GM arthropods. COGEM has further included a list of considerations based on the characteristics and behaviour of groups of arthropods which can be used to determine whether the basic set of containment measures should be extended (and if so, with what measures), or whether they can be relaxed. With this advisory report COGEM has attempted to provide guidance on suitable measures to ensure the proper containment of GM arthropods when carrying out activities under 'contained use' conditions.

The considerations applied by COGEM and the advice arrived at on basis of these is provided in the enclosures to this document.

Yours sincerely,

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COGEM Chairman

c.c. Drs. H.P. de Wijs, Head GMO Office
Dr. I. van der Leij, Ministry of Infrastructure and the Environment

**Containment measures for activities involving the use of GM arthropods under 'contained use' conditions**

**COGEM advisory report CGM/130416-01**

## 1. Introduction

Research using genetically modified (GM) arthropods, such as insects, has increased in recent years. In the Netherlands research using GM arthropods takes place under conditions of 'contained use' in laboratories, breeding units or greenhouses. Because of the greater use of GM insects in research COGEM and the GMO Office had a study carried out on containment measures to prevent the escape of GM arthropods during 'contained use' activities. This study was carried out by dr. ir. C.J.H. Booij of Plant Research International and resulted in the report 'Options for containment of genetically modified mobile arthropods' (CGM 2013-02) which we hereby enclose. The findings of the research report led to the advice offered below.

During 'contained use' activities with GMOs, the organisms concerned must not escape. Therefore there are standards for the design of the space used and the way in which the activities are carried out. These design guidelines and operational procedures are set out in Annex 4 to the present Genetically Modified Organisms Regulation (*Regeling GGO*). To prevent the escape of GM arthropods during activities using GM arthropods the containment measures currently used are based on those which apply to closed GM animal housing (*DI gesloten dierverblijf)*. These housing design guidelines and operational procedures however are aimed at preventing the spread of larger animals, such as mice, apes and cows, because these have been in use longer for research purposes. Neither these procedures, nor the containment measures for activities using GM micro-organisms in laboratories, are suitable to prevent the escape of GM arthropods. GM arthropods are often small, actively mobile and can hide. Arthropods often respond to light, odour or moisture content. They can also actively attach themselves to clothing, skin, hair, plants or to the materials used in experiments. For activities using GM arthropods the containment measures which apply to closed GM animal housing are therefore always supplemented by additional measures to prevent the escape of the GM arthropods.

Arthropods include a large group of organisms which vary widely in terms of their characteristics. Insects and spiders, as well as centipedes and crustaceans all belong to the arthropod group. Arthropods may greatly differ in size from one another. There are grasshoppers bigger than 15 cm and mites only 0.1 mm in size. There are also major differences in organisation and behaviour. Bees and ants live in colonies and have a social structure. Other arthropods, such as ichneumon flies, have a solitary existence. There are also major differences in the method of locomotion. Mosquitoes and fruit flies fly, while wood lice walk. Spiders can walk, but with the aid of their silk thread they can be carried along by an air current.

## 2. Current experience with the containment of GM and non-GM arthropods

At the moment there is not a lot of experience in the Netherlands with the containment of GM arthropods. There is, however, experience with the containment of non-GM arthropods. This includes research with quarantine organisms, such as *Thrips palmi*, or research with vectors of infectious diseases, such as malaria mosquitoes. Other countries too, have experience with the containment of GM or non-GM arthropods. Other countries often use a classification system with different safety levels. These levels have been set for defined groups. In Canada, for example, a classification system with four safety levels is used for activities involving plant pathogens (basic level, PPC-1 up to PPC-3)[1]. Such a system is also recommended by researchers working on vector transferrable diseases (ACL-1 to ACL-4).[2] The safety levels provide for a progressive level of containment measures. Typical measures at the lower levels include wearing lab coats and gloves by staff, ensuring that windows are sealed, along with autoclaving waste and wastewater, etc. At the highest safety levels safety cabinets are used, while the facility has negative air pressure and an ante-room. Staff change clothing completely and shower in the ante-room before leaving.

## 3. Checklist for characteristics where additional containment measures may be necessary

Because arthropods differ greatly and have a wide variety of characteristics, COGEM is of the opinion that it is not possible at the moment to specify standard safety levels in the regulation, together with associated containment measures, such as those which have been set in the Netherlands for activities involving GM micro-organisms, for example. For activities involving GM arthropods therefore it will have to be determined on a case-by-case basis what containment measures must be taken to prevent escape.

