



## FAQS – EXPM6 ANOXIA DISINFESTATIONS CHAMBER

**ANOXIA – WHAT IS IT?**

what does anoxic disinfestation consist of?

Anoxic disinfestation is a process whereby the combat against infestation by insects (one of the main causes of destruction of documents and works of art) is undertaken by asphyxia, through the use of completely innocuous gases such as nitrogen, argon or carbon dioxide.

The process is simple and is not toxic. It is based on the removal of atmospheric air and its replacement with nitrogen, argon or carbon dioxide. This method can be employed in a disinfestation chamber (an air-tight steel chamber in which the objects are placed) or in a bubble of plastic film wrapping the object (the process is extremely flexible and can be used with every kind of object, big or small).

This technique requires isolation of the documents and objects to be treated: the atmosphere inside is modified and several parameters are controlled, such as: oxygen/ carbon dioxide content, temperature, gas pressure and moisture).

**Anoxic disinfestation chamber and anoxic bubble: owing to the nature of the biological cycles of the insects that attack the material of books and other substances found in the collections of libraries and in archives, the disinfestation operations have to be co-ordinated with the customer to determine the type of infestation of the documents.**

Safety: the collections of museums, libraries and archives may be threatened by several pests, constituting a serious threat to their preservation. The method of pest control least prejudicial to the collections and to the personnel is carried out by means of modifying the atmosphere, an alternative to chemical control.

Anoxic disinfestation is a method that has no noxious effect on the items that are treated or on the operator. It is safe, ecological, non-toxic, non-flammable and non-chemical.

It consists of wrapping the item to be treated in a special film and removing the oxygen inside. The oxygen is replaced by an inert gas, thus eradicating all insects no matter what their stage of development (egg, larva, pupa, adult, etc.).

This process is monitored by state-of-the-art equipment of extreme sensitivity and precision.

It does not modify the physical or chemical properties of the item treated, and its original form is retained, though freeing it from the action of the pests.

**CONVERSION / UPGRADE OF TOXIC DISINFESTATION CHAMBERS**

can traditional pesticide-based disinfestation chambers be converted?

Yes, our history of anoxic treatment includes the conversion of the disinfestations chambers of the Portuguese Torre do Tombo National Archives and of the National Library that used to work with toxic gases.

**EXPM ANOXIC CHAMBER: ACCESSORIES**

What is understood by documentation stacking and handling ?

Construction solutions and accessories that optimise the use of the chamber

**EXPM ANOXIC CHAMBER: AMBIENT TEMPERATURE REQUIREMENTS**

What is the ideal temperature for the room where the chamber and monitoring equipment are located?

The determinant temperature is the temperature inside the chamber.

**EXPM ANOXIC CHAMBER:  
CAPACITY**

How many books can the EXPM6 chamber take?

The quantity of the documents depends on their volume, and the conversion is therefore approximate, calculated in accordance with the average found for other chambers in use.

The use of the chamber with medium- and low-pressure cycles is designed, among other things, to force the penetration of the anoxic atmosphere into every document to be treated, even in those parts more inaccessible under normal atmospheric conditions.

**EXPM ANOXIC CHAMBER:  
CHAMBER OPERATOR**

What knowledge or specific vocational training should the person have who is to receive training in the operation of the EXPM6 chamber?

There are no specific requirements for an EXPM chamber operator. Its use is intuitive and is simplified by the automation that is provided.

**EXPM ANOXIC CHAMBER:  
COMPATIBLE MATERIALS**

What types of documentation and articles (objects) can be submitted to this treatment?

Non-toxic treatment is effective in all matter that constitutes insect food since no chemical reaction is associated with the treatment. We have records of successful treatment on paper, leather, wood and textiles.

**EXPM ANOXIC CHAMBER:  
DURABILITY**

What is the life expectancy of the chamber?

The EXPM chamber is an industrial category item of equipment and is therefore of long duration (provided it is properly maintained).

**EXPM ANOXIC CHAMBER:  
DURATION OF TREATMENT**

How many days does treatment last?

Anoxic treatment using the EXPM6 chamber is effectively complete in a minimum of one week to a maximum of three weeks.

**EXPM ANOXIC CHAMBER:  
GUARANTEE OF  
EFFECTIVENESS**

How can effectiveness of the treatment be attested?

Current practice is to systematically monitor the document archives using insect traps (information available on the site) so as to determine the existence and/or continuation of pests.

**EXPM ANOXIC CHAMBER:  
LOADING THE CHAMBER**

What care should be taken when placing material in the chamber?

As an optional accessory, the chamber can be provided with a stacking trolley that allows the material to be stacked and introduced into the chamber safely and easily.

