

# WHO aircraft disinsection methods and procedures

Second edition





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World Health  
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WHO aircraft disinsection methods and procedures, second edition

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## Foreword

The first edition of this document was published in February 2021 after peer review of a draft and discussions with experts and stakeholders in a consultation held by the World Health Organization (WHO) on 19–21 February 2020. WHO received feedback from various users and used it to update the document. The draft update was peer-reviewed in early 2023 by technical experts and stakeholders. This second edition incorporates the corrections and updates to the technical content.

Please send your feedback to WHO by e-mail ([VVE@who.int](mailto:VVE@who.int)), indicating the title of the document and the relevant section and page number.

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## Declarations of interest

WHO received and reviewed declarations of interest and confidentiality undertakings from all the experts who participated in the peer review and concluded that none could give rise to a potential or reasonably perceived conflict of interest related to the subjects discussed at the meetings.

# Acronyms and abbreviations

AE	aerosol
a.i.	active ingredient
EC	emulsifiable concentrate
ICAO	International Civil Aviation Organization
IHR	International Health Regulations (2005)
TC	technical material
USA	United States of America

# Glossary

**Aerosol:** a space spray with droplets  $< 30 \mu\text{m}$  in diameter (volume median diameter), with a low terminal velocity so that they remain airborne for long enough to exert the insecticide effect (*adapted from reference 1*).

**Aircraft disinsection:** procedure whereby health measures are taken to control or kill insects present in aircraft, baggage, cargo, containers, goods and post. This is a requirement in order to meet the International Health Regulations (2005) (IHR) to control insect vectors of human diseases.

**Integrated vector management (2):** a rational decision-making process to optimize use of resources for vector control. As there is a strong risk that vectors will enter aircraft at airports with high vector populations, the local health authorities and airport management should organize vector surveillance and control within an at least a 400-m perimeter of the airport (3). Well-implemented reduction of vector populations in and around airports will reduce the risk of vectors entering aircraft and the requirement for disinsection.

**Long-term treatment (residual treatment) method:** application of pesticides in cabins and holds that leaves an insecticide deposit that persists for much longer than one flight sector. Such deposits are intended to remain effective for up to 8 weeks. See *sections 3.2 and 4.5* for further information.

**Pre-arrival method:** approved aircraft disinsection methods completed before departure of the aircraft (i.e. pre-embarkation, pre-departure, residual or pre-departure hold spray).

**Short-term treatment:** aircraft disinsection treatments that last for one flight sector only. (See *sections 4.2, 4.3 and 4.4* for further information.)

- **Pre-embarkation method:** aerosol spraying of aircraft cabins, in the absence of passengers, before embarkation. The treatment is effective for the duration of a single flight sector. In pre-embarkation cabin spraying, all areas of the aircraft cabin are sprayed, including the flight deck, open overhead and coat lockers and toilets.
- **Pre-departure method:** replaces the previous “blocks-away” and “top of descent” methods and comprises aerosol spraying of the aircraft cabin after passenger embarkation but before the overhead lockers are closed and the aircraft is pushed back for departure. The treatment is effective for the duration of a single flight sector. All areas of the aircraft cabin are sprayed, including the flight deck, open overhead and coat lockers and toilets.
- **Pre-departure cargo hold disinsection:** treatment of aircraft cargo holds that were not treated by residual disinsection.
- **On-arrival disinsection method:** treatment of aircraft that were not disinfected before arrival or not disinfected correctly or as required as an additional treatment.

**Volume median diameter ( $D_v$ ):** the droplet diameter that bounds a cumulative volume of the spray emitted. For example, in  $D_v10$ ,  $D_v50$  and  $D_v90$ , 10%, 50% and 90% of the volume is emitted in droplets smaller than those diameters, respectively. For  $D_v50$ , half the volume of a spray contains droplets with a diameter less than the  $D_v$ , and the other half contains droplets with a diameter larger than the  $D_v$ .

# 1. Introduction

This document replaces WHO's previous formal publications on aircraft disinsection (4). It is a dynamic electronic document, which may be updated from time to time as new information becomes available. Links to other websites are provided for the users' convenience but do not constitute WHO's endorsement of the information or materials presented on those websites.

This document was prepared by WHO to describe the latest aircraft disinsection methods and procedures. Aircraft are disinsected to protect countries from introduction of:

- potential disease vectors, to help prevent the spread of pathogens borne by mosquitoes and other vectors; and
- agricultural pests and other insects that may be considered threats.

Each country should, in liaison with the country of aircraft departure, assess the requirements for disinsection of arriving aircraft, taking into consideration the following risk assessment factors:

- region of the departure airport
  - known to have targeted vectors, indicated by local entomological information;
  - known to have active circulation or transmission of vector-borne pathogens of public health significance;
  - known to have relevant seasons and climate for the targeted vector; and
  - volume of flights
- departure airport
  - surveillance for the presence of targeted vectors;
  - routes to regions not endemic for the targeted vectors;
  - jetway, walkway, stairway or door to the aircraft closed when not in service; and
  - can provide a designated parking position to isolate aircraft from vector threats
- arrival airport
  - can provide a designated parking position if arriving aircraft may be carrying infectious agents or vectors;
  - vector control programme implemented; and
  - alternative airports in the region if diversion is necessary
- aircraft operator
  - disinsection practices;
  - aircraft parking area enclosed (doors open if not enclosed); and
  - can disinsect aircraft at non-base airports.

Countries that require disinsection of aircraft should periodically review their requirements and modify them, as appropriate, in the light of current evidence on the transmission of insects to their territories via aircraft.

When disinsection is required, a country should authorize or accept only methods, chemical or non-chemical, and/or insecticides, that are recommended by WHO<sup>1</sup> and are considered efficacious by that country.

Aircraft may introduce insect vectors, including disease agents, to locations in which they were not previously present. In addition, insects (vectors) may transmit pathogens to people in places served by aircraft (e.g. “airport malaria”). Mosquitoes act as vectors of pathogens that cause a number of serious diseases, such as malaria, dengue, chikungunya, Zika virus disease and yellow fever.

WHO’s previous formal publication on aircraft disinsection was published in 1995 in the International Programme of Chemical Safety series (5). In 2000, the importance of disinsection of aircraft departing from airports in disease-endemic areas into non-endemic areas was discussed (6). The International Health Regulations (2005) (IHR), which were adopted by the World Health Assembly in 2005 and came into force in 2007, establish global benchmark standards to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks and that avoid unnecessary interference with international traffic and trade. The position of the IHR is that disinsection of aircraft is a necessary measure to help prevent the spread of vectors. The IHR define disinsection as

*the procedure whereby health measures are taken to control or kill the insect vectors of human disease present in baggage, cargo, containers, conveyances, goods and postal parcels (IHR, Part I, article 1)*

and state that it should “be carried out so as to avoid injury and, as far as possible, discomfort to persons ...” (IHR, Part IV, article 22, section 3) (7).

The International Civil Aviation Organization (ICAO), which harmonizes standards in civil aviation, including aircraft and at airports, encourages Member States to complete the Airport Vector Control Register maintained by ICAO and emphasizes the importance of guidelines on vector surveillance and control in airports (8).

In 2016, WHO convened an expert group in response to the spread of Zika virus, which considered that disinsection would have little effect in preventing importation of the virus, as it is imported mainly by infected travellers and, to a lesser extent, by mosquito vectors (9). Some cases have been identified of dengue viruses carried by mosquitoes in aircraft. Even if the risk is very low, it nevertheless remains, and WHO considered it important to address the issue.

A WHO consultation in 2018 recognized that guidance on aircraft disinsection methods and procedures was required, with standard operating procedures for aircraft disinsection

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<sup>1</sup> This does not preclude the trial and testing of other methods for ultimate assessment and approval or recommendation by WHO.

and training materials and tools (10). The first edition of the WHO aircraft disinsection methods and procedures was published in 2021 to address the first requirement (4). The present guideline provides an update of the first edition.

This document describes methods and procedures for effective disinsection, but it is not intended to cover all issues related to aircraft disinsection comprehensively. The regulatory aspects of approval of products for aircraft disinsection and occupational risk assessment, for example, are not within the scope of this document. The document addresses only the control of arthropods (mainly insect vectors of disease) in all areas inside the cabin and flight deck and all cargo areas of aircraft. Separate guidance is available for surveillance and control of vectors in and around airport premises (3). Although prevention of the importation of agricultural pests is beyond the scope of this document, many countries will require aircraft disinsection for this purpose.

The guidance given here is for use by the airline industry, airport authorities, national pesticide regulatory agencies, the pesticide industry, public health and pest control organizations, aviation authorities and other stakeholders.

## 2. Aircraft disinsection products

Aircraft disinsection products must meet national pesticide registration requirements, the product specifications contained in this document, national aviation policy, aircraft manufacturers' technical and safety requirements and standards, and the practices recommended by ICAO. The only disinsection products approved for use on aircraft are those that have been fully tested by aircraft manufacturers or test laboratories to ensure that they do not damage aircraft materials such as plexiglas, plastics and metals. The manufacturers should provide pesticide product label and safety data sheets to airlines or to aircraft disinsection applicators for each pesticide product handled or applied for disinsection.

WHO has published guidance on testing the efficacy of aircraft disinsection products (11) and a generic risk assessment model with worked examples and evaluation of different types of aircraft disinsection products against the risk assessment model (12). Additionally, a systematic review on the safety and applicability of pyrethroid insecticides for aircraft disinsection was undertaken in 2020 (13).

The active ingredients (a.i.'s) of pesticides and their end-use formulations that have been evaluated and recommended by WHO for aircraft disinsection are described below. Manufacturers of aircraft disinsection products may submit applications for WHO prequalification of specific product(s).<sup>1</sup> After assessment of dossiers and WHO prequalification, new products containing these and other a.i.'s could be added to the list of prequalified products.

### Permethrin

- permethrin (25:75 *cis:trans* isomer ratio) technical material (TC)
- permethrin 2% aerosol (AE)
- permethrin emulsifiable concentrate (EC) of different concentrations to be diluted to permethrin 2% for residual treatment. A ready-to-use suspension containing permethrin 2% may be supplied for this purpose.

### d-Phenothrin and 1*R-trans*-phenothrin

- d-phenothrin TC or 1*R-trans*-phenothrin TC
- d-phenothrin 2% aerosol (AE) or 1*R-trans*-phenothrin 2% AE

*Note:* 1*R-trans*-phenothrin TC has a higher ratio of the R isomer than d-phenothrin TC.

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<sup>1</sup> For information on the process and data requirement for WHO prequalification of products, manufacturers of aircraft disinsection products should contact WHO at <https://extranet.who.int/pqweb/vector-control-products>.



**A combination formulation containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%)**

- An aerosol combination of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) with a single-shot vertical ejection nozzle<sup>1</sup> is the currently recommended aerosol for application in cargo holds.
- Subject to approval from the destination country authority, airlines may select the alternative of an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% with a single-shot vertical ejection nozzle when there is no authorization of use for a combination aerosol formulation in a spray can with final concentrations of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin).

The difference between permethrin and d-phenothrin (1*R-trans*-phenothrin) pyrethroids is principally in their residual effect. Permethrin leaves a residual effect on surfaces, while d-phenothrin (or 1*R-trans*-phenothrin) has a primarily knock-down and killing effect, with lesser residual efficacy.

No alternative pesticide product has been prequalified to replace pyrethroids in case of resistance of mosquitoes to these products.

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<sup>1</sup> A multi-shot nozzle may also be used for treatment of small cargo and baggage holds, as described in *section 5.3*.

## 3. Types of pesticide application and equipment

Pesticides are applied in passenger cabins, including toilet areas and the cargo hold, with aerosols and residual treatment of aircraft surfaces, while the flight deck, cockpit and crew rest areas are treated by aerosol application only.

### 3.1 Aerosol sprays

Aerosol dispensers are used currently in the airline industry to treat all spaces accessible from the interior. The doors of overhead luggage racks should be closed only after space spraying has been completed. A specification for these dispensers was published by WHO in the specifications for equipment used in vector control (1), which state that they shall consist of a can and a valve or release mechanism, such that, when the valve is actuated, the entire contents will be discharged in the form of an aerosol without interruption and within a stated time.

#### 3.1.1 Droplet spectrum

Space treatments require that droplets  $< 30 \mu\text{m}$  (volume median diameter,  $D_v$ ) remain airborne for a long time. To kill most vector species, airborne droplets should optimally measure  $10\text{--}15 \mu\text{m}$ .

#### 3.1.2 Discharge rate

When a dispenser is operated according to the manufacturer's instructions, the rate of discharge should be  $1.0 \text{ g} \pm 0.2 \text{ g/s}$  at  $27 \text{ }^\circ\text{C}$ <sup>1</sup>. The aerosol produced shall comply with the following physical requirements:

- $\leq 20\%$  by weight (droplet size statistic:  $D_v80^2$ ) of the aerosol shall consist of droplets of diameter  $> 30 \mu\text{m}$ ; and
- $\leq 1\%$  by weight (droplet size statistic:  $D_v99^3$ ) of the aerosol shall consist of droplets of diameter  $> 50 \mu\text{m}$ .

These requirements may not necessarily be met during discharge of the last 10% of the content of cans.

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<sup>1</sup> If the manufacturers declare a discharge rate at a temperature other than  $27 \text{ }^\circ\text{C}$ , they should also provide a declaration of the discharge rate at  $27 \text{ }^\circ\text{C}$ .

<sup>2</sup>  $\leq 80\%$  by weight of aerosol consisting of droplets smaller than the specified diameter, i.e.  $< 30 \mu\text{m}$  and only  $20\%$  in droplets  $> 30 \mu\text{m}$

<sup>3</sup>  $\leq 99\%$  by weight of aerosol consisting of droplets smaller than the specified diameter, i.e.  $< 50 \mu\text{m}$  and only  $1\%$  of droplets  $> 50 \mu\text{m}$ .

A droplet size with a  $D_v < 30 \mu\text{m}$  is selected to produce a “space spray” that remains airborne, so that droplets are deposited on mosquitoes flying through the spray cloud. The dispensers are operated when the air-conditioning system is temporarily turned off. After it is turned back on, these small droplets are rapidly removed from the air inside the passenger cabin, so that there is minimal if any spray in the cabin atmosphere. Hence, passengers are not expected to be exposed after pre-embarkation space spraying.