It is not possible to say in advance what measures these should be, because this will depend on the specific characteristics of the species in question. The research report provides the following checklist as a means of determining whether the GM arthropod concerned has characteristics which should be taken into account when determining the necessary containment measures.

- The species in question is not native (exotic) or a quarantine organism.
- The species in question is potentially harmful to crops or commodities.
- The species in question may be a (potential) vector of a plant, animal or human pathogen.
- The (intended) modification may enhance the fitness of the organism.
- The species in question is able to survive or reproduce (either indoors and/or outdoors).
- The species in question is mobile, can fly or attach itself to clothing, hair or skin.
- The species in question has a life stage (e.g. adult, larva or eggs) that is very small and difficult to detect.
- A life stage of the species in question has a predisposition to hide or to attach itself to hair or clothing.
- It is difficult to capture an escaped individual (by hand, with a trap or any other device).

- The species in question responds to light, temperature, air currents, or moisture in a way which could increase the possibility of escape.
- A life stage of the species in question exhibits resistance to or tolerance of a particular destruction method (e.g. freezing).
- The destruction methods have not been validated for the species in question.
- The larvae or eggs of the species can survive in water or wastewater.

**4. Basic set of design guidelines and operational procedures as a starting point for the containment of GM arthropods**

At the moment most experience has been gained with the containment of GM *Drosophila melanogaster* (the fruit fly). *D. melanogaster* is a model organism which can be modified relatively easily in order to investigate the function or expression of a particular gene, for example. In the Netherlands too, there are several research groups working with *D. melanogaster*.

Based on the prescribed containment measures for *D. melanogaster* COGEM has arrived at the following basic set of design guidelines and operational procedures which could serve as a starting point for activities involving GM arthropods. Wherever the guidelines refer to 'facility' this should be taken to mean the work space together with the ante-room.

*Design guidelines*

1. The facility should have an ante-room with two doors which cannot be opened at the same time. The doors should be fitted with brushes on the underside and with draught-proofing strips in the gaps at the sides and on top;
2. The windows of the facility should be sealed;
3. All cracks and crevices should be sealed;
4. The following text should be mounted on the entrance door: 'Genetically modified arthropods, no entry to unauthorized personnel' together with a sign which warns that the facility should not be entered while the activities are in progress;
5. The work surfaces, floors, walls, doors, and the ceiling of the facility, as well as all the furniture should preferably be white;
6. All ventilation openings should be screened with appropriate mesh. The mesh size should have been validated for the arthropod species in question;
7. There should be a suitably adapted electrocution trap, sticky traps and, where applicable, a food or pheromone-baited trap in the work space and ante-room;
8. Coat hooks for personal clothing should be provided outside the facility; with coat hooks for work clothing in the ante-room;
9. There should be a sink/hand basin in the work space;
10. There should be a safety cabinet in the work space;
11. There should be a deep freeze (-20°C) in the work space;
12. There should be an autoclave in the building.

*Operating procedures*

13. Access to the work spaces should be restricted to personnel who are directly involved with the activities; others only with written permission from the BVF (Biological Safety Officer);
14. Staff should be knowledgeable about the arthropods and have been instructed and trained;
15. Work clothing must be worn. This work clothing should preferably be white and without pockets. After the completion of the activities the work clothing should be left behind on the contaminated side of the ante-room. Personal clothing which is not worn under the work clothing should remain on the non-contaminated side.
16. Before the work clothing leaves the facility it should be treated in such a way than any arthropods which may be present are destroyed;
17. Personal possessions should be kept outside the facility;
18. The arthropods should be kept in cages or containers. Prior to opening these, the arthropods should be immobilized using a validated method;[1]
19. The door remains closed during the activities;
20. The facility must be locked when there are no staff present;
21. Open activities should be conducted in a safety cabinet;
22. After the completion of open activities the individuals should be counted and checked to ensure that none have escaped;
23. GM and non-GM arthropods must be kept separately from one another;
24. Animals (including arthropods) and plants, modified or unmodified, which are not part of the experiment should not be present in the facility;
25. Contaminated material should be decontaminated and waste should be sterilized using a validated method for the arthropod in question. At the end of the experiment the arthropods should be killed before disposal.[2]

[1] The following method has been validated for the immobilization of *D. melanogaster*. Prior to opening the insect cages the insects are immobilized by blowing pure $CO_2$ for at least 60 seconds into a container (of up to 75 ml) containing a maximum of 300 flies. To ensure that the flies remain immobile they are shaken onto a petri dish cooled on ice or onto a mat issuing $CO_2$ and kept there. After the activities have been completed the flies are transferred to a container which is placed on ice. The immobilization ends by bringing the container with the flies back up to room temperature.