**EXPM ANOXIC CHAMBER:  
NITROGEN GENERATORS VS.  
NITROGEN BOTTLES**

What problems do you consider to be inherent in nitrogen generating equipment?

The option for nitrogen bottles in conjunction with the use of pressure and low-pressure cycles allows every part of the documents to be reached, even if there are bubbles of oxygen inside the documents, and the stabilisation of the internal atmosphere at the optimal parameters for treatment within a very short space of time.

Our knowledge of nitrogen generators shows that the equipment is more expensive (as a result of the greater nitrogen consumption), they provide relatively low flows of nitrogen, increasing the waiting time until the proper parameters are reached. Another disadvantage is that we are tied to the nitrogen atmosphere and cannot opt, in some treatments, to use carbon dioxide, which is seen to be more effective in certain cases.

The nitrogen generator has the advantage of being a complete system, with no need for the additional supply of gas. Should you be interested, we are in a position to offer a nitrogen generator, as additional equipment, to feed the chamber (this equipment can event be fitted at any time in the future).

**EXPM ANOXIC CHAMBER:  
PARAMETER STABILISATION**

How long does it take to achieve ideal environmental conditions inside the chamber for the treatment?

Use of nitrogen bottles allows optimal anoxic treatment parameters to be reached in 2 to 5 hours

**EXPM ANOXIC CHAMBER:  
PROCEDURES INVOLVING  
DOCUMENTS**

What care or procedures should be employed with the documents before and after the treatment?

Anoxic treatment is curative and not preventive. Therefore, disinfested documents should not be put in direct contact with any infested documents.

However, we do recommend prevention in terms of the development of fungi and bacteria (mould and similar things) by means of sterilising the atmosphere of the archives, treatment of the archive's furniture and systematic hygiene routines for the documents (we have several technical solutions in this field).

**EXPM ANOXIC CHAMBER:  
SAFETY IN THE SURROUNDING  
SPACE**

If the chamber and the process variables are pre-programmed and there is an oxygen analyser, why is there an optional lack-of-oxygen detector?

The lack of oxygen detector is an optional accessory designed to monitor the space where the chamber is located (to complement the safety of the inert gas exhaustion system in the event of a defect). The programmed parameters refer to the inside the chamber.

**EXPM ANOXIC CHAMBER: SELF-  
ADJUSTMENT SYSTEM**

After reaching the ideal atmosphere (temperature, relative humidity and oxygen content) inside the chamber is nitrogen introduced again only if a shortage is detected? Or when the monitoring system detects an alteration of the figures?

The EXPM6 chamber processor controls, records and automatically maintains the optimal parameters for effective treatment.

**EXPM ANOXIC CHAMBER:  
SPACE REQUIREMENTS /  
CONTROL EQUIPMENT**

Do the chamber and the control equipment have to be located in separate compartments or can they be in just one?

They can be located in a single compartment.

**EXPM ANOXIC CHAMBER:  
SUPPORT / TRAINING**

What type of training is provided for the EXPM chamber operator?

Training in use of the chamber is directed at its operator – all mechanical procedures are automated.

Orders for the chamber are fulfilled complete with all support required to train the personnel operating the chamber, including the presence of an EXPM technician, to clear up any doubts arising during the opening and closing of the chamber.

**EXPM ANOXIC CHAMBER:  
TEMPERATURE CONTROL**

Are temperature control mechanisms required in the compartment where the chamber and the monitoring systems are located?

The EXPM6 chamber has an optional accessory to control and maintain adequate temperature parameters.



## FUMIGATION – WHAT IS IT?

what hazards are linked to fumigation?

Fumigation is a traditional method, now falling into disuse, that consists of disinfesting documents and other objects using chemical agents or pesticides. Fumigants are among the most toxic pesticides.

Ethylene oxide was used as a fumigant in archives and libraries up to the 1980s, using special fumigation chambers. This pesticide is effective against insects in any stage of development, from eggs to adults. It is, however, very dangerous to workers and users at these institutions. It reacts with some matters and can even alter the physical and chemical properties of paper and some types of binding leathers. Levels of tolerance to the use of this pesticide have been progressively lowered by the authorities, rendering installed fumigation chambers obsolete. One of the specialised services provided by EXPM Lda is the conversion of chambers of this type into anoxic chambers.

Residues of ethylene oxide tend to remain in disinfested objects and documents during long periods, with concentration levels that can constitute a permanent human health hazard.

In general, fumigants and other pesticides can cause serious damage to health, particularly nausea, respiratory problems and cancer. Many chemical treatments may be apparently inoffensive during exposure, but the consequences of this exposure may appear years later in the health of those people coming into contact with these agents.