### 3.1.3 Aerosol application

The objective of aerosol treatment of cabin airspace with d-phenothrin or 1*R-trans*-phenothrin is to quickly knock down and kill any small flying insects that are present. Permethrin acts more slowly and is used not only to treat the cabin space but also to provide a fine residual coating on many internal surfaces. When insects come into contact with the treated surfaces, they are knocked down to the floor. Aerosol cans should have a discharge rate of 1 g/s (with a tolerance rate of 20%) and provide a droplet size according to the WHO specifications for equipment used in vector control (1). The propellant used in spray cans for disinsection of aircraft must be registered with the appropriate authority and must meet the technical and safety requirements of aviation and aircraft manufacturers for its use (i.e. not flammable).

The spray rates for the cabin and the cargo holds are as follows.

**Cabin spraying:** 10 g formulation per 28 m<sup>3</sup> (1000 ft<sup>3</sup>).

**Cargo hold spray:** Manual activation of the aerosol while the cargo hold door is still ajar results in loss of spray outside the aircraft until door is fully closed. Therefore, the amount of formulation required has been increased from the previously recommended rate of 10 g/28 m<sup>3</sup> (1000 ft<sup>3</sup>) to:

- 40 g of formulation per 28 m<sup>3</sup> (1000 ft<sup>3</sup>) for the lower cargo hold and
- 15 g of formulation per 28 m<sup>3</sup> (1000 ft<sup>3</sup>) for the upper cargo hold area of a freighter.

**Lower cargo holds:** A combination aerosol of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) in a spray can with a single-shot vertical ejection nozzle is the recommended aerosol for application in cargo holds in which residual treatment with permethrin 2% EC has not been completed. In special circumstances,<sup>1</sup> the airline may select, subject to approval by the destination country authority, the alternative of an aerosol containing either d-phenothrin 2% or 1*R-trans*-phenothrin 2% with a single-shot vertical ejection nozzle.

**Upper cargo hold area of a freighter:** A combination aerosol in a spray can containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) is the recommended aerosol for application in the upper cargo hold area of freighters. In special circumstances,<sup>1</sup> the airline may select, subject to approval by the destination country authority, the alternative of an aerosol containing either d-phenothrin 2% or 1*R-trans*-phenothrin 2% with either a single-shot vertical or a multi-shot ejection nozzle when residual treatment with permethrin 2% EC has not been completed.

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<sup>1</sup> For example, no authorization of the combination 2% permethrin and 2% d-phenothrin (or 1*R-trans*-phenothrin) aerosol.

## 3.2 Residual application

Residual application is an alternative method for use in empty aircraft, which provides a more persistent spray deposit, namely “residual treatment”. Residual deposits are intended to remain effective for a maximum of 8 weeks. This preparation provides an insecticidal deposit on all internal aircraft surfaces (cargo areas and/or passenger cabins) that kills target insects that come into contact with the treated surface.

Note: The flight deck, cockpit and crew rest areas are treated with a permethrin 2% aerosol. In such areas, an aerosol containing permethrin 2% is applied instead of residual treatment with permethrin 2% EC.

### 3.2.1 Insecticide formulation for residual treatment

Residual disinsection with permethrin 2% EC at a rate of 0.2 g a.i./m<sup>2</sup> provides an insecticidal deposit on all internal aircraft surfaces (cargo areas and/or passenger cabins) to kill target insects that come into contact with the treated surface. Properly applied permethrin 2% EC deposits are intended to remain effective for 8 weeks.

When permethrin formulations other than 2% EC are authorized for use by national regulatory agencies, the application rate of such products is adjusted to achieve the final target rate of 0.2 g a.i./m<sup>2</sup> on cabin surfaces.

The floor surface of the cabin and areas with cargo should be treated with permethrin 2% EC to deposit 0.5 g a.i./m<sup>2</sup>. This can be achieved by spraying floor surfaces twice with 0.2 g a.i./m<sup>2</sup>, thus depositing a total of 0.4 g a.i./m<sup>2</sup>. As some of the large droplets produced when spraying other surfaces may fall on the floor, especially along aisles, the maximum dose at floor level is estimated to be 0.5 g a.i./m<sup>2</sup>. It is essential to follow the instructions on the label of the permethrin 2% EC formulation.

### 3.2.2 Equipment for residual treatment

Where applicable, equipment for aircraft residual treatment must comply with *WHO specification guidelines for vector control equipment*, second edition, 2018 (1). WHO encourages development of alternative methods of residual treatment with proven efficacy. For residual treatment of aircraft cabins and cargo with permethrin 2% EC at a target rate of 0.2 g a.i./m<sup>2</sup>, the discharge volume of the equipment should be ≤ 10 mL/m<sup>2</sup> to avoid the risk of run off of the liquid and wetting of aircraft surfaces.

The equipment should produce spray with Dv of the droplets ≥ 50 µm. To avoid the risk of inhalation of small droplets, no more than 10% droplets should be < 30 µm at the specified operating pressure at the nozzle.

Operators who apply residual sprays must be trained to:

- configure the equipment used to treat various surfaces correctly;
- use the appropriate application technique for the type of equipment so that the residual droplets are distributed evenly over all surfaces that require treatment; and
- distribute and maintain the appropriate swath width, which is determined partly by the angle of spray emitted and partly by the distance between the nozzle and treated surface. For example, when using a sprayer fitted with a hydraulic flat-fan nozzle, it is important that the operator maintains the correct distance between the nozzle and the surface being treated in relation to the angle of the fan of spray emitted from the nozzle to ensure that the swath is maintained and the residual droplets are distributed evenly over all surfaces that require treatment. For example, when using a sprayer fitted with a 160° angle flat-fan nozzle, the distance between the nozzle tip and the surface being sprayed should be 45 cm, and the operational speed should be 0.4 m/s. These parameters should be adjusted in aircraft, particularly when low volumes are applied.

The current options are as follows.

- **Compression sprayers** fitted with a flat-fan hydraulic nozzle and a control flow valve (1.5 bar) or battery-operated sprayers that can provide a constant discharge rate to achieve an application rate  $\leq 10$  mL/m<sup>2</sup>.
- **Ultra-low volume cold foggers** set to a maximum discharge rate of 300 mL/min (5 mL/s). To achieve an application rate of 0.2 g a.i./m<sup>2</sup> of permethrin (i.e. 10 mL/m<sup>2</sup> of a 2% permethrin emulsion), it is necessary to apply spray at a rate of 1 m<sup>2</sup> area every 2 s. The advantage of this equipment is that even distribution of the droplets can be achieved more easily in hard-to-reach areas, such as under seats.
- **Electrostatic sprayers** have been used extensively for aircraft disinfection but not for aircraft disinsection. The sprayers must generate an output of charged spray droplets with Dv50 equal to 70–80  $\mu$ m and Dv10  $\geq 40$   $\mu$ m at a flow rate of 60–150 mL/min. It is mandatory that the sprayer be designed so that the droplets are air-assisted to direct the spray droplets to the target surfaces. The velocity of the air assist should be 0.46–0.6 km/min. A hollow cone spray nozzle of 60–70° at an application distance of 60–90 cm while the sprayer outlet is moved over the target surfaces at 1 m/s in a figure-8 pattern is the proven application method. The charged spray droplets have better coverage than non-charged droplets due to the electrical attraction between the spray droplets and target surfaces. Battery-powered electrostatic sprayers are the most convenient and mobile and do not require a power source external to the aircraft or service location.

### 3.2.3 Personal protective equipment

Use of effective personal protective equipment should be prioritized during disinsection and handling of pesticides to reduce operator exposure. Follow the insecticide manufacturer's product label in selecting equipment and use a tiered approach for pesticide risk reduction and provisions for personal protective equipment and protective clothing as described in FAO/WHO guidance (14).

## 3.3 Guidance, standards and regulatory requirements

### 3.3.1 Registration of products

The technical materials and formulations of pesticides, including spray cans, should adhere to the following requirements:

- manufacturer's product specifications approved by a regulatory body (usually a national pesticide registration authority) or according to WHO specifications;
- FAO/WHO guidelines on good labelling practice;
- compliance with regulations in the country of both flight departure and arrival;
- compliance with other international standards;<sup>1</sup>
- individual airlines might require additional testing of aircraft disinsection products to meet the aircraft manufacturer's specifications;
- national regulations may require registration of aircraft disinsection products.

Changes to regulatory schemes may affect the availability of co-formulants used to manufacture aircraft disinsection products, e.g. propellant. The testing of alternative chemicals for application in aircraft (testing for efficacy, human safety and aircraft material safety) may take a significant amount of time. Public health authorities, aviation authorities and other stakeholders should ensure that they are aware of and anticipate the future consequences of regulatory changes that may affect the use of chemicals in different jurisdictions.

### 3.3.2 Customer notification on disinsection requirements

Airlines should notify passengers and cargo customers at the time of booking that aircraft disinsection may be required on flights to and/or from their destination.

*Note:* Countries should, upon request, provide aircraft operators with appropriate information, in plain language, for dissemination to air crew and passengers, explaining the pertinent national regulation, the reasons for the requirement and the safety of properly performed aircraft disinsection.

### 3.3.3 Storage and disposal of used cans

Airlines should follow national regulations on storage and disposal of used containers.

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<sup>1</sup> Other standards cover disinsection procedures as required on international passenger flights. See ICAO Annex 9 – Facilitation on relevant standards and recommended practices at: <https://www.icao.int/Security/FAL/ANNEX9/pages/Publications.aspx>.

## 4. Aircraft disinsection

The methods and insecticides recommended in this document must meet the requirements of both the country in which treatment is applied and the country of arrival.

Tables 1–4 show recommended methods for disinsection of the aircraft cabin and cargo hold and the a.i.'s used. Products must be fit for purpose and contain the corresponding a.i. for each treatment type. Pre-flight and top-of-descent cabin treatment, which were previously recommended, have been replaced by pre-embarkation and pre-departure methods.

**Table 1. Approved pre-arrival aerosol methods for each flight**

Option	Method	Area	Passengers on board	Formulation	Technique
1	Pre-embarkation	Cabin	No	Permethrin 2% aerosol	See section 4.2
2	Pre-departure	Cabin	Yes	d-phenothrin 2% or 1 <i>R-trans</i> -phenothrin 2% aerosol	See section 4.3
3	Pre-departure cargo holds <sup>a</sup>	Lower cargo holds	Either	An aerosol containing permethrin 2% and d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1 <i>R-trans</i> -phenothrin 2% <sup>b</sup>	See section 4.4
3 <sup>a</sup>		Upper cargo area on freighter	Either	A combination aerosol containing permethrin 2% and d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1 <i>R-trans</i> -phenothrin <sup>b</sup>	See section 4.4

a Not required if the residual method has been completed.

b This method is used when residual treatment has not been completed and in special circumstances, such as no authorization of 2% permethrin and 2% d-phenothrin (or 1*R-trans*-phenothrin) aerosol or for small aircraft with very small holds.

**Table 2. Approved pre-arrival residual method**

Option	Method	Area	Frequency	Passengers on board	Formulation	Technique
4	Residual long-term	Cabin or lower cargo holds, including upper cargo area of freighters	Every 8 weeks	No	Permethrin 2% EC	See section 4.5

**Table 3. Pre-arrival aircraft disinsection method**

Flight type	Area	Options (Tables 1 and 2)
Single sector or first sector of multi-sector flights	Cabin	1, 2, 4
Single sector or first sector of multi-sector flights	Cargo holds	3, 4
Multi-sector, second and subsequent flights	Cabin	1, 2, 4
Multi-sector, second and subsequent flights	Cargo holds	3, 4

**Table 4. Approved on-arrival contingency method only, for each flight**

Option	Method	Area	Passengers on board	Formulation	Technique
5	On-arrival	Cabin	Yes	d-phenothrin 2% or 1 <i>R-trans</i> -phenothrin 2% aerosol	See section 4.6
6	On-arrival	Lower cargo holds, including upper cargo area of freighters	No	A combination aerosol containing permethrin 2% and d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) or an aerosol containing d-phenothrin 2% or 1 <i>R-trans</i> -phenothrin 2% <sup>a</sup>	See section 4.6

<sup>a</sup> Used when residual spraying has not been completed and in special circumstances such as no authorization of 2% permethrin and 2% d-phenothrin (or 1*R-trans*-phenothrin) aerosol or for small aircraft with very small holds.



## 4.1 Certification of aircraft disinsection

Contracting States to ICAO are responsible for ensuring that ICAO Standards and Recommended Practices as per Annex 9 (Facilitation) are implemented by the relevant aviation stakeholders. Guidance is available in the ICAO Facilitation Manual (Document 9957) (15); section D of Chapter 2 in Annex 9 stipulates the specific standards for aircraft disinsection.

The airline operator is responsible for ensuring that certification meets the requirements of the arrival country. These may include ensuring that a certificate detailing the cabin and cargo hold disinsection treatment has been completed by the relevant authorized agent<sup>1</sup> or the pilot in command.

Certificates include the Aircraft General Declaration (Appendix 1 to ICAO Annex 9), the Certificate of Residual Disinsection (Appendix 4 to ICAO Annex 9) and/or any other certificates required by the destination country.

When the aircraft has received both residual and aerosol disinsection treatments, both documents in Annex 9 should be completed. Copies of the ICAO Certificate of Residual Disinsection and the General Declaration (16) are provided in this document as *annexes 4* and *5*, respectively.

When aerosol methods have been used, fully or partly used aerosol cans should remain on board for authorities to check, if necessary, at the arrival destination.

## 4.2 Pre-embarkation cabin treatment

Pre-embarkation cabin disinsection involves aerosol spraying of aircraft cabins before embarkation of passengers. The treatment lasts for the duration of a single flight sector. This method not only kills mosquitoes and other vectors present in the cabin at the time of disinsection but also leaves a minimal but effective residue, which will kill mosquitoes and other vectors that board between the time of disinsection and flight departure. Details for estimating the amounts of aerosol spray required for different types of aircraft are given in *section 5*.