[2] A validated method for destroying *D. melanogaster* is freezing at -20°C for at least 10 hours.

*Good laboratory practice*

26. The facility should be kept clean and tidy at all times;
27. Eating, drinking, smoking, the presence of tableware, the use of cosmetics and the storage of food and drink in the facility is forbidden;
28. No vermin may be present;
29. Work surfaces must be disinfected at the end of the activities and at the end of every working day;
30. Before leaving the facility hands must be washed with soap and water.

## 5. Characteristics of arthropods and taking these into account in containment measures

As previously indicated, for activities involving GM arthropods COGEM takes the view that it will have to be determined on a case-by-case basis what containment measures should be taken to prevent escape. For certain GM arthropods the basic set of containment measures as set out above will be sufficient to prevent escape. For other GM arthropods the containment measures included in the basic set of measures will not be adequate to prevent escape and these will need to be supplemented with further containment measures. The basic set of containment measures could be relaxed if it can be properly substantiated that GM arthropods can be adequately contained with a reduced set of containment measures.

To provide a starting point for the containment of arthropods, some aspects to be taken into account for each characteristic are given below. Appendix 1 provides a more detailed overview of various precautions which could be applied to contain arthropods, while Appendix 2 provides examples of possible containment measures for various types of GM arthropods.

### 5.1 Small arthropods

For small arthropods (e.g. midges, thrips, aphids, ichneumon flies, mites and ticks) the mesh size of the gauze used for insect curtains and screens and the mesh size of the gauze/filters for ventilation openings needs to be considered. To prevent the escape of tiny arthropods the mesh size in some cases has to be so small that a HEPA filter is necessary.

With very small arthropods it is also important to pay extra attention to hidden escape routes such as ceilings, openings to technical support areas, wall-mounted sockets, electric cables, etc. With very small arthropods it is also essential that staff wear hair caps and in some cases it may be advisable to wear overshoes as well.

Another consideration with very small arthropods, which also applies to arthropods with certain small stages of development (e.g. larvae or eggs), is that they can easily be carried by air currents.

5.2 Arthropods which can bite or chew

Certain arthropods can bite or chew and in this way actively create an escape route. With such arthropods materials which can withstand this must be used.

5.3 Flying and/or floating arthropods

Some arthropods can easily fly against air currents. This means that containment measures such as under pressure, overpressure, air curtains, safety cabinets, etc. may be less effective and it may be necessary to take extra precautions.

5.4 Anthropophilic arthropods

Certain arthropods, such as ticks, head lice, and certain mites, actively seek out human beings. These arthropods could potentially hide under clothing and be carried outside by a person. For activities involving such organisms additional measures such as wearing a cap, together with a complete change of clothing combined with showering, may be necessary to prevent the escape of the arthropods.

5.5 Arthropods sensitive to differences in light intensity

Some arthropods are sensitive to differences in light intensity and are either attracted by light or seek darkness. When an arthropod is attracted by light it may be advisable not to have an entrance door with a window but to install a solid access door instead. Light sensitivity can also be used to keep arthropods in a space or safety cabinet. If a lit area is created which is far away from a possible escape route, arthropods which are attracted by the well lit spot will not escape. Similar measures could also be applied for arthropods which are attracted to the dark.

5.6 Arthropods with life stages in water

Certain arthropods, such as mosquitoes, lay their eggs in water. For these and other similar arthropods, decontamination of waste water is therefore essential.

5.7 Arthropods that live in colonies

Various arthropods, including aphids, thrips and mites, normally live together in large numbers in colonies. This makes it difficult to detect escape. When work is done using a GM arthropod species which lives in a colony, it should be attempted to keep the number of individuals as small as possible. Synchronization of the development of the individuals can also help to maintain control over an arthropod colony and its containment.

5.8 Arthropods which are particularly tolerant of low temperatures

Although most arthropods are killed when placed in a freezer at -20$^{o}$C for several hours, there are certain arthropods which are less sensitive to the cold at one or more development stages. It is known, for example, that the eggs of certain arthropods are particularly tolerant of cold conditions. Some arthropods are also less sensitive to the cold during diapause. With such arthropods additional consideration needs to be given to the destruction method used.