Generally speaking, treatment with chemical pesticides does not prevent reappearance of the pests.

Knowledge of the risks associated with this method of disinfestations led to the search for and research and development of non-chemical methods of pest control.

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## INTEGRATED PEST MANAGEMENT

What is understood by integrated pest management?

**Integrated pest management** consists of a number of safe practices and procedures to prevent infestation by insects, rodents and birds, as part of the **pest control programme**, which is included in archive, library and museum management. The main goal of this programme is the definition of **infestation risk prevention strategies**.

**What's it for?** The aim is to avoid the need for the traditional **corrective measures** in which detection of pests involves discovery of evidence of their direct action on the documents, objects and spaces of the archive, a dangerous phase in which we can consider the occurrence to be a serious infestation.

**Implementation:** Integrated pest management is implemented in three distinct stages:

- control of the environment;
- monitoring; and
- regular, systematic non-toxic treatment.

The main advantages of its implementation are **safety** for the workers and for those using the documents and **progressive reduction of costs** through the widespread adoption of preventive measures.

**About 3% of insects that are identified constitute a threat to the collections of archives, libraries and museums, since the organic matter that constitutes paper, parchment, textiles, leather, etc., is food for these pests.**

The pest control programme is intended to **reduce the risk of infestation by acting in an integrated manner** in every aspect linked to the presence of pests, particularly environmental conditions, upkeep of spaces and equipment, and cleanliness, allowing the reality of existing collections to be monitored.

**The pest control programme involves the following stages:**

- **preventive measures: prevent pests from entering;**
- **Identifying pest and their activities;**
- **monitoring; and**
- **how to act in the event of infestation.**

## PREVENTIVE MEASURES

- Prevent pests from **entering** the building;
- Eliminate the **sources** of pest development;
- **Food:** remove organic waste daily; avoid eating at the place of work and in areas where the



collections are kept; cleaning methods: vacuum cleaner and bio-alcohol based detergents;

- **Temperature and Relative Humidity:** Keep the values low: Temperature between 18° and 20° C; Relative Humidity between 40% and 55%;
- **Habitat:** control places of little human activity, chimneys and fireplaces, air, ventilation and heating ducts, cracks and cavities in walls and floors, basements, accumulation of waste matter (cardboard boxes, furniture, etc.).
- **Quarantine:** Inspect objects, isolate objects, keep records of the state of repair, carry out treatments
  - The **Inspection Area** should have its own isolated room allowing:
    1. **Inspection** of documents and transport containers;
    2. **Isolation** of material in duly-identified bags;
    3. If no activity is encountered, isolate the material and wait for **spring or summer**;
    4. If activity is detected, carry out **disinfestations** – residual pesticides should not be used;
    5. In the **cleaning** area, after disinfestations use a suction table, brushes and personal protection equipment (gloves and mask as protection against the activities of micro-organisms responsible for respiratory and skin allergies; and
    6. **In the packing area, following disinfestations, the packing should be done using boxes of the correct size and the transport should be undertaken using special trolleys for the purpose.**

#### IDENTIFY PESTS AND THEIR ACTIVITY

**Insects:** the larvae cause most damage; the adult insect is easier to detect; casual visitors; cockroaches that prefer food; flies that leave droppings, etc.

**Deteriorated matter:** includes wood, plywood with glue, cellulose-based composite materials, books, wool, feathers, hides, textiles, animal and vegetable adhesives, stick-on labels, etc.

#### MONITORING

##### **Pest detection means include:**

- regular, periodic inspection of the building;
- control of environmental conditions; and
- setting out insect traps.

**Insect traps** have a non-toxic adhesive and allow detection of the presence of insects but do not fight the infestation. Having been set out in strategic places they must be inspected periodically.

When the traps lose their adhesive and are very dirty they should be replaced (in the latter case, the traps also detect dirt).

- Use of traps to monitor insects involves determining the risk zones, determining material that can attract the insects and calculating the number of traps in accordance with the area;
- The traps should be identified, placed on the floor or on the shelves and the environmental conditions of these places should be determined (temperature and relative humidity) by means of a digital apparatus or portable thermograph;
- The traps and their locations should be inspected 2 to 4 times a year;
- The location of each trap, which has its own identification sheet, should be marked on a copy of the plan of the building. Each trap's identity sheet should record:
  - environmental conditions;
  - amount and type of insects;
  - date;
  - season of the year; and



- the technician in charge.
- Proper control of pest monitoring allows reports and comparative charts to be drawn up, and also the detection of the presence of organisms of other types.

#### HOW TO ACT IN THE EVENT OF INFESTATION

##### Procedures

- isolate the infested material;
- clean the surroundings;
- collect samples of the insects and/or traces of their activity, record temperature and relative humidity;
- contact colleagues or institutions experienced in infestations and contact a company specialised in disinfestations (EXPM, Lda).