Perform pre-embarkation cabin disinsection in conjunction with cargo hold disinsection, as specified in *sections 4.4* and *4.5*.

Examples of pre-embarkation cabin treatment for different types of aircraft are summarized in *Annex 1*.

### 4.2.1 Procedure

The aim of treatment is a short-term and not a long-term residual effect. It is designed to kill any mosquitoes and other vectors that come on board with passengers. When surfaces

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<sup>1</sup> An authorized agent is a person who represents an aircraft operator and who is authorized by or on behalf of the operator to act on formalities connected with the entry and clearance of the operator's aircraft, crew, passengers, cargo, mail, baggage or stores. When national law permits, a third party may be authorized to handle cargo on the aircraft.

are intensively cleaned or wiped, pre-embarkation treatment should be undertaken after cleaning has been completed and the surfaces have dried.

**The procedure for pre-embarkation cabin treatment is as follows.**

For single sector flights, perform the treatment at the departing airport. For multi-stop flights, pre-embarkation treatment may be optional only at transit airports where all passengers disembark.

The treatment must be conducted after the aircraft has been fully catered and the service doors closed and before passengers board the aircraft. One main entry door per level may remain open for operational requirements.

Spraying must be completed with an aerosol of permethrin 2% as the a.i. See Table 1 for more information on aerosol methods and section 5 and Annex 3 for the amounts of spray required for each aircraft type.

During application of spray and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off. Recirculation fans may be left on if they are essential for operation of the aircraft but should be set at the lowest flow rate.

Keep overhead and sidewall lockers open during spraying.

Direct spray towards the open overhead lockers and ceiling to ensure that the spray does not fall on the face of the operator while he or she is walking along the aisle at a rate of not more than one step or one row of seats per second.

Spray all galleys, including those on lower levels, and the lift access.

Spray all toilets and coat lockers for 2 s each. Ensure that toilet seats and baby changing tables are up and not sprayed.

Spray all crew rest areas, avoiding bedding, and the flight deck for 3 s each. Spray must be directed away from aircraft equipment, officials and crew.

Any non-compliance with these procedures should be reported to the intended first port before arrival.

#### 4.2.2 Certification of pre-embarkation cabin treatment

Contracting States to ICAO are responsible for ensuring implementation of the ICAO Standards and Recommended Practices as per Annex 9 by the relevant aviation stakeholders. Guidance is available in relevant extracts of the ICAO facilitation manual (16).

The airline operator is responsible for ensuring that certification meets the arrival country requirements.

When the aircraft has had both residual and aerosol disinsection treatments, both documents in Annex 9 of the ICAO Standards should be completed.

Copies of the ICAO aircraft disinsection residual certificate and the General Declaration are provided in this document as *annexes 4* and *5*, respectively.

On arrival of the aircraft, authorities may require that all exterior doors and windows, including cargo hold doors, remain closed and be opened only once clearance has been granted.

### 4.3 Pre-departure cabin treatment

Pre-departure cabin disinsection involves aerosol spraying of the aircraft cabin after passenger embarkation but before the overhead lockers are closed and the aircraft is pushed back for departure. The treatment is effective for the duration of a single flight sector. In pre-departure cabin spraying, all areas of the aircraft cabin are sprayed, including the flight deck, open overhead and coat lockers and toilets. This method kills mosquitoes and other vectors that are present in the cabin at the time of disinsection.

Details for estimating the amounts of aerosol spray required for different types of aircraft are given in *section 5*.

Examples of pre-departure cabin treatment for different types of aircraft are summarized in *Annex 2*. Pre-departure cabin disinsection should be performed in conjunction with cargo hold disinsection, as specified in *section 4.4* or *4.5*.

<b>The procedure for pre-departure cabin treatment is as follows.</b>
This is an alternative to pre-embarkation treatment for single sector flights and may be an option in transit airports of multi-stop flights.
The treatment is applied after passengers have boarded and are seated and all service doors are closed. The main entry door must be closed before commencement of cabin spraying.
Overhead and sidewall lockers must be kept open during spraying.
Before commencing aerosol spraying, an in-flight announcement should be made to inform passengers that aerosol spraying will be taking place for disinsection according to the WHO procedure. <sup>1</sup>
Spraying must be completed with an aerosol of d-phenothrin 2% or 1 <i>R</i> - <i>trans</i> -phenothrin 2% as the a.i. See <i>Table 1</i> for more information on the aerosol, and <i>section 5</i> and <i>Annex 3</i> for the amount of spray required for each aircraft type.
During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off or set to normal flow (not high flow), and the recirculation fans must be on.
Starting at the end of the cabin, walk along the aisle at a rate of not more than one step or one row of seats per second with the spray directed towards the open overhead lockers and ceiling. This will ensure that the spray does not fall on the face of the operator.
Spray all galleys, including those on lower levels, and the lift access.
Spray all toilets and coat lockers for 2 s each. Ensure that the toilet seats and baby changing tables are up and are not sprayed. Do not direct the spray at the smoke detectors as it may set them off.
Spray all crew rest areas, avoiding the bedding, and the flight deck and cockpit for 3 s each. Direct the spray away from aircraft equipment, officers and crew.
Any non-compliance with procedures should be reported to the intended first port before arrival.

<sup>1</sup> The following text could be read:

“Ladies and gentlemen, to conform to health requirements, the aircraft cabin will now be sprayed with an insecticide. This procedure is recommended by the World Health Organization. The treatment is necessary to avoid introduction of insects at our destination airport that can be carriers of serious human diseases. Please remain seated and keep the aisles clear while spraying takes place. If you have a serious medical condition that could be affected by the spray, please press your call button to discuss this with your cabin crew. Thank you.”

### 4.3.1 Certification of pre-departure cabin treatment

Contracting States to ICAO are responsible for ensuring implementation of the ICAO Standards and Recommended Practices as per Annex 9 by the relevant aviation stakeholders. Guidance is available in the ICAO facilitation manual (16).

The airline operator is responsible for ensuring that certification meets the arrival country requirements.

When the aircraft has had both residual and aerosol disinsection treatments, both documents in ICAO Standards Annex 9 should be completed.

Copies of the ICAO aircraft disinsection residual certificate and the General Declaration are provided in this document as *annexes 4* and *5*, respectively.

On arrival of the aircraft, authorities may require that all exterior doors and windows, including cargo hold doors, remain closed and be opened only once permission has been granted.

## 4.4 Pre-departure cargo hold disinsection

In addition to the cabin, cargo holds also undergo disinsection. If the cargo holds were previously treated with residual spray, the procedures described in this section do not apply.

Perform pre-departure cargo hold disinsection in conjunction with cabin disinsection, as specified above. Details for estimating the amount of aerosol spray necessary for different types of aircraft for pre-departure cargo hold disinsection are given in *section 5*.

#### 4.4.1 Lower cargo hold

**The procedure for pre-departure lower cargo hold treatment is as follows.**

Spraying must be carried out manually at the last departure airport after all cargo has been loaded and just before the cargo hold door is closed.

Aerosols must be discharged into each cargo hold in such a manner as to ensure that all parts of the cargo hold are disinfected.

Spraying must be completed with a single-shot aerosol can with a vertical ejection nozzle containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.'s, subject to approval by the destination country authority.

In special circumstances in which permethrin-based products are not authorized, use a single-shot aerosol can with a vertical ejection nozzle containing either d-phenothrin 2% aerosol or 1*R-trans*-phenothrin aerosol alone may be used, subject to approval from the destination country authority.

Advise the crew that the cargo hold is about to be sprayed. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must remain off. Recirculation fans may be left on if essential for operation of the aircraft but should be set to the lowest rate.

When closing the lower cargo door(s), leave the door open just enough to place the aerosol(s) in a secure, upright position, and activate the lock-down nozzle(s).

Once the spray appears to be functioning correctly, immediately close the hold door to complete disinsection. If either hold has to be re-opened (except for the purpose of loading animals) or an aerosol malfunction, the above steps must be repeated.

Full discharge of the aerosols takes 2 min, and the saturation period takes another 5 min.

Used aerosol containers should remain in the lower holds and be retrieved by ground handlers at the destination airport. They should be accessible to the ground handlers.

If an airline chooses to remove aerosol containers before departure, the containers must be carried on board with the disinsection certificate. Allow 7 min after activation before retrieval. The door of the disinfected cargo hold must be opened only to the minimum necessary to retrieve used containers and then immediately closed to avoid recontamination.

Any non-compliance with procedures should be reported to the intended first port before arrival.

#### 4.4.2 Lower cargo hold when small animals are to be loaded

**The procedure for pre-departure disinsection of the lower cargo hold when small animals are to be loaded is as follows.**

Disinsection should be conducted before the animals are loaded but after all other cargo is on board. Consideration should be given to procedures of the International Air Transport Association for animals (Chapter 5) and the regulations of the World Organisation for Animal Health.

Spraying must be conducted manually at the last departure airport after all cargo has been loaded and just before the cargo hold doors are closed.

Aerosols must be discharged into each cargo hold in such a manner as to ensure that all parts of the hold are disinsected.

Spraying must be completed with a single-shot aerosol with a vertical ejection nozzle containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.s, subject to approval by the destination country authority.

In special circumstances in which permethrin-based products are not authorized, use a single shot aerosol with a vertical ejection nozzle containing d-phenothrin 2% AE or 1*R-trans*-phenothrin 2% AE alone, subject to the approval of the destination country.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (section 5) required for each aircraft type.

Advise the crew that the cargo hold is about to be sprayed. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must remain off. Recirculation fans may be left on if they are essential for operation of the aircraft but should be set at the lowest flow rate.

When closing the lower cargo door(s), leave just enough open to place the aerosol(s) in a secure, upright position, and activate the lock-down nozzle(s).

Once the spray aerosol(s) appears to be functioning correctly, immediately close the hold door to complete disinsection. If either hold requires re-opening (except for the purpose of loading animals) or an aerosol malfunction, the above steps must be repeated.

Allow 7 min after activating aerosols before loading animals.

Used aerosol containers should remain in the lower holds and be retrieved by ground handlers at the destination airport. They should be accessible to ground handlers.

If an airline chooses to remove aerosol containers before departure, the containers must be carried on board with the disinsection certificate. Allow 7 min after activation before retrieval. The door of the disinsected cargo hold must be opened only to the minimum necessary to retrieve used containers and then immediately closed to avoid recontamination.

Open the hold only to load animals and close it immediately afterwards to avoid recontamination.

Any non-compliance with procedures should be reported to the intended first port before arrival.

### 4.4.3 Cargo hold for freighter aircraft

**The pre-departure cargo hold procedure for freighter aircraft is as follows.**

Spraying must be carried out manually at the last departure airport after all cargo has been loaded.

Non-essential personnel must have vacated the cabin and cargo areas before disinsection is begun.

#### Cabin area

See *section 4.2* or *4.3*.

#### Upper cargo area

For the upper cargo deck of a freighter, permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.'s are used, subject to the approval of the destination country authority.

See **Table 1** for more information on aerosols and the amounts of aerosol spray required for each aircraft type (*section 5*).

When there is also a cargo area on the main deck (freighter aircraft), this area should be accessed for spraying via the passenger access door after the large cargo door is closed. Discharge the aerosols while walking away from the spray and vacate the area once spraying has been completed.

Spray must be discharged as high as possible and directed towards the centre of the aircraft ceiling by an operator walking at approximately one step per second.

If cargo prohibits access to certain parts of the aircraft:

- discharge the aerosol into the centre of aircraft, directed towards the ceiling above the cargo for the appropriate duration for the section of the aircraft that could not be accessed; or
- position the aerosols evenly throughout the aircraft on top of the cargo (applicable when using single-shot aerosols only).

Once spraying is completed, allow at least 5 min for the spray to settle before departure.

#### Lower cargo holds

Spraying must be carried out manually at the last departure airport after all cargo has been loaded and just before the cargo hold door is closed.

Aerosols must be discharged into each cargo hold in such a manner as to ensure that all parts of the hold are disinsected.

Spraying must be completed with a single-shot aerosol can with a vertical ejection nozzle containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.'s, subject to the approval of the destination country authority.

In special circumstances in which permethrin-based products are not authorized, use a single-shot aerosol can with a vertical ejection nozzle containing either d-phenothrin 2% or 1*R-trans*-phenothrin alone, subject to the approval of the destination country.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

Advise the crew that the cargo hold is about to be sprayed. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must remain off. Recirculation fans may be left on if they are essential for operation of the aircraft but be set at the lowest flow rate.

When closing the lower cargo door(s), leave just enough open to place the aerosol(s) in a secure, upright position, and activate the lock-down nozzle(s).

Once the spray aerosol(s) appears to be functioning correctly, immediately close the hold door to complete disinsection. If either hold requires re-opening (except for the purpose of loading animals) or an aerosol malfunction, the above steps must be repeated.

Full discharge of the aerosols takes 2 min, and saturation takes another 5 min.

Used aerosol containers should remain in the lower holds and be retrieved by ground handlers at the destination airport. They must be accessible to ground handlers.

If an airline chooses to remove aerosol containers before departure, the containers must be carried on board with the disinsection certificate. Allow 7 min after activation before retrieval. The door of the disinfected cargo hold must be opened only to the minimum necessary for retrieval of used containers and then immediately closed to avoid recontamination.

Any non-compliance with procedures must be reported to the intended first port before arrival.

#### 4.4.4 Certification of pre-departure cargo hold treatment

Contracting States to ICAO are responsible for ensuring that ICAO Standards and Recommended Practices as per Annex 9 are implemented by the relevant aviation stakeholders. Guidance is available in the ICAO facilitation manual (16). The airline operator is responsible for ensuring that certification meets the arrival country requirements.

When the aircraft has received both residual and aerosol disinsection treatments, both ICAO Annex 9 documents must be completed. Copies of the ICAO aircraft disinsection residual certificate and the General Declaration are provided in this document as *annexes 4 and 5*, respectively.

On arrival of the aircraft, authorities may require that all exterior doors and windows, including cargo hold doors, remain closed and be opened only once permission has been granted.

#### 4.5 Residual treatment of cabin and cargo hold

Residual treatment of the cabin should be performed in conjunction with cargo hold disinsection. Similarly, residual treatment of the cargo hold should be performed in conjunction with cabin disinsection.