5.9 Arthropod quarantine organisms or exotic species

In some cases research will be carried out with arthropods which are harmful to humans, animals and/or plants and which appear on the list of quarantine organisms, as specified in Directive 2000/29/EC[3], or the 'Regulation on the prevention, control and monitoring of infectious animal diseases, zoonoses and TSEs'[4] or which function as a vector for pathogens included on these lists. When this is the case then the containment measures applicable to the quarantine organism in question must be applied while additional measures may also be necessary to prevent the escape of these arthropods.

Similarly, when research is carried out using exotic species, i.e. arthropods which do not naturally occur in the Netherlands but which could establish themselves in the Netherlands, it may be advisable to take additional measures to prevent the possibility of escape.

5.10 Arthropods in association with other organisms

Arthropods are sometimes kept in association with other organisms. An example of this is when research is conducted on ticks in combination with their host. Another example is research on certain infectious diseases which are transferred by arthropod vectors, as occurs with malaria. Here too, it is possible that more complex experiments may be carried out, e.g. when research is conducted with arthropod vectors which are kept in association with their host and infected with the pathogen which they transfer. In such situations it may be necessary to modify the measures that were taken to contain the arthropod.

## 6. Waste and decontamination

Most arthropods can be destroyed by freezing them for a day at -20$^{o}$C or by placing them in 70% ethanol. This is not sufficient for some arthropods, however. COGEM has therefore already recommended that waste, work clothing and the GM insects that have been used be autoclaved until it has been demonstrated that the insects can be destroyed by freezing.[5] Autoclaving is an effective destruction method for arthropods in all cases. If the autoclave is not inside the facility, the waste and the work clothing should be placed in the autoclave in a frozen state. This will immobilize any arthropods which may be present, they will not be able to escape when the autoclave is started or during transport, if this is necessary.

A consideration related to the decontamination of material is apparatus or equipment which cannot be frozen or autoclaved. It will be necessary to consider in advance what other methods could be used to decontaminate such equipment.

Waste water is another consideration. For some arthropods it will be necessary to decontaminate the waste water too.

## 7. Validation

When screens or filters are used the mesh size must be validated for all mobile life stages of the arthropod. The method of immobilization and the destruction/decontamination method must be validated. The number of individuals to be immobilized or destroyed needs to be taken into

account here. For the traps used it must also be known that these work for the arthropod species in question.

**8. Transport**

Closed, non-breakable containers or cages must be used for the transport of GM arthropods. Ventilation openings should be fitted with a filter which has been validated for the arthropod species in question. It should state on the packaging and in the accompanying paperwork that genetically-modified organisms are being transported.

**9. Conclusion**

Because arthropods have a wide variety of characteristics and greatly differ from one another in their behaviour, COGEM is of the opinion that for activities involving GM arthropods it will have to be determined on a case-by-case basis what containment measures should be applied to prevent escape. At present it is not possible to specify standard safety levels with associated containment measures in the Genetically Modified Organisms Regulation (*Regeling GGO*), such as those which have been set in the Netherlands for activities involving GM micro-organisms.

In this advisory report COGEM offers some guidelines for suitable containment measures for GM arthropods. The report recommends that there should be a basic set of procedures and design guidelines based on the present containment measures for activities involving GM *D. melanogaster* which could serve as a starting point for preventing the escape of GM arthropods. COGEM has further included a list of considerations based on the characteristics and behaviour of groups of arthropods which could be used to investigate whether the basic set of containment measures should be extended (and if so, with what measures) or whether these can be relaxed. With these guidelines COGEM aims to provide an indication of the measures necessary for the proper containment of GM arthropods when carrying out activities under ‘contained use’ conditions.

**References**


1. Scott TW (2005). Containment of arthropod disease vectors. Ilar Journal 46: 53-61
2. Canadian Food Inspection Agency (2007). Containment standards for facilities handling plant pests. First edition. ISBN 978-0-662-47481-4
3. Directive 2000/29/EC of the Council (of 8 May 2000), on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community
4. http://www.vwa.nl/xmlpages/page/voorkomen-en-bestrijden-van-dierziekten/melden-dierziekten/overzicht-aangifteplichtige-dierziekten

5. COGEM (2005). Afdoden van genetisch gemodificeerde insecten. Advies CGM/050215-04 [Killing genetically modified insects. Advisory Report CGM/050215-04]

## Appendix 1: Overview of possible measures for the containment of GM arthropods

### *1) Physical containment measures*

Containers

The arthropods should as far as possible be kept in properly closed containers, tubes, cages, or petri dishes, etc. For high risk activities sleeve cages, glove boxes or isolators can be used.