##### Disinfestations Methods

- **residual insecticides** (desiccants, capsules, suspension, gel);
- traps containing **ratocide**;
- low and high temperature conditioning;
- **modified atmospheres**: inert gas systems – nitrogen or argon or carbon dioxide;

**chemical compounds**: methyl bromides and ethylene oxide; very toxic for users, have a cumulative effect, reduce the ozone layer in the atmosphere, leave residues on the objects, which are released over time (during years) and contaminate the atmosphere; and **natural repellents**.

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#### NITROGEN – WHAT IS IT?

What are the chemical characteristics of nitrogen?

Nitrogen is a gas that is extremely important to living creatures, such as plants, animals and human beings, which depend on this gas for their survival. The earth's atmosphere is the greatest source of nitrogen. About 78% of the air we breathe consists of this inert gas.

Nitrogen has no smell and no colour, and is not toxic. Large quantities of nitrogen are found in humus and in organic matter in soil.

Nitrogen exists in the earth's atmosphere in the form of diatomic molecules comprising two nitrogen atoms.

Among other uses, nitrogen is used to create anoxic (oxygen-free) atmospheres to preserve materials and to eliminate insect pests.

Liquid nitrogen is used in freezing food and in many instruments.



## PREVENTIVE CONSERVATION: CONSERVATION

What is understood by conservation?

“Conservation is the set of measures directed at systematic, direct intervention in respect of the documents to **prevent** their deterioration, without altering the physical characteristics of the support “ (in IFLA).

It consists of specialised technical measures designed to correct the physical deterioration of the materials, involving no internal intervention in the work. It includes tasks and procedures that include environmental control, pest control and collection hygiene, cleaning, storage, packing, maintenance, measures to prevent, monitor and identify pests and their activity, how to act in the event of infestation, book binding and support transfer, among others. It requires assignment of specialised human resources, specialised outsourcing, basic equipment and adequate raw materials.

### CLEANING:

Cleaning is an elementary, priority and time-consuming task since, to be effective, it has to be systematic and permanent.

**What's it for?** Proper cleaning prolongs the life of a document, avoiding contact with dust, which, in addition to being abrasive, causes the appearance of mould and attracts insects.

**How is it done?** Observance of cleaning rules is intended to safeguard the integrity of fragile paper or bindings. In cleaning, the following should be taken into account:

- the physical condition of the documents;
- the type of dirt;
- the extent of the job; and
- the value of the works.

The area of the archives should be vacuumed regularly and water should not be used. When being cleaned the documents should be closed and cleaning should begin with the dirtiest part, removing items such as clips, elastic bands, bookmarks, photos, pieces of paper, etc.

**Necessary equipment:** cleaning must be carried out using dusters, soft brushes, bio-alcohol based detergents (with no ammonia or chlorine); the use of gloves and masks, regulable - suction vacuum cleaners and cleaning tables with suction is recommended.



## PREVENTIVE CONSERVATION: PRESERVATION

What is meant by preservation?

It consists of a policy and strategic measures employed in the management of archives and libraries, the principal aim of which is to **avoid the deterioration of the collection as a whole**. This field complements the general maintenance of the buildings, involving co-ordination with other departments.

In conservation strategy control of the environmental conditions is of particular importance. The main factors to consider are: **Temperature and Relative Humidity, Lighting and Air Quality**

### 1) Temperature and Relative Humidity

- i) **Effects:** heat accelerates the deterioration of documents, high relative humidity causes oxidation and, when combined with high temperature, leads to the appearance of mould and insects. Low relative humidity makes paper fragile;
- ii) **Ideal values:** temperature should lie between 18 and 20° C and relative humidity between 45% and 55%;
- iii) **Control Mechanisms:** adequate control equipment: air-conditioning, humidifiers, dehumidifiers, air purifiers; constant monitoring: thermographs and computerised system; building maintenance.

### 2) Lighting

- i) **Effects:** light accelerates the deterioration of paper, and weakens and yellows or darkens paper. UV rays are particularly harmful owing to photochemical deterioration (high level of energy absorbed by the molecules of the object). Damage is cumulative and irreversible;
- ii) **Ideal values:** the maximum light level should not exceed 50 lux/hour;
- iii) **Control Mechanisms:** use of UV filters or optic fibre and of low UV ray emission tungsten lamps is recommended.

### 3) Air quality

**Effects:** acidification and discolouration of paper and leather by action of gases and particles such as nitrogen dioxide, sulphuric anhydride, peroxides and ozone. Particles, of silica in particular, are abrasive.