*Section 6* provides details for estimating the amount of residual spray necessary for each type of aircraft.

Any non-compliance with disinsection procedures between the departure airport and the intended first port should be reported before arrival.



**The general procedures for residual disinsection are as follows.**

Treatment must be at maximum interval of 8 weeks and completed at any time the aircraft is available.

The formulation used for residual spraying is permethrin 2% EC.

Residual spraying must be undertaken with either a hand compression sprayer fitted with a 1.5-bar control flow valve or a mist sprayer that can discharge approximately 0.2 g a.i. of permethrin per m<sup>2</sup> (i.e. liquid volume of ≤ 10 mL/m<sup>2</sup>).

An aerosol formulation (permethrin 2% AE) should be used to treat the flight deck, cockpit and crew rest areas and any other areas in which use of an emulsion could damage the aircraft or be a safety concern. Aircraft should be configured to ground service mode before spraying.

**The procedure for residual treatment of cabins is as follows.**

The required dosage rate is 0.2 g a.i. of permethrin per m<sup>2</sup> on interior surfaces and 0.5 g a.i./m<sup>2</sup> on floors.

Floors are treated twice at 0.2 g/m<sup>2</sup>. Spray aimed at other surfaces may be deposited by fall-out of larger droplets onto the floor, especially along aisles; therefore, the maximum dose at floor level is estimated to be 0.5 g/m<sup>2</sup>. The aim is to achieve uniform coverage of all surfaces, with no run-off.

Prepare the aircraft by opening, clearing and cleaning all lockers, cupboards and storage units and closing all curtains and window blinds. Remove any carpet covers.

Turn off the air-conditioning system, including any preconditioned air from a ground support unit.

Recirculation fans may be left on if they are essential for operation of the aircraft but should be set at the lowest flow rate.

Spray all surfaces, including floors, ceilings, walls, lockers, curtains, toilets, galley floor and wall areas behind curtains. All doors and locker lids must be sprayed on both sides. Then, respray the floor areas only.

Spray carefully around permanently stored items such as loudhailers, first aid kits, oxygen bottles and fire extinguishers.

Do not spray food preparation areas, bench tops, seats, mirrors, windows, medical equipment, separate crew rest areas or modules, bassinets, baby changing tables, toilet seats, electronic equipment or removable galley components, such as food trolleys. Any spray spilt onto these areas must be immediately wiped up to remove any chemical deposit. Areas that will be in contact with food shall additionally be wiped with soap and water.

After spraying is completed and the spray has dried, the air-conditioning system and recirculation fans may be reactivated and run for at least 1 h or in accordance with the a.i. label guidance to clear the air of the volatile components of the spray.

**The procedure for residual disinsection of cargo holds is as follows.**

The required dosage rate is 0.2 g/m<sup>2</sup> of permethrin for interior hold surfaces and 0.5 g/m<sup>2</sup> of permethrin on hold floors. To achieve 0.5 g/m<sup>2</sup> of permethrin, the floor must be sprayed twice at a rate of 0.2 g/m<sup>2</sup> of permethrin (the remaining 0.1 g is from drift from higher surfaces).

The areas must be free of any cargo, pallets, containers and rubbish.

Spray compartment walls, ceilings, floors, both sides of dividing curtains as well as the inside of doors. Pay particular attention to sidewall and floor cavities. Advise the crew that cargo hold spraying is about to commence. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

#### 4.5.1 Certification of residual treatment of cabin and cargo hold

Contracting States to ICAO are responsible for ensuring that the relevant aviation stakeholders implement ICAO Standards and Recommended Practices (ICAO Annex 9). Guidance is available in the ICAO facilitation manual. The template for certification can be found in Appendix 4 to ICAO Annex 9 (Certificate of Residual Disinsection) (16).

When the aircraft has received both residual and aerosol disinsection treatments, both ICAO Annex 9 documents should be completed.

Copies of the ICAO aircraft disinsection residual certificate and the General Declaration are provided in this document as *annexes 4* and *5*, respectively.

#### 4.5.2 Residual top-up after fixture replacement or intense surface cleaning procedures

If an airline or its contractor wishes to change the cleaning products for aircraft cabins or holds, they should check with the manufacturer of the residual a.i. to ensure that there is no chemical incompatibility that would negate the effectiveness of the residual treatment.

Intensifying or increasing the frequency or method of cleaning or disinfecting large surface areas in aircraft may compromise the effectiveness of a residual insecticide. If this occurs, localized, more frequent retreatment may be necessary or an alternative aerosol application method used.

After a residual spray application, internal areas of aircraft < 1 m<sup>2</sup> that undergo additional or substantial cleaning, such as wall linings and carpets, should receive a supplementary “top-up” with an aerosol spray containing permethrin 2%.

**Procedures for top-up after fixture replacement or intense surface cleaning are as follows.**

The permethrin 2% aerosol must be directed at the cleaned surfaces and discharged approximately 30 cm away in a method to ensure that the droplets of spray cover all cleaned surfaces to achieve 0.2 g a.i./m<sup>2</sup> (for floor areas, 0.5 g a.i./m<sup>2</sup>).

Relatively minor interior cleaning and replacement of soiled items are considered negligible in the overall programme, and re-spraying is not required during turnaround; however, the areas should be treated at the first opportunity, to ensure compliance.

Residual spray should be reapplied when fixtures such as entire walls or large sections of carpet are replaced or deeply cleaned.

Replacement fixtures may be treated off the aircraft but must be treated either on the same day or shortly after aircraft disinsection in order to comply with certification.

## 4.6 On-arrival cabin and hold disinsection

Aerosol disinsection will be conducted on arrival if:

- the airline has not conducted one of the approved pre-arrival procedures (i.e. pre-embarkation, pre-departure, residual or pre-departure hold spray);
- the authorities at the arrival airport are not satisfied that the operator has used the chosen method correctly; or
- additional on-arrival treatment is required by the authorities at the arrival airport.

It is the responsibility of the authorized agent or the pilot in command of an aircraft to complete the ICAO General Declaration (Appendix 1 of Annex 9) and notify the relevant authorities at the arrival airport if disinsection has not been conducted. The notification must be made before arrival so that the local authority can meet the aircraft and supervise or perform on-arrival disinsection.

Details for estimating the amount of spray required for on-arrival cabin and cargo hold disinsection of different types of aircraft are given in *section 5*.

### 4.6.1 Passenger exemption

The authorities at the arrival airport may permit a passenger who has notified the crew of a medical condition that might be affected by on-arrival treatment, verbally or in writing, to disembark from the aircraft before such treatment, leaving their belongings on the aircraft. Such a procedure is used in Australia and New Zealand. Once the aircraft has undergone on-arrival disinsection treatment and all the other passengers have disembarked, exempted passengers may retrieve their belongings from the aircraft cabin.

## 4.6.2 On-arrival cabin and hold procedures

### On-arrival procedures for cabin spraying are as follows.

All exterior doors and windows must remain closed and may be opened only with directions from the authorities at the arrival airport.

Before spraying, an in-flight announcement should be made to inform passengers about disinsection according to the WHO procedure.<sup>1</sup>

If a passenger has notified the crew of a serious medical condition that may be affected by spraying, the crew must inform the local authorities who meet the aircraft, who will advise them whether there is a local procedure that would allow the passenger to disembark before spraying.

Spraying must be completed with an aerosol of d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i. See Table 1 for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

Cabin crew must prepare the cabin for disinsection by opening all overhead lockers and requesting all passengers to remain seated.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off. Recirculation fans may be left on if they are essential for operation of the aircraft but be set at the lowest flow rate.

Starting at the end of the cabin, walk along the aisle at a rate of not more than one step or one row of seats per second, with the spray must be directed towards the open overhead lockers and ceiling. This will ensure that the spray does not fall on the face of the operator.

Spray all galleys, including those on lower levels, and the lift access. Spray all toilets and lockers for 2 s each.

Spray all crew rest areas and the flight deck for 3 s each, with the spray directed away from aircraft equipment, officers and crew.

On completion of spraying, a 5-min saturation period must be observed before the air-conditioning is turned on and the airflow maximized. Passengers must remain seated during this time, until clearance to disembark is given by the local authority.

For freighters (aircraft with a cargo hold on the main deck), see procedures below.

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<sup>1</sup> The following text could be read:

“Ladies and gentlemen, to conform to health requirements, the aircraft cabin will now be sprayed with an insecticide. This procedure is recommended by the World Health Organization. The treatment is necessary to avoid introduction of insects at our destination airport that can be carriers of serious human diseases. Please remain seated and keep the aisles clear while spraying takes place. If you have a serious medical condition that could be affected by the spray, please press your call button to discuss this with your cabin crew. Thank you.”

**On-arrival procedures for lower cargo hold spraying are as follows.**

Under no circumstances should a hold door be opened without the approval of the local authority.

Aerosols must be discharged into each hold in such a manner as to ensure that all parts of the hold are disinfected.

Spraying must be completed with a single-shot aerosol with a vertical ejection nozzle containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.s.

In special circumstances in which permethrin-based products are not authorized, use a single-shot aerosol can with a vertical ejection nozzle containing either d-phenothrin 2% aerosol or 1*R-trans*-phenothrin.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

Advise the crew that cargo hold spraying is about to commence. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off. Recirculation fans may be left on if they are essential for operation of the aircraft but be set at the lowest flow rate.

Open the hold door by no more than 30 cm, place the aerosols inside the hold in a secure upright position, and activate the lock-down nozzle(s).

Once the spray aerosol(s) appears to be functioning correctly, immediately close the hold door to complete disinsection.

Allow 2 min for the aerosols to fully discharge, and then wait a further 5 min for saturation. Once the procedure has been carried out, the local authority will permit unloading of cargo.

For freighters (aircraft with a cargo hold on the main deck), see procedures below.

**On-arrival procedures for freighter aircraft spraying are as follows.**

**Under no circumstances should any aircraft door be opened without the approval of the local authority.**

#### **Cabin area**

The main entry door must be closed before cabin spraying.

Before spraying, inform the crew about disinsection according to the WHO procedure.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off. Recirculation fans may be left on if they are essential for operation of the aircraft but be set at the lowest flow rate.

Spraying of the flight deck, galley, toilets and cabin areas must be completed with an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2%.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

All overhead and sidewall lockers must be open during spraying.

Spray must be directed towards the open overhead lockers and ceiling by an operator walking at a rate of not more than one step per second.

Spray all toilets and coat lockers for 2 s each. Ensure that the toilet seat is up and not sprayed.

Spray all crew rest areas, avoiding bedding, and the flight deck for 3 s each. Spray must be directed away from aircraft equipment, officers and crew.

#### **Upper cargo area**

For the upper cargo deck of a freighter, permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.s.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

When there is also a cargo area on the main deck (freighter aircraft), this area should be accessed for spraying via the passenger access door with the large cargo door remaining closed. Discharge the aerosols while walking away from the spray, and vacate the area once spraying is completed.

Spray must be discharged as high as possible and directed towards the centre of the aircraft ceiling by an operator walking at approximately one step per second.

If cargo prohibits access to certain parts of the aircraft:

- discharge the aerosol into the centre of aircraft, directed towards the ceiling above the top of the cargo, for the appropriate duration for the section of the aircraft that could not be accessed; or
- position aerosols evenly throughout the aircraft on top of the cargo (applicable when using single-shot aerosols only).

On completion of spraying, allow at least 5 min for the spray to settle before the local authority permits unloading of cargo.

### Lower cargo holds

All exterior doors and windows must remain closed and may be opened only in accordance with directions from the authorities at the arrival airport.

Advise the crew that cargo hold spraying is about to start. As it is not uncommon for cargo hold spray to set off smoke detectors, sensitive electronic equipment must not be directly sprayed, and the crew must be fully aware of the procedures before disinsection.

Spraying must be completed with a single-shot aerosol with a vertical ejection nozzle containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.'s.

In special circumstances in which permethrin-based products are not authorized for use, a single-shot aerosol with a vertical ejection nozzle containing d-phenothrin 2% aerosol or 1*R-trans*-phenothrin alone may be used.

See **Table 1** for more information on aerosols and the amounts of aerosol spray (*section 5*) required for each aircraft type.

During disinsection and for 5 min after completion of spraying, the aircraft's air-conditioning must be switched off. Recirculation fans may be left on if they are essential for operation of the aircraft but be set at the lowest flow rate.

The local authority will permit unloading of cargo once the procedure has been completed.

## 5. Amounts of aerosol spray required for aircraft

### 5.1 General information

See *section 4, Aircraft disinsection*, to ensure the correct aerosol a.i.

The listing covers four aircraft types:

- commercial passenger aircraft;
- small jets, regional and private aircraft (including private helicopters);
- military aircraft; and
- freighter aircraft.

#### 5.1.1 Aerosol spray in cabins

The rate of application of spray in cabins is based on 10 g of formulation/28 m<sup>3</sup> (1000 ft<sup>3</sup>) = 35 g/100 m<sup>3</sup> and is typically achieved by discharging aerosols when walking at a rate of one step or row of seats per second. Wide-bodied aircraft may require the operator to use up to two 100-g aerosol cans per aisle.

Spray is typically discharged at a rate of  $1 \pm 0.2$  g/s of aerosol; for example, a 100-g aerosol is discharged in about 100 s. Knowing the discharge rate can help the operator to achieve even coverage.

*Note:* For spraying on arrival, use the amounts listed for pre-departure cabin treatment.

#### 5.1.2 Aerosol spray in cargo holds

For cargo hold area spray treatment, manual activation of the aerosol while the cargo hold door is still open results in a loss of spray outside of the aircraft. Therefore, the required amount of formulation has been increased from the previously recommended rate of 10 g/28 m<sup>3</sup> (1000 ft<sup>3</sup>) to:

- 40 g of formulation per 28 m<sup>3</sup> (1000 ft<sup>3</sup>) for the lower cargo hold, and
- 15 g of formulation per 28 m<sup>3</sup> (1000 ft<sup>3</sup>) for the upper cargo of a freighter.