Facility

The facility should be properly finished. It must not have any cracks, chinks, crevices, openings, gaps or holes, etc. which would enable an arthropod to escape. Any windows should be sealed shut. The space, furnishings and equipment should preferably be white because this would enable any escaped arthropods to be more easily detected. The presence of separate working units or a lowered ceiling can also help to facilitate the discovery and recapture of any escaped arthropods. The facility should have no areas which could serve as a breeding spot, such as areas where water can collect.

When working with arthropods which are very difficult to contain, the space should be designed in such a way that it can be disinfected with gas, for example.

Location of the facility

The facility should ideally be isolated (away from other human activity). When working with arthropods in greenhouses, ideally the facility should be accessed from an adjoining building. Where this is not the case, the greenhouses should be surrounded by a buffer zone which is free of dense vegetation or crops and is accessible only to authorized personnel. This will help to prevent the spread of GM arthropods should they escape as a result of an accident.

Ante-room, doors and moats

The facility should be entered by means of an ante-room with double, automatically closing doors which cannot both be opened at the same time. The doors are sealed when in the closed position. Generally, the doors should preferably open inwards, except when the arthropod can easily fly against air currents, in which event sliding doors would be advisable. In some cases an ante-room with a single door on the outside which is sealed when shut in combination with an insect curtain on the inside will be sufficient.

Plastic curtains, air curtains and insect curtains or screens made of gauze can be used to provide an additional barrier to escape.

The presence of a moat filled with water and soap (or other detergents) to break the surface tension is recommended to prevent the escape of walking arthropods.

Coat hooks, mirror and shower

The ante-room should have coat hooks for the work clothing. The presence of a mirror in the ante-room may be useful when working with some types of arthropods because this will make it easier to check whether any arthropods have attached themselves to personnel. The ante-room should have a shower for when it is necessary for staff to shower after the activities. This may

be required in the context of activities involving GM arthropods that are very difficult to contain.

Ventilation system and under pressure
The openings in the ventilation system must be fitted with gauze/filters with a sufficiently small mesh size to prevent the escape of the arthropods. In some cases the use of under pressure is advisable.

Safety cabinet and isolator
The work space should have a safety cabinet or an isolator. In many cases it will be advisable to perform open activities with GM arthropods in a safety cabinet. In the case of GM arthropods that are very difficult to contain, the use of an isolator may be necessary to prevent them from escaping.

Fridge
There should be a refrigerator in the facility if one is required to immobilize the arthropods before open activities are carried out.

Traps or differences in light intensity
Traps should be present in both the work space and the ante-room. Traps will ensure that a GM arthropod which accidentally escapes from its container or cage can be caught and therefore will not leave the facility. There are many different types of traps available which are suitable for various species of arthropods, such as different coloured sticky traps, UV traps, light traps and pheromone-baited traps. In some cases it may also be advisable to set up traps in the corridor just outside the ante-room.

Freezer and autoclave
The work space should have a freezer so that contaminated material, waste and work clothing can be frozen thereby immobilizing any arthropods which may be present. There should be an autoclave in the building. When working with GM arthropods that are very difficult to contain the autoclave should be present in the work space itself.

***2) Operational containment measures***

*Staff*
Work clothing
Staff should wear white work clothing (lab coat or overalls), preferably without pockets. Personal clothing which is not worn under the work clothing should remain in the ante-room on the non-contaminated side. Work clothing with collars in different colours could be used where there are different containment levels present. The use of caps and overshoes is recommended in many cases. The clothing should be changed in the ante-room. After the end of the activities the work clothing should be left on the contaminated side of the ante-room. In some cases it may be necessary to disinfect or sterilize work clothing before it is washed. During activities with

certain types of arthropods it may be useful to use a mirror to check whether any arthropods have ‘hitched a lift’ with a staff member.

During activities with arthropods that are very difficult to contain, a complete change of clothing and showering on leaving may be necessary to prevent escape.

Good laboratory practice

The basic rules for ‘good laboratory practice’ should be followed. A clean and tidy working environment will limit the number of places where any escaped arthropods could hide or reproduce.

Training

Staff should be trained and instructed in handling arthropods and, in particular, how to deal with GM arthropods. New members of staff should be instructed by experienced entomologists. The staff should have at least a basic knowledge of the behaviour, reproduction and development of the arthropod in question, under natural and laboratory conditions. They should be familiar with the response of the arthropod concerned to light and temperature, as well as the relevant sterilization method(s). This will provide insight into how to work with the arthropod in question in order to prevent its escape.