Spraying must be completed with a single-shot aerosol(s) with vertical ejection nozzles containing permethrin 2% and d-phenothrin 2% (or 2% 1*R-trans*-phenothrin) as the a.i.s. The airline may, in special circumstances and subject to the approval of the destination country, select the alternative of an aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin in a single-shot vertical ejection nozzle.<sup>1</sup>

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<sup>1</sup> For example, no-authorization of the combination aerosol containing permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%).



### 5.1.3 Aircraft with very small cargo or baggage holds

These holds must be treated with a single-shot or multi-shot aerosol containing permethrin 2%, a combination of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) or d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) alone, subject to the approval of the destination country.

Note that the aerosol may activate the on-board smoke detectors.

### 5.1.4 Rate and method of application

The amounts of spray depend on the aircraft model or use and are listed in *Annex 3* of this document. If the aircraft model is not listed, use the [aerosol spray amount calculator tool](#).

## 5.2 Commercial passenger aircraft

Sample calculations for disinsection of commercial passenger aircraft are given in *Annex 3*.

### 5.3 Small jets, regional and private aircraft (including private helicopters)

Detailed estimates of the volumes of aerosol required are given in *Annex 3*. The aerosol spray delivery rate is  $1 \text{ g} \pm 0.2 \text{ g/s}$  aerosol.

For small one- or two-seater aircraft not listed in *Annex 3*, use the amounts of aerosol spray estimated for the nearest type of listed aircraft.

For helicopters and any non-listed aircraft flying or carried on board a vessel, disinsection must be conducted at a rate of  $1 \text{ g} \pm 0.2 \text{ g}$  aerosol per  $2.8 \text{ m}^3$  ( $100 \text{ ft}^3$ ) of internal space (equivalent to 1 s of discharge).

For aircraft with very small cargo or baggage holds, a single-shot or multi-shot aerosol must be used, containing:

- permethrin 2%, or
- a combination of permethrin 2% and d-phenothrin 2% (or 2% 1*R-trans*-phenothrin), or
- d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) alone, subject to the approval from the destination country.

Note that the aerosol may activate the on-board smoke detectors.

When cargo holds can be accessed internally, they will have been accounted for in the amount of spray required for the cabin. The amounts have been rounded up to the nearest 5 g. Unless otherwise specified, the amount of spray required for external holds (number of seconds for which the aerosol is discharged) refers to the total number of “external access only” holds.

## 5.4 Military aircraft

Detailed estimates are given in *Annex 3*. The aerosol spray delivery rate is  $1 \text{ g} \pm 0.2 \text{ g/s}$ . One- or two-seat fast jet aircraft and combat helicopters are usually exempt from disinsection because they contain sensitive electronic equipment and because they are at low risk of carrying live mosquitoes.

For helicopters and any non-listed aircraft flying or carried on board a vessel, disinsection must be conducted at a rate of 1 g of spray (equivalent to 1 s of aerosol spraying) per  $2.8 \text{ m}^3$  ( $100 \text{ ft}^3$ ) of internal space.

For aircraft with very small cargo or baggage holds, a single-shot or multi-shot aerosol must be used, containing:

- permethrin 2%, or
- a combination of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%)  
or
- d-phenothrin 2% (or 1*R-trans*-phenothrin 2%) alone subject to the approval from the destination country.

Note that the aerosol may activate on-board smoke detectors.

When holds can be accessed internally, they will have been included in the amount of spray required for the cabin. The amounts have been rounded up to the nearest 5 g. Unless otherwise specified, the amount of spray required for external holds (number of seconds for which aerosol is discharged) refers to the total number of “external access only” holds.

## 5.5 Freighters

Detailed calculations for the amounts of spray required are given in *Annex 3*. The rate of aerosol spray delivery is  $1 \text{ g} \pm 0.2 \text{ g/s}$  of aerosol. Depending on the disinsection method used, the aerosol must be:

- a combination of permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%),  
or
- d-phenothrin 2% (or 1*R-trans*-phenothrin 2%).

A single-shot or a multi-shot aerosol may be used for the galley, toilets and passenger compartment.

Note that the aerosol may activate on-board smoke detectors.

To disinsect the upper cargo area on the main deck, spraying may be done with aerosols with a single-shot vertical ejection nozzle, containing either:

- d-phenothrin 2% or 1*R-trans*-phenothrin or
- permethrin 2% and d-phenothrin 2% (or 1*R-trans*-phenothrin 2%).

Spray must be discharged as high as possible and directed towards the centre of the aircraft ceiling by an operator walking at approximately one step per second.

If cargo prohibits access to certain parts of the aircraft:

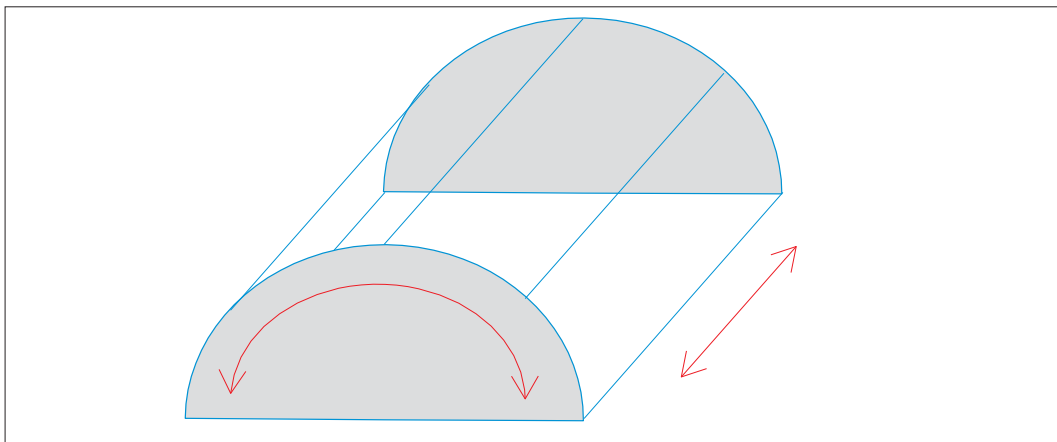
- discharge the aerosol into the centre of aircraft towards the ceiling above the cargo for the appropriate duration, or
- position aerosols evenly throughout the aircraft on top of the cargo (*note*: applicable only when using single-shot aerosols).

On completion of spraying, allow at least 5 min for the spray to settle before departure.

## 6. Estimation of amounts of residual spray required for aircraft

This section provides guidance on estimating the internal area of an aircraft in order to calculate the appropriate amount of product necessary for residual disinsection of passenger cabins and cargo holds. For each aircraft type (model) in the fleet, all calculations should be completed and recorded in the operator's manual for use by staff conducting spraying. Standards are available for calculating the amount of product required per square metre of area to be treated but not for calculating the surface area, which is left to organizations and individuals. This can be derived from a simple initial measurement that can be made by someone with little practical knowledge of engineering or geometry and no access to expensive measuring devices. The estimate can be used as a baseline to compare current practices with either actual spray application measurements or alternative calculations. A drawing of the roof, walls and cabin floor of an aircraft is shown in Fig. 1.

**Fig. 1. Roof or wall and aircraft cabin floor**



The estimates allow construction of a “near-enough” estimate that can be completed with documents on aircraft characteristics available from manufacturers, such as Airbus Aircraft Characteristics Documents (17) and Boeing Aircraft Characteristics (18). Examples of use of these documents are given below.

## 6.1 Calculations for specific areas

Calculations for estimating the areas that require spraying are as follows.

Cabin floor area = maximum width of the cabin floor × cabin length

Cabin walls and roof + “errata” (e.g. lockers, bulkheads) = [(maximum width of the cabin floor × π ÷ 2) × cabin length] × area errata ratio<sup>1</sup>

Cargo hold(s): ( $\sqrt[3]{\text{cargo hold}} \times \sqrt[3]{\text{cargo hold}} \times 6$ )

This calculation is for converting the internal volume of the hold to its surface area.

### 6.1.1 Compensation for under-spraying (volume errata ratio)<sup>2</sup>

An additional 33% should be added to the results of the calculations to allow for any inconsistencies in spraying. These numbers are deduced from previous residual disinsection procedures documented in the *Report of the informal consultation on aircraft disinsection* (5).

**Calculation and source:** This calculation is found in cross-sectional diagrams of interior arrangements (see example of calculation for Boeing 737-800 on p. 2-29 of the Boeing document (18)).

**Exclusions:** Any variation in width, such as of doorways, partitions or near flight deck or tail sections of an aircraft, is not considered in the calculations.

**Cabin length (door to door) (L):** the cabin length measured from the front passenger or crew doors to the rear passenger or crew doors (inclusive).

**Calculation and source:** This calculation is derived from diagrams of the relative position of doors from the nose of the aircraft (see example of calculation for Boeing 737-800 on p. 2-36 of the Boeing document (18)).

Rear door distance – front door distance = cabin length.

**Exclusions:** The calculation may omit the small length between a door and the flight deck and the tail of the aircraft.

This calculation is valid only for aircraft in which doors are located at the extreme front and aft of the cabin. Other calculations may be required for double-decker planes such as the A380, in which the top deck does not follow this configuration and the calculation is made manually.

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<sup>1</sup> Increase in the area calculation to account for additional surfaces such as bulkheads and lockers.

<sup>2</sup> An additional 33% added to the results of the calculations to allow for any inconsistencies in spraying.

**Cabin walls and roof (height):** A measurement that bisects the cabin wall and roof, running from the floor, up one wall and around onto the roof and lockers and then down again to the other side of the floor.

**Calculation and source:** This calculation is based on the cabin width to calculate the circumference of a semi-circle, an approximation of the actual length of the internal roof.

**Area errata ratio:** The area errata ratio is an approximation of various additional surfaces as a proportion of the cabin wall and roof. The errata ratio is set at 2 and is multiplied by the total cabin wall and roof area, in effect doubling the cabin wall and roof area. For freighters, the value is set at 1, as there are no bulkheads or overhead lockers.

**Calculation and source:** The calculation is based on the additional area inside lockers, including each side. In addition, all aircraft have front and rear bulkheads and additional partitions throughout. A typical single-aisle aircraft has lockers on each side, whereas an aircraft with two aisles has an additional two banks of lockers. The area errata ratio reasonably accommodates these differences.

Area errata ratios cover:

*Lockers:* Typical lockers have a curvature inside, with depths of approximately 400 and 500 mm.

*Locker walls:* The sides may be roughly approximated from the area of a semi-circle and multiplied by the length of the plane and average widths.

*Bulkheads:* The front and rear of the aircraft are calculated as semi-circles from the cabin width.

**Cargo holds (fore, aft and bulk):** The total surface area of cargo holds in an aircraft is calculated by converting the cargo hold volume to surface area.

**Calculation and source:** Volume capacity can be found in tables of general characteristics. Each hold volume should be calculated separately (17,18).

**Exclusions:** All calculations are based on usable capacity only. Some characteristics, such as water volume, may be stated; however, for consistency, these should not be used.

Some aircraft have variable cargo hold volumes because of optional auxiliary fuel tanks. It should be assumed that such optional tanks are not installed, and the maximum cargo volume should be used.

Some characteristics may combine the total capacity of all holds. The section on loading combinations will provide a breakdown of how such loads are placed in holds. Additional calculation may be required, such as multiplying the total number of containers by their volume capacity (e.g. 22 LD3<sup>1</sup> containers at 4.5 m<sup>3</sup> each). Although this gives a slightly smaller area, the difference is not significant at the scale being calculated.

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<sup>1</sup> LD3 is an air container model.

**Freighters and double-decker commercial aircraft:** The area of freighters is calculated in the same way as that of regular commercial craft. The only difference is that the area errata ratio is set at 1 because freighters do not have a lining, bulkheads or overhead compartments.

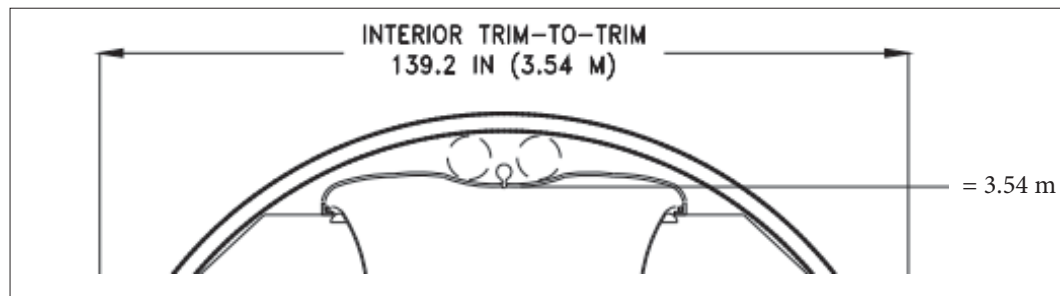
For double-decker commercial craft (747 and A380), the upper deck calculations must be added to the cabin floor area in  $m^2$  (upper deck cabin length  $\times$  width).

Additionally, the area errata ratio is set at 2.5, as there are two levels of overhead lockers, although the bulkhead and lining areas are similar to those of commercial aircraft such as Boeing 737-800.

Example of calculation: Boeing 737-800.

**Source of data:** Data on aircraft characteristics are available on the manufacturers' websites.

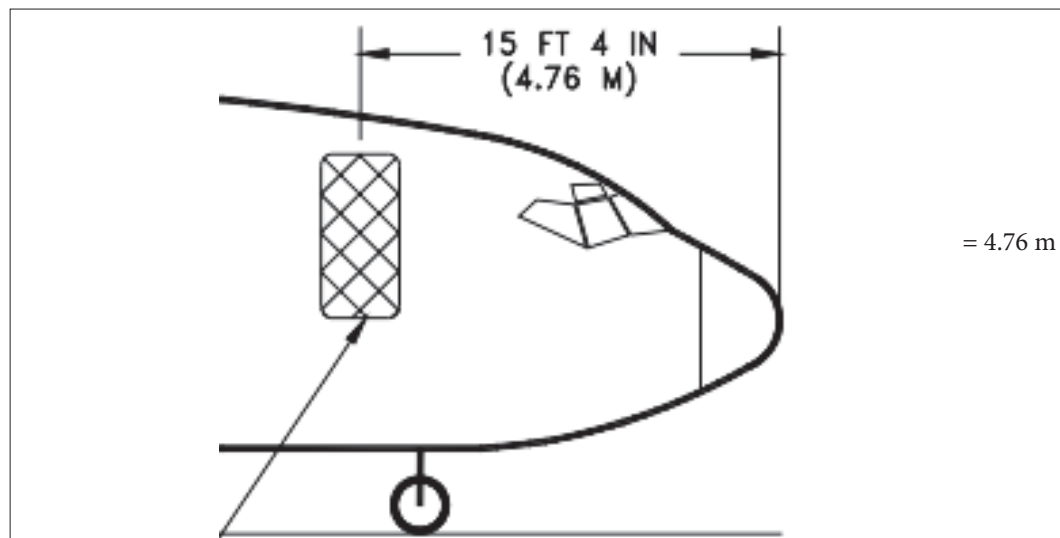
Cabin floor width (W)



Source: Boeing Aircraft Characteristics Documents (18).

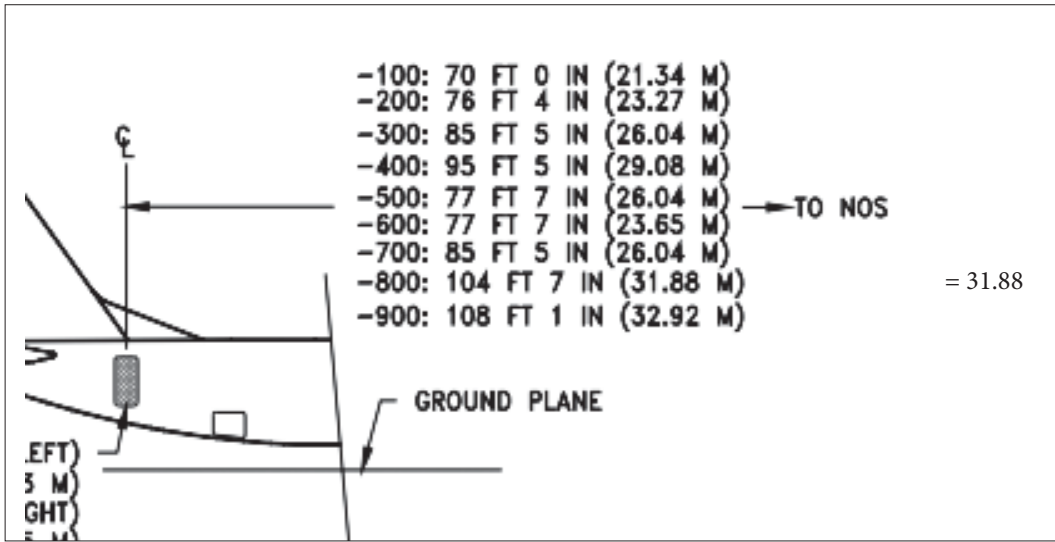
Cabin length (door to door) (L):  $31.88 \text{ m} - 4.76 \text{ m} = 27.12 \text{ m}$

Front door from nose



Source: Boeing Aircraft Characteristics Documents (18).

Rear door from nose



Source: Boeing Aircraft Characteristics Documents (18).



### Cargo holds: forward (fore), rear (aft) and bulk

Volume of cargo in Boeing aircraft: Calculation of the volume of cargo in Boeing aircraft is shown in Table 5.

**Table 5. Calculation of the volume of cargo in Boeing aircraft**

Airplane model	Aft cargo compartment			Capacity of bulk cargo		Notes	Calculation of volume for Boeing 737-800
	Bulk cargo	Capacity of auxiliary fuel tank	Capacity of auxiliary fuel tank compartment	Forward compartment	Total		
737-600	13.8 m <sup>3</sup> (488 ft <sup>3</sup> )	0	0	7.6 m <sup>3</sup> (268 ft <sup>3</sup> )	21.4 m <sup>3</sup> (756 ft <sup>3</sup> )	(1)	
737-700	16.9 m <sup>3</sup> (596 ft <sup>3</sup> )	0	0	11.5 m <sup>3</sup> (406 ft <sup>3</sup> )	28.4 m <sup>3</sup> (1002 ft <sup>3</sup> )	(1)	
737-800	25.5 m <sup>3</sup> (899 ft <sup>3</sup> )	0	0	19.6 m <sup>3</sup> (692 ft <sup>3</sup> )	45.1 m <sup>3</sup> (1591 ft <sup>3</sup> )	(1)	Fore = 19.6 m <sup>3</sup> Aft = 25.5 m <sup>3</sup> Bulk = included in aft hold
737-900	28.7 m <sup>3</sup> (1012 ft <sup>3</sup> )	0	0	23.8 m <sup>3</sup> (840 ft <sup>3</sup> )	52.5 m <sup>3</sup> (1852 ft <sup>3</sup> )	(1)	
737-900ER	28.2 m <sup>3</sup> (996 ft <sup>3</sup> )	0	0	23.5 m <sup>3</sup> (830 ft <sup>3</sup> )	51.7 m <sup>3</sup> (1826 ft <sup>3</sup> )	(2)	
737-900ER	23.9 m <sup>3</sup> (843 ft <sup>3</sup> )	1968 L (520 gal)	4.3 m <sup>3</sup> (153 ft <sup>3</sup> )	23.5 m <sup>3</sup> (830 ft <sup>3</sup> )	47.7 m <sup>3</sup> (1673 ft <sup>3</sup> )	(3)	
737-900ER	21.4 m <sup>3</sup> (755 ft <sup>3</sup> )	3641 L (963 gal)	6.8 m <sup>3</sup> (241 ft <sup>3</sup> )	23.5 m <sup>3</sup> (830 ft <sup>3</sup> )	44.9 m <sup>3</sup> (1585 ft <sup>3</sup> )	(4)	

Source: Boeing Aircraft Characteristics Documents (18).

### Area calculations (Basic calculations from published data)

#### Cabin floor

$$3.54 \text{ m} \times 27.12 \text{ m} = 96 \text{ m}^2$$

Cabin wall or roof plus area errata (e.g. lockers, bulkheads)  
 $= (3.54 \times \pi \div 2) \times 27.12 \times 2 = 301.73 \text{ m}^2$

### Cargo holds (fore, aft and bulk)

#### Fore

$$(\sqrt[3]{19.6} \times \sqrt[3]{19.6}) \times 6 = 43.6 \text{ m}^2$$

#### Aft

$$(\sqrt[3]{25.5} \times \sqrt[3]{25.5}) \times 6 = 52.0 \text{ m}^2$$

## All holds

$$43.6 \text{ m}^2 + 52.0 \text{ m}^2 = 95.6 \text{ m}^2$$

## Amounts of disinsection spray (total mix)

### Recommended dilutions to provide 2% emulsion of permethrin

For example, when using a permethrin 50% EC formulation, mix one part of the 50% EC with 24 parts of water (42 mL permethrin 50% EC per 1 L water) to obtain a permethrin 2% emulsion.

### *Disinsection requirements:*<sup>1</sup>

Cabin wall ceiling or cargo holds = 10 mL permethrin per m<sup>2</sup>. Cabin floor = 20 mL permethrin per m<sup>2</sup>

**Cabin floor:** 20 mL × 96 m<sup>2</sup> = 1920 mL

**Cabin wall and roof + volume errata (e.g. lockers, bulkheads):** 10 mL × 301.73<sup>2</sup> = 3017 mL

**Cargo holds (fore, aft and bulk):** 10 mL × 95.6 m<sup>2</sup> = 956 mL

**Total (including under-spray factor):** (1920 mL + 3017 mL + 956 mL) × 1.33 = 5.89 L × 1.33 = 7.84 L.

## 6.2 Amounts of residual spray in aircraft

The following amounts of residual spray are those recommended for effective treatment when mixed and applied correctly.

### 6.2.1 Commercial passenger aircraft

Calculations for the amounts of residual spray in commercial aircraft are shown in the **Table 6**.

### 6.2.2 Freighter aircraft

The calculations for the residual spray amounts for freighter aircraft are shown in **Table 7**.

### 6.2.3 Aircraft residual spray amount calculator

To calculate the amount of residual spray required for aircraft that are not listed in *sections 6.2.1* and *6.2.2*, follow the guidance above, and use the [aircraft residual amount calculator](#), which can be downloaded [here](#).

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<sup>1</sup> For this calculation and practical application, the floor is sprayed twice with a 10-mL solution = 20 mL; the other 5 mL are for assumed drift from application on higher areas.

**Table 6. Spray amounts, commercial passenger aircraft**

Aircraft manufacturer and model	Cabin calculations										Cargo hold calculations							L per area			Spray amount for the whole aircraft (L)
	No. of aisles	Front door measurement (m)	Rear door measurement (m)	Cabin length (m)	Cabin width (m)	Area of cabin floor (m <sup>2</sup> )	Area of wall + ceiling (m <sup>2</sup> )	Area of wall + ceiling	Area of wall and ceiling (m <sup>2</sup> )	Forward hold (m <sup>3</sup> )	Area of forward hold (m <sup>2</sup> )	Aft hold (m <sup>3</sup> )	Bulkhold (BLK) (m <sup>3</sup> )	Aft + BLK (m <sup>3</sup> )	Aft + BLK (m <sup>2</sup> )	Total cargo area (m <sup>2</sup> )	Cabin floor	Cabin ceiling, walls, bins + bulkheads	All lower cargo hold areas		
<b>Airbus</b>																					
A300-600	2			40.5	5.64	228.42	8.86	358.95	717.89	76.51	108.13	61.03	21.00	82.03	113.27	221.41	6.08	9.55	2.94	18.57	
A310-200	2			35.5	5.64	200.22	8.86	314.63	629.26	55.00	86.77	36.20	21.00	57.20	89.07	175.85	5.33	8.37	2.34	16.03	
A319-100/NEO	1	5.04	25.81	20.70	3.63	75.40	5.70	118.48	236.96	8.52	25.03	11.92	7.22	19.14	42.93	67.96	2.01	3.15	0.90	6.06	
A320-200/NEO	1	5.04	29.53	24.40	3.63	88.90	5.70	139.70	279.40	13.28	33.65	18.26	5.88	24.14	50.12	83.76	2.36	3.72	1.11	7.19	
A321-NEO	1	5.04	36.47	31.43	3.63	114.09	5.70	179.29	358.57	22.81	48.26	23.03	5.88	28.91	56.52	104.78	3.03	4.77	1.39	9.20	
A330-200/800	2	5.85	45.63	39.70	5.18	206.06	8.14	323.81	647.62	60.70	92.67	52.00	19.70	71.70	103.55	196.22	5.48	8.61	2.61	16.70	
A330-300/900	2	5.85	50.96	45.10	5.17	233.22	8.12	366.49	732.97	78.00	109.53	60.70	19.70	80.40	111.77	221.30	6.20	9.75	2.94	18.90	
A340-200	2	5.85	46.69	40.84	5.29	216.04	8.31	339.50	678.99	60.70	92.67	52.00	19.70	71.70	103.55	196.22	5.75	9.03	2.61	17.39	
A340-300	2	5.85	50.96	45.11	5.29	238.63	8.31	374.99	749.99	78.00	109.53	60.70	19.70	80.40	111.77	221.30	6.35	9.97	2.94	19.27	
A340-500	2	5.85	54.14	48.20	5.29	255.45	8.31	401.43	802.86	78.00	109.53	52.00	19.70	71.70	103.55	213.09	6.80	10.68	2.83	20.31	
A340-600	2	5.85	61.58	55.73	5.29	294.81	8.31	463.28	926.55	104.00	132.69	78.00	19.70	97.70	127.28	259.97	7.84	12.32	3.46	23.62	
A350-900	2	6.82	52.55	45.70	5.61	256.55	8.82	403.14	806.29	89.50	120.05	71.60	9.12	80.72	112.07	232.12	6.82	10.72	3.09	20.64	
A350-1000	2	6.82	59.53	52.70	5.61	295.70	8.82	464.68	929.35	107.40	135.57	89.50	9.12	98.62	128.07	263.64	7.87	12.36	3.51	23.73	
<b>Boeing</b>																					
727-200	1	4.60	24.78	20.18	3.56	71.84	5.59	112.89	225.79	15.50	37.30	8.80	7.40	16.20	38.41	75.71	1.91	3.00	1.01	5.92	
737-200	1	4.76	23.27	18.51	3.54	65.53	5.56	102.97	205.94	10.48	28.73	14.31	0.00	14.31	35.37	64.10	1.74	2.74	0.85	5.33	
737-800	1	4.76	31.88	27.12	3.54	96.00	5.56	150.86	301.73	19.60	43.62	25.50	0.00	25.50	51.98	95.60	2.55	4.01	1.27	7.84	
737-900	1	4.76	32.92	28.16	3.54	99.69	5.56	156.65	313.3	23.8	49.64	28.7	0	28.7	56.24	105.9	2.65	4.17	1.41	8.23	
757-200	2	5.05	38.23	33.18	3.54	177.46	5.56	184.58	369.15	25.5	51.98	25.5	0	25.5	51.98	104	4.72	4.91	1.38	11.01	
757-300	2	5.05	45.34	40.29	3.54	202.63	5.56	224.13	448.26	33.75	62.66	33.75	0	33.75	62.66	125.3	5.39	5.96	1.67	13.02	