*Activities with GM arthropods*

Immobilization

GM arthropods should be immobilized before being removed from their containers. The method of immobilization for the arthropod concerned must be validated.

Checking for escapees

Before and after the activities for which the arthropods were taken from their containers, the number of arthropods present should be counted. This will enable any escape which occurs to be detected in time allowing an escaped individual either to be recaptured or killed. It should be determined in advance what methods are most suitable for recapturing or killing any individual which may escape. For certain arthropods it will not be feasible to count the total number present.

**Appendix 2 Examples of containment measures for different types of arthropods**

| **Type of organisms** | **Mobile (not flying/floating) arthropods and arthropods which are biologically contained**<br><br>For example: wood lice, spiders | **Mobile (not flying/floating) arthropods which are attracted to human beings**<br><br>For example: ticks, certain mites | **Small flying arthropods**<br><br>For example: fruit flies, ichneumon fly | **Large flying arthropods**<br><br>For example: grasshoppers, cicadas | **Arthropods that are very difficult to contain**<br><br>For example: thrips |
|---|---|---|---|---|---|
| Facility, ante-room, ventilation, etc. | Fully closing doors with brushes fitted on the underside and draught-proofing strips in the gaps at the sides and top. | Ante-room with door on the outside and insect curtain on the inside.<br><br>Fully closing inward opening doors with brushes fitted on the underside and draught-proofing strips in the gaps at the sides and top. | Ante-room preferably with two doors which cannot be opened at the same time (possibly with insect curtain).<br><br>Fully closing inward opening doors with brushes fitted on the underside and draught-proofing strips in the gaps at the sides and top.<br><br>Sometimes: ante-room with one door.<br><br>Sometimes: two sliding doors. | Ante-room preferably with two doors which cannot be opened at the same time (possibly with insect curtain).<br><br>Fully closing inward opening doors with brushes fitted on the underside and draught-proofing strips in the gaps at the sides and top.<br><br>Sometimes: ante-room with one door.<br><br>Sometimes: two sliding doors. | Ante-room with two doors which cannot be opened at the same time (possibly with insect curtain).<br><br>Fully closing inward opening doors with brushes fitted on the underside and draught-proofing strips in the gaps at the sides and top.<br><br>Sometimes: two sliding doors. |
| | Moat with water and detergents. | Moat with water and detergents. | | | |
| | | | Under pressure and ventilation system with filters. | Under pressure | Under pressure and ventilation system with filters. |
| | Traps in work space. | Traps in work space and ante-room. | Traps in work space and ante-room. | Traps in work space and ante-room. | Traps in work space, ante-room and just outside the |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | facility. |
| | | | Low ceiling. | Low ceiling. | Low ceiling. |
| | | | | | Facility can be disinfected with gas. |
| | | Mirrors in work space and ante-room. | Mirrors in work space and ante-room. | Mirrors in work space and ante-room. | Mirrors in work space and ante-room. |
| | Coat hooks outside the facility for personal clothing.<br><br>Coat hooks in the facility for work clothing. | Coat hooks outside the facility for personal clothing.<br><br>Coat hooks in the ante-room for work clothing. | Coat hooks outside the facility for personal clothing.<br><br>Coat hooks in the ante-room for work clothing. | Coat hooks outside the facility for personal clothing.<br><br>Coat hooks in the ante-room for work clothing. | Coat hooks outside the facility for personal clothing.<br><br>Coat hooks in the ante-room for work clothing. |
| Staff | Suitable protective clothing to be worn (lab coat or overalls). | Fully protective clothing including cap, gloves and overshoes to be worn.<br><br>Complete change of clothing combined with showering before leaving. | Suitable protective clothing (lab coat or overalls plus cap) to be worn. | Suitable protective clothing (lab coat or overalls) to be worn. | Fully protective clothing including cap, gloves and overshoes to be worn.<br><br>Complete change of clothing combined with showering before leaving. |
| Activities | | Activities in a safety cabinet. | Activities in a safety cabinet. | Activities in a safety cabinet. | Activities in an isolator. |
| | | | Restricted number of people during activities. | Restricted number of people during activities. | Restricted number of people during activities. |
| Waste | Autoclave in the building. | Autoclave in the building. | Autoclave in the building. | Autoclave in the building. | Autoclave in the work space. |