Aircraft manufacturer and model	Cabin calculations										Cargo hold calculations							L. per area			Spray amount for the whole aircraft (L)
	No. of aisles	Front door measurement (m)	Rear door measurement (m)	Cabin length (m)	Cabin width (m)	Area of cabin floor (m <sup>2</sup> )	Area of wall + ceiling (m <sup>2</sup> )	Area of wall + ceiling (m <sup>2</sup> )	Area of wall and ceiling (m <sup>2</sup> )	Area of wall and ceiling (m <sup>2</sup> )	Forward hold (m <sup>3</sup> )	Area of forward hold (m <sup>2</sup> )	Aft hold (m <sup>3</sup> )	Bulkhold (BLK) (m <sup>3</sup> )	Aft + BLK (m <sup>3</sup> )	Aft + BLK (m <sup>2</sup> )	Total cargo area (m <sup>2</sup> )	Cabin floor	Cabin ceilings, walls, bins + bulkheads	All lower cargo hold areas	
767-200	2	5.7	36.12	30.42	4.72	143.58	7.42	225.63	451.26	40.78	71.09	33.98	12.18	46.16	77.21	148.3	3.82	6	1.97	11.79	
767-300	2	5.7	42.55	36.85	4.72	173.93	7.42	273.32	546.64	54.4	86.14	47.6	12.2	59.8	91.75	177.9	4.63	7.27	2.37	14.26	
767-400	2	5.7	48.95	43.25	4.72	204.14	7.42	320.79	641.58	68	99.96	61.2	12.2	73.4	105.18	205.1	5.43	8.53	2.73	16.69	
777-200	2	6.75	49.54	42.79	5.82	249.04	9.15	391.35	782.69	81	112.32	63	17	80	111.4	223.7	6.62	10.41	2.98	20.01	
777-300 ER	2	6.74	59.67	52.93	5.82	308.05	9.15	484.08	968.17	108	136.07	90	17	125	150	286.1	8.19	12.88	3.80	24.88	
787-8	2	6.3	43.56	37.26	5.47	203.81	8.6	320.28	640.55	72	103.84	54	11.4	65.4	97.39	201.2	5.42	8.52	2.68	16.62	
787-9	2	6.3	49.66	43.36	5.47	237.18	8.6	372.71	745.42	90	120.5	72	11.4	83.4	114.53	235	6.31	9.91	3.13	19.35	
787-10	2	6.3	55.14	48.84	5.47	267.15	8.6	419.81	839.63	99	1208.4	81	11.4	92.4	122.63	251	7.11	11.17	3.34	21.61	
<b>Twin-level cabin area (Note: for 747 and A380 add upper deck cabin width × length to the area of cabin floor m<sup>2</sup>)</b>																					
747-400	2	0	57.00	57.00	6.13	409.41	9.63	549.07	1372.68	79.20	110.65	79.20	22.30	101.50	130.56	241.2	10.89	18.26	3.21	32.36	
747-800	2	0	60.08	60.08	6.13	428.29	9.63	578.74	1446.86	69.37	101.3	92.63	18.10	110.73	138.35	239.7	11.39	19.24	3.19	33.82	
A380-800	2	6.32	53.63	47.31	6.30	557.25	9.90	468.37	1170.92	131.00	154.76	107.8	1730.0	125.1	150.08	304.8	14.82	15.57	4.05	34.45	
<b>Other models</b>																					
Falcon 900	1	0	11.88	11.88	2.35	27.92	3.69	43.87	87.74	0	0	0	3.60	3.60	14.09	14.09	0.74	1.17	0.19	2.10	
ATR42-320	1	0	13.87	13.87	2.57	35.65	4.04	56.01	56.01	0	0	0	4.80	4.80	17.07	17.07	0.95	0.74	0.23	1.92	
ATR42-500	1	0	13.85	13.85	2.26	31.3	3.55	49.19	98.37	0	0	0	4.80	4.80	17.07	17.07	0.83	1.31	0.23	2.37	
ATR72-500	1	0	19.20	19.20	2.26	43.39	3.55	68.19	136.37	0	0	0	4.80	4.80	17.07	17.07	1.15	1.81	0.23	3.20	
Saab 340	1	0	14.20	10.33	1.70	17.56	2.67	27.60	55.19	0	0	0	8.30	8.30	24.60	24.60	0.47	0.73	0.33	1.53	

**Table 7. Spray amounts, freighter aircraft**

Aircraft manufacturer and model	Cabin calculations										Cargo hold calculations							Number of litres per area (L)			Spray amount for the whole aircraft (L)
	Front door measurement (m)	Rear door measurement (m)	Cabin length (m)	Cabin width (m)	Area of cabin floor (m <sup>2</sup> )	Area of wall + ceiling (m <sup>2</sup> )	Area of wall + ceiling (m <sup>2</sup> )	Area of wall and ceiling (m <sup>2</sup> ) + bin and bulkheads (m <sup>2</sup> )	Forward hold (m <sup>3</sup> )	Area of forward hold (m <sup>2</sup> )	Aft hold (m <sup>3</sup> )	Bulkhold (BLK) (m <sup>3</sup> )	Aft + BLK (m <sup>3</sup> )	Aft + BLK (m <sup>2</sup> )	Total cargo area (m <sup>2</sup> )	Cabin floor	Cabin ceiling, walls, bins + bulkheads	All lower cargo hold areas			
767-300F	2	2 5.70	42.55	36.85	4.72	173.93	7.42	273.32	273.32	273.32	54.50	86.25	47.60	12.20	59.80	91.75	178.00	4.63	3.64	2.37	10.63
767-400F	2	2 5.70	48.95	43.25	4.72	204.14	7.42	320.79	320.79	320.79	68.00	99.96	61.20	12.20	75.50	107.18	207.14	5.43	4.27	2.75	12.45
777F	2	2 6.74	49.53	42.79	5.82	249.04	9.15	391.35	391.35	391.35	81.00	112.32	63.00	17.00	80.00	111.40	223.72	6.62	5.2	2.98	14.8
MD11/M1F	2	NA	46.51	46.51	5.74	266.97	9.02	419.52	419.52	419.52	72.48	104.30	72.48	14.44	86.92	117.73	222.04	7.10	5.58	2.95	15.63
Twin-level cabin area (Note: for 747 and A380 add upper deck cabin width × length to cabin floor m <sup>2</sup> amount)																					
747-400F	NA	NA	NA	55.00	6.13	397.15	9.63	529.81	1324.52	79.20	110.65	79.20	14.70	93.90	123.95	234.61	10.56	17.62	3.12	31.30	
747-800F	NA	NA	NA	60.08	6.13	428.29	9.63	578.74	1446.86	107.80	135.90	88.20	14.72	102.92	131.77	267.67	11.39	19.24	3.56	34.19	

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# Annex 1. Examples of pre-embarkation cabin treatment by aircraft type

Use of various-sized aerosol cans is acceptable to achieve the same total.

## Boeing 747

A B747 requires up to  $4 \times 100$  g aerosols containing permethrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.2.1*.

Downstairs: two operators, each with one aerosol in each hand, starting at the rear of the aircraft and moving forward at a rate of not more than one step or one row of seats per second, with the spray directed towards the open overhead lockers.

Upstairs: one operator using the remaining spray from all four aerosols with all lockers open and moving at one step or one row of seats per second with one aerosol in each hand.

The rear portion of the main cabin of a B747 Combi is a cargo area. This can be accessed via a door at the end of the main cabin. Carry out all procedures as outlined in *section 4.4.3* and refer to *Annex 3*.

## Boeing 777-300

A B777-300 requires up to  $3 \times 100$  g aerosol containing permethrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.2.1*.

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead lockers. When the two aerosols are empty, the remaining unsprayed aisle is sprayed up and back with the third aerosol.

## Boeing 737 and Airbus A320

A B737 and an A320 require up to  $1 \times 100$  g aerosol containing permethrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.2.1*.

One operator with one aerosol starts at the front of the aircraft and moves down the aisle at a rate of not more than one step or one row of seats per second, with the spray directed towards the open overhead lockers on one side only. The other side is sprayed in the same manner when walking back.

## Airbus A380

An A380 requires  $3 \times 100$  g on the main deck and  $2 \times 100$  g on the upper deck, containing permethrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.2.1*.

Main deck – 300 g:

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead lockers. When the two aerosols are empty, the remaining unsprayed aisle is sprayed up and back with the third aerosol directed towards the open overhead lockers

Upper deck with no suites – 200 g:

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead lockers.

Upper deck with suites – 200 g:

One operator starts from the suite and takes two to three steps in and out of the bedroom, spraying at one step per second, and then sprays the shower room and the living room, ensuring that any stowage compartments are open.

The operator then moves to the “apartments”, with one or two steps in from the aisle for each apartment to ensure adequate coverage at one step per second and ensuring that all stowage compartments are open during treatment.

The operator with one aerosol in each hand sprays the rest of the upper deck by moving down the left-hand aisle and up the other at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead stowage compartments.

## Small aircraft (corporate jets and other small aircraft)

Small aircraft require less than  $1 \times 100$  g aerosol containing permethrin 2% as the a.i.

Carry out procedures described in *section 4.2.1*, except for the flight deck, which must be sprayed for 2 s, and the internally accessed baggage storage area, which must be sprayed for 4 s. The access door must be closed during treatment.

One operator with one aerosol sprays the flight deck, internally accessed baggage storage areas and toilet(s) and then sprays the cabin, moving from the rear of the aircraft and directing the spray high in the air towards the ceiling and wall areas at a rate of not more than one step or row of seats per second.

On completion of spraying, the operator applies a short burst of spray when exiting the aircraft. The aircraft must remain closed for a full 5 min before it is opened and air-conditioning and normal flight preparations are resumed.

The external door to the internally accessed baggage area shall be opened only after spraying is completed and for a short time while bags are loaded.

If there are any separate cargo holds with external access only, these must be sprayed after all cargo and luggage has been loaded. The amount is specified in section 5.

During spraying of cargo holds, ensure that the cargo hold doors are opened only just enough to introduce the aerosol can, to prevent spray from escaping to the exterior.

The cargo hold door must be closed immediately after spraying.

## Annex 2. Example of pre-departure cabin treatment by aircraft type

Use of various sized aerosol cans is acceptable to achieve the same total.

### Boeing 747

A B747 requires up to  $4 \times 100$  g aerosols containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.3*.

Downstairs: Two operators, each with **one aerosol in each hand**, start at the rear of the aircraft and move forwards at a rate of not more than one step or one row of seats per second, the spray being directed towards the open overhead lockers.

Upstairs: One operator uses the remaining spray from all four aerosols, with all lockers opened and moving at one step or row of seats per second with **one aerosol in each hand**.

In a B747 Combi, the rear portion of the main cabin is a cargo area. This can be accessed via a door at the end of the main cabin. Carry out all procedures as outlined in *section 4.4.3* and refer to *Annex 3*.

### Boeing 777-300

A B777-300 requires  $3 \times 100$  g aerosols containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i. Carry out all procedures as outlined in *section 4.3*.

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of one step or one row of seats per second, the spray being directed towards the open overhead lockers. When the two aerosols are empty, the remaining aisle is sprayed up and back with the third aerosol.

### Boeing 737 and Airbus A320

A B737 and an A320 require up to  $1 \times 100$  g aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.3*.

One operator with one aerosol starts at the front of the aircraft and moves down the aisle at a rate of not more than one step or one row of seats per second, the spray being directed towards the open overhead lockers on one side only. The other side is sprayed in the same manner when the operator walks back.

## Airbus A380

An A380 requires  $3 \times 100$  g aerosols for the main deck and  $2 \times 100$  g aerosols for the upper deck, containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.

Carry out all procedures as outlined in *section 4.3*.

Main deck—300 g:

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead lockers. When the two aerosols are empty, the remaining aisle is sprayed up and back with the third aerosol, the aerosol being directed towards the open overhead lockers.

Upper deck with no suites – 200 g:

One operator with one aerosol in each hand starts at the rear of the aircraft and moves up one aisle and down the other, at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead lockers.

Upper deck with suites – 200 g:

One operator starts from the suites and takes two to three steps in and out of the bedroom using the spray at one step per second and then proceeds to spray the shower room and the living room, ensuring that any stowage compartments are open.

The operator then moves to the “apartments”, taking one or two steps in from the aisle for each apartment to ensure adequate coverage, taking one step per second and ensuring that all stowage compartments are open during treatment.

The operator, with one aerosol in each hand, sprays the rest of the upper deck by moving down the left-hand aisle and up the other at a rate of not more than one step or one row of seats per second, directing the aerosols towards the open overhead stowage compartments.

## Small aircraft (corporate jets and other small aircraft)

Small aircraft require less than  $1 \times 100$  g aerosol containing d-phenothrin 2% or 1*R-trans*-phenothrin 2% as the a.i.

Carry out the procedures as outlined in *section 4.3*, except for the flight deck, which is to be sprayed for 2 s, and any internally accessed baggage storage area, which is sprayed for 4 s. The access door is to be closed during treatment.

One operator with one aerosol sprays the flight deck, internal baggage storage areas and toilet(s) and then sprays the cabin, moving from the rear of the aircraft while directing the spray high in the air towards the ceiling and wall areas at a rate of not more than one step or row of seats per second.

Any separate external cargo holds must be sprayed with the amount specified in *Annex 3* after all cargo and luggage have been loaded.

During spraying of cargo holds, ensure that the cargo hold doors are opened only just enough to introduce the aerosol can, in order to prevent spray from escaping to the exterior.

The cargo hold door must be closed immediately after spraying.

## Annex 3. Amounts of aerosol spray required by aircraft type

Note: These are the minimum amounts of aerosol spray required.

Table A3.1 Commercial passenger aircraft

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
<b>Airbus</b>				
A300-100/200	102	102	107	116
A300-600	207	207	108	116
A310-200	165	165	78	81
A318	41	41	12	24
A319	46	46	15	30
A320	52	52	22	40
A321	58	58	36	47
A330-200/800	126	126	120	133
A330-300/900	136	136	152	153
A340-200	126	126	120	133
A340-300	136	136	152	153
A340-500	177	177	151	136
A340-600	201	201	202	177
A350-900	170	170	160	154
A350-1000	170	170	195	179

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
A380	465	465	185	177
<b>Boeing</b>				
BBJ	65	65	15	9
BBJ2	80	80	39	22
Boeing 727-100	70	70	17	19
Boeing 727-200	85	85	28	33
Boeing 737-100	54	54	11	15
Boeing 737-200	59	59	15	20
Boeing 737-300	65	65	17	26
Boeing 737-400	73	73	24	31
Boeing 737-500	59	59	11	21
Boeing 737-600	59	59	11	20
Boeing 737-700	65	65	16	24
Boeing 737-800	80	80	28	36
Boeing 737-900	83	83	34	40
Boeing 737-1000	87	87	36	42
Boeing 747-100/200	321	321	78	87
Boeing 747-300	345	345	78	87
Boeing 747-400	344	344	112	145
Boeing 747-800	384	384	98	96
Boeing 747 SP	249	249	45	61
Boeing 757	115	115	26	42
Boeing 767-200/200ER	124	124	58	65
Boeing 767-300/300ER	146	146	77	84
Boeing 767-400ER	168	168	96	100
Boeing 777-200 ER/LR	246	246	114	112
Boeing 777-300 ER/LR	296	296	152	150
Boeing 777-900(X)	307	307	164	161
Boeing 787-800	204	204	101	92
Boeing 787-900	233	233	126	117

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:	
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	
Boeing 787-1000	259	259	139	130	
<b>Bombardier</b>					
CRJ 900	29	29	6	18	
<b>British Aerospace</b>					
Bae146-100/200/300	47	47	16	16	
	50	50	20 <sup>a</sup>	20 <sup>a</sup>	
<b>Embraer</b>					
170 E-Jet	40	40	12	8	
175 E-Jet	45	45	14	10	
190 E-jet	50	50	15	11	
195 E-jet	55	55	20	18	
<b>Tupolev</b>					
TU-134	50	50	8	12	
TU-154	95	95	12	16	
<b>McDonnell Douglas</b>					Separate bulk
DC 8 –Series 60-70 <sup>b</sup>	137	137	–	–	–
DC9	68	68	29	18	–
DC10/MD10	200	200	101	83	32
MD11	224	224	114	109	–
MD81/82/88 <sup>c</sup>	60	60	19	15	18
MD83 <sup>c</sup>	60	60	17	10	13
MD87 <sup>c</sup>	55	55	10	15	12
MD90 <sup>c</sup>	56	56	17	14	16

–, no spray requirement.

<sup>a</sup> Electronic and equipment bay, hydraulics bay and adjacent to holds.

<sup>b</sup> Most have four belly holds. Spray at 48 g per hold.

<sup>c</sup> These aircraft typically have forward, centre and rear holds.

Table A3.2. Small jets, regional and private aircraft (including private helicopters)

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
<b>Bombardier</b>				
Challenger 300	10	10	–	–
Challenger 600	15	15	–	–
Challenger 601	15	15	–	–
Challenger 605	15	15	–	–
Challenger 850	25	25	–	–
Challenger 5000	25	25	–	–
CRJ 200	25	25	–	–
CRJ 700 (CL-6000)	24	24	4	18
Dash 8 (DHC-8) 100/200	15	15	–	–
Dash 8 (DHS-8) 300	20	20	–	–
Dash 8 (DHC-8) 400	32	32	4	16
Global 5000	25	25	–	–
Global Express	25	25	–	–
Learjet 24	5	5	–	–
Learjet 25	5	5	–	–
Learjet 31	5	5	–	–
Learjet 35	5	5	–	–
Learjet 36	5	5	–	–
Learjet 40	4	4	–	2
Learjet 45	4	4	–	2
Learjet 55	4	4	1	2
Learjet 60	5	5	–	2
Learjet 85	7	7	–	4
<b>Cessna</b>				
Citation I	5	5	1	–
Citation II/SP	5	5	1	2
Citation V	5	5	1	2



Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
Citation VI	5	5	1	–
Citation VII	5	5	1	–
Citation X	5	5	1	3
Citation Bravo	5	5	1	2
Citation CJ1	5	5	1	2
Citation CJ2	5	5	1	3
Citation CJ3	5	5	1	3
Citation CJ4	3	3	1	3
Citation S/II	5	5	1	–
Citation Encore	3	3	1	2
Citation Encore +	5	5	1	2
Citation Excel	5	5	1	–
Citation Jet	5	5	1	2
Citation Mustang	2	2	1	2
Citation Sovereign	8	8	1	4
Citation Ultra	3	3	1	2
Citation XLS	4	4	1	4
<b>Dassault</b>				
Falcon 7x	18	18	–	–
Falcon 10	2	2	–	2
Falcon 50	8	8	–	4
Falcon 100	5	5	–	–
Falcon 900	15	15	–	–
Eclipse	50	50	8	12
Eclipse 400/500	5	5	–	1
<b>Embraer</b>				
120	16	16	–	12
135	18	18	–	13
140	20	20	–	13
145	22	22	–	13

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
Legacy 450 (Emb-550)	13	13	–	6
Legacy 500	14	14	–	6
Legacy 600	23	23	–	10
Legacy Shuttle	22	22	–	13
Phenom 100/300	6	6	1	3
<b>Fokker</b>				
F27 Friendship	25	25	–	–
F28	41	41	13	7
F50	31	31	–	–
F60 – militarized F50	35	35	–	–
F70	43	43	12	8
F100	53	53	16	8
<b>Galaxy Aerospace</b>				
Galaxy	9	9	–	5
<b>Gulfstream</b>				
GII/GIII	15	15	–	–
GIV	20	20	–	–
GV	21	21	–	–
G100	5	5	–	–
G150	6	6	–	2
G200/250	11	11	–	5
G350/G450/ G500/G550	21	21	–	–
G650	28	28	–	–
<b>Hawker Beechcraft</b>				
Beechcraft 1900	8	8	–	–
Beechcraft Premier I	5	5	–	2
Hawker 400	5	5	–	1
Hawker 750	10	10	–	1
Hawker 800	6	6	–	–

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
Hawker 900XP	10	10	–	–
King Air	5	5	1 <sup>a</sup>	1 <sup>a</sup>
<b>Honda</b>				
Honda Jet	5	5	1	2
<b>Israel Aircraft Industries</b>				
Astra SP	5	5	–	3
Astra SPX	5	5	–	2
Westwind II	5	5	–	2
<b>Pilatus</b>				
PC – 12 NG	5	5	1	2

–, no spraying requirement.

<sup>a</sup> Over wing lockers.

Table A3.3. Military aircraft<sup>a</sup>

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
<b>Airbus</b>				
KC-30/A330 MRTT	212	212	120	133
A400M	120	120	-	-
<b>Dassault</b>				
Osprey	15	15	-	-
B-52 Stratofortress (bomber)	200	200	-	-
B757	100	100	26	42
C40 (B737-700)	70	70	16	19
KC B767	124	124	58	65
KC-135R Stratotanker	100	100	-	-
P-8A Poseidon	100	100	-	-
<b>Bombardier</b>				
Learjet C21	5	5	-	-
<b>EADS CASA/IPTNf</b>				
CASA CN235	20	20	-	-
<b>Embraer</b>				
145 AEW	25	25	-	-
C-99A (Transport 145)	25	25	-	-
E-99	25	25	-	-
P-99 (Maritime)	25	25	-	-
R-99	25	25	-	-
<b>Gulfstream</b>				
C-20 (A/D) Gulfstream III	15	15	-	-
C-20 (G) Gulfstream IV	20	20	-	-
C-37 Gulfstream V	20	20	-	-
<b>Hawker Beechcraft</b>				
C-12	5	5	1 <sup>b</sup>	1 <sup>b</sup>

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Forward hold:	Aft hold:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phenothrin 2%) (g)
<b>Ilyushin</b>				
IL-62	100	100	-	-
IL-96	274	274	126	98
IL-II 76	88	88	-	-
<b>Lockheed</b>				
C5 Galaxy	700 <sup>c</sup>	700 <sup>c</sup>	-	-
C130 Hercules	60	60	-	-
MH60R	5	5	-	-
L-101 Tristar	200	200	76	62
P3 Orion	100	100	10 <sup>d</sup>	10 <sup>d</sup>
<b>McDonnell Douglas</b>				
C17 Globemaster	200	200	-	-
<b>Sikorsky</b>				
UH-60 Blackhawk	5	5	-	-
SH-60 Seahawk	5	5	-	-
<b>Northrop Grumman</b>				
E-2C Hawkeye	20	20	-	-
C-2 Greyhound	20	20	-	-
<b>Leonardo's Aircraft Division</b>				
Alenia C-27J Spartan	50	50	-	-

<sup>a</sup> Fighter jets are usually exempt from disinsection because they contain sensitive electronic equipment and are at low risk of carrying live mosquitoes.

<sup>b</sup> Over wing lockers.

<sup>c</sup> 600 g for main deck and 100 g for upper deck.

<sup>d</sup> Spray bomb bay via external hatch with 10 g of pre-spray.

Table A3.4. Freighter aircraft

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Main deck cargo area:	Forward hold:	Aft hold:	Separate bulk:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)
<b>Airbus</b>						
A300-F4200	6	6	151	107	96	-
A300-F4600	4	4	286	107	116	-
A300-600ST Beluga	2	2	997	-	121	32
A310-200/300F	4	4	240	78	81	-
A330-200F	4	4	212	120	133	-
A330-300P2F	4	4	240	152	153	-
A330-700XL Beluga	2	2	1170	-	153	32
<b>Antonov</b>						
Antonov 124	50	50	539	-	-	-
Antonov 225	50	50	646	-	-	-
<b>Boeing</b>						
Boeing 707-320C	4	4	120	35	36	-
Boeing 727-100	4	4	49	17	19	-
Boeing 727-200	4	4	70	28	33	-
Boeing 737	4	4	87	24	28	-

Aircraft manufacturer and model	Cabin pre-embarkation:	Cabin pre-departure or on-arrival:	Main deck cargo area:	Forward hold:	Aft hold:	Separate bulk:
	permethrin 2% (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)	d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) + permethrin 2%, or d-phenothrin 2% (or 1 <i>R-trans</i> -phe-nothrin 2%) (g)
Boeing 747-100/200	33	33	265	78	87	
Boeing 747-300/400	56	56	281	112	145	
Boeing 747-800	66	66	367	98	96	
Boeing 747 Combi	218 <sup>a</sup>	218 <sup>a</sup>	105	104	144	
Boeing 747 LCF (Dream Lifter)	30	30	975	80	80	
Boeing 757	4	4	99	43	52	
Boeing 767	4	4	252	77	84	
Boeing 777	4	4	255	152	150	
Boeing 787	4	4	389	139	130	
KC.135	3	3	90	-	-	
<b>McDonnell Douglas</b>						
DC 8 – 60-70 Series b	3	3	202	-	-	
DC 9	3	3	98	29	18	
MD11	4	4	331	114	109	
<b>Shorts</b>						
Belfast	4	4	165	-	-	

<sup>b</sup>-, no spraying requirement.

<sup>a</sup> Passenger cabin.

## Annex 4. ICAO residual aircraft disinsection certificate

GOVERNMENT OF .....

**CERTIFICATE OF RESIDUAL DISINSECTION**

Interior surfaces, including cargo space, of this aircraft . . . . . were treated with an approved residual  
(aircraft registration)  
disinsection product on . . . . . in accordance with the World Health Organization recommendations (WHO Weekly  
(date)  
Epidemiological Record No. 7, 1985, p. 47; No. 12, 1985, p. 90; No. 45, 1985, pp. 345-346; and No. 44, 1987, pp. 335-336) and  
any amendments thereto.

The treatment must be renewed if cleaning or other operations remove a significant amount of the residual disinsection product,  
and in any case within 8 weeks of the above date.

Expiry date: .....

Signed: .....

Designation: .....

Date: .....

The updated Annex 9 Standards and Recommended Practices on aircraft disinsection can be found on the ICAO website.

- Recommendations on the disinsecting of aircraft. Wkly Epidem Rec. 1985;60(7):45–7 (<https://iris.who.int/bitstream/handle/10665/225266/WER6007.PDF>).
- Recommendations on the disinsecting of aircraft. Wkly Epidem Rec. 1985;60(12):90 (<https://iris.who.int/bitstream/handle/10665/225306/WER6012.PDF>).
- Recommendations on the disinsecting of aircraft. Wkly Epidem Rec. 1987;60(44):335–6 (<https://iris.who.int/bitstream/handle/10665/226485/WER6244.PDF>).
- Recommendations on the disinsecting of aircraft. Wkly Epidem Rec. 1985;60(45):345–6 (<https://iris.who.int/bitstream/handle/10665/225575/WER6045.PDF>).
- International Civil Aviation Organization. Annex 9 – Facilitation. Montreal: International Civil Aviation Organization; (<https://www.icao.int/Security/FAL/ANNEX9/Pages/Publications.aspx>).



# Annex 5. ICAO aircraft general declaration

<b>GENERAL DECLARATION (Outward/Inward)</b>		
Operator.....		
Marks of Nationality and Registration.....Flight No. ....Date.....		
Departure from ..... Arrival at .....		
(Place) (Place)		
<b>FLIGHT ROUTING</b> ("Place" column should always list origin, every stop and destination)		
PLACE	NAMES OF CREW*	NUMBER OF PASSENGERS ON THIS STAGE**
		<i>Departure place:</i>
		Embarking .....
		Through on same flight .....
		<i>Arrival place:</i> .....
		Disembarking .....
		Through on same flight .....
<i>Declaration of health</i>		For official use only
<p>Name and seat number or function of persons on board with illnesses other than airsickness or the effects of accidents, who may be suffering from a communicable disease (a fever – temperature 38 °C/100 °F or greater – associated with one or more of the following signs or symptoms, e.g. appearing obviously unwell; persistent coughing; impaired breathing; persistent diarrhoea; persistent vomiting; skin rash; bruising or bleeding without previous injury; or confusion of recent onset, increase the likelihood that the person is suffering a communicable disease) as well as such cases of illness disembarked during a previous stop.</p> <p>Details of each disinsecting or sanitary treatment (place, date, time, method) during the flight. If no disinsecting has been carried out during the flight, give details of most recent disinsection</p> <p>.....</p> <p>Signed, if required, with time and date .....</p> <p>(Crew member concerned)</p>		
<p>I declare that all statements and particulars contained in this General Declaration, and in any supplementary forms required to be presented with this General Declaration, are complete, exact and true to the best of my knowledge and that all through passengers will continue/have continued on the flight.</p> <p>SIGNATURE .....</p> <p>Authorized Agent or Pilot-in-command</p>		

Size of document to be 210 mm × 297 mm (8 ¼ × 11 ¾ inches).

\* To be completed when required by the State.

\*\* Not to be completed when passenger manifests are presented and to be completed only when required by the State.

Source: International Civil Aviation Organization. Annex 9 – Facilitation (<https://www.icao.int/Security/FAL/ANNEX9/Pages/Publications.aspx>).

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