

# **Quarantine Treatments and Application Procedures: I. Methyl Bromide Fumigation**



**Government of India**  
Ministry of Agriculture  
Department of Agriculture & Cooperation  
**Directorate of Plant Protection, Quarantine & Storage**  
N.H-IV., Faridabad-121001, Haryana (State)

February 2005

CONTENTS		
Section	Particulars	Page No.
	<i>Title</i>	1
	<i>Contents</i>	2
	<i>Endorsement</i>	5
	<i>Review &amp; Amendment</i>	6
	<i>Control &amp; Distribution of standard</i>	6
	<b>INTRODUCTION</b>	7
	Scope	7
	Purpose of the Standard	7
	References	7
	Definitions & Terms	8
	Outline of Requirements	10
<b>1.0.</b>	<b>GENERAL REQUIREMENTS</b>	11
<b>1.1.</b>	<b>Background</b>	11
<b>1.2.</b>	<b>Authority</b>	11
<b>1.3.</b>	<b>Regulation Requirements</b>	12
<b>1.4.</b>	<b>Organizations/Agencies Responsible for Fumigation Treatments</b>	13
1.4.1.	Role of Regulating Agencies	13
1.4.2.	Responsibilities of Client (Importer/Exporter or his agents)	14
1.4.3.	Responsibilities of Fumigation Agencies (Pest Control Operators)	14
1.4.4.	Responsibilities of Transport/Shipping Agencies	15
1.4.5.	Responsibilities of other relevant Agencies	15
<b>1.5.</b>	<b>Treatment of import consignments</b>	15
1.5.1.	Off-shore treatments	16
1.5.2.	On-shore treatments	16
<b>1.6.</b>	<b>Treatment of export consignments</b>	16
<b>1.7.</b>	<b>Documentation of Treatment</b>	16
<b>2.0.</b>	<b>SPECIFIC REQUIREMENTS</b>	17
<b>2.1.</b>	<b>Properties and Use of Methyl Bromide</b>	17
2.1.1.	Physico-chemical properties	17
2.1.2.	Safety & formulation	17
2.1.3.	Storage & transport of fumigant	18
2.1.4.	Specification of cylinders/cans	18
<b>2.2.</b>	<b>Fumigation forbidden/sorptive commodities</b>	18
<b>2.3.</b>	<b>Fumigation of commodities with impervious packing/shrink wrapping</b>	19
<b>2.4.</b>	<b>Fumigation of perishable commodities</b>	20
2.4.1.	Live plant fumigation	20
2.4.2.	Fresh fruits/vegetables/cut-flowers fumigation	20

<b>2.5.</b>	<b>Timber and timber products fumigation</b>	20
<b>2.6.</b>	<b>Performance of fumigation operations by Methyl Bromide</b>	21
2.6.1	Approved Pest Control Operators	21
2.6.2	Selection of site for fumigation	21
<b>2.7.</b>	<b>Requirements of fumigation enclosures</b>	21
<b>2.8.</b>	<b>Relation of temperatures to fumigation</b>	22
<b>2.9.</b>	<b>Specification of fumigation chambers</b>	22
2.9.1.	Specifications of atmospheric fumigation chambers	23
2.9.2.	Specification of vacuum fumigation chambers	23
<b>2.10.</b>	<b>Fumigation under gas-proof covers (sheets)</b>	24
2.10.1.	Specification of fumigation covers (sheets)	24
2.10.2.	Placement of fumigation sheets	24
2.10.3.	Specification of sand/water snakes	25
<b>2.11.</b>	<b>Fumigation of containers</b>	25
2.11.1.	Container selection	25
2.11.2.	Procedure for pressure testing	26
2.11.3.	Inspection of containers	26
2.11.4.	Measure the pressure halving time	26
2.11.5.	Materials and equipment for pressure testing containers	27
2.11.6.	Specifications of finger manifold	27
<b>2.12.</b>	<b>Laying down gas supply/distribution lines and sampling lines</b>	27
<b>2.13.</b>	<b>Calculation of dosage/CT Products/exposure periods</b>	28
<b>2.14.</b>	<b>Use of safety equipments and first-aid measures</b>	30
2.14.1.	Specifications of gas mask & canister	30
2.14.2.	Specification of self-contained breathing apparatus	30
2.14.3.	Fitness test of face mask	30
2.14.4.	Maintenance and care of gas mask (respirator/SCBA	31
2.14.5.	Emergency aid	32
2.14.6.	Safety Precautions	33
<b>2.15.</b>	<b>Application of correct quantities of fumigant</b>	34
<b>2.16.</b>	<b>Application of methyl bromide in gaseous state</b>	34
2.16.1.	Specifications of vapourizer	34
<b>2.17.</b>	<b>Distribution of gas within fumigation enclosure</b>	35
<b>2.18.</b>	<b>Gas monitoring equipment/leak detector</b>	35
2.18.1.	Specifications & use of gas monitoring equipment	36
2.18.2.	Specifications & use of gas leak detector	36
<b>2.19.</b>	<b>Measuring and monitoring gas concentrations</b>	36
2.19.1.	Options for ensuring maintenance of correct fumigant concentrations	37
2.19.2.	Option 1 - Pressure testing and correct dosage application	37
2.19.3.	Option 2 – Initial and endpoint monitoring with top-up option at the end	37
2.19.4.	Problems with methyl bromide concentrations and sampling lines	38
2.19.5.	Minimum fumigant concentrations for initial and endpoint monitoring	39
2.19.6.	Final monitoring above the standard line	39
2.19.7.	Final monitoring between the standard and the lower limit	39
2.19.8.	Final monitoring below the lower limit line	39
2.19.9.	Option 3 – Continuous monitoring with top-up options	40

<b>2.20.</b>	<b>Degassing/aeration of commodity/container</b>	41
<b>2.21.</b>	<b>Issue of fumigation certificate and release of commodity</b>	41
<b>2.22.</b>	<b>Fumigation of ship holds</b>	41
2.22.1.	Safety aspects of ship fumigation	41
2.22.2	Selection of ship	41
2.22.3	Prior notification to shipping agent/captain	42
2.12.4.	Inspection of ship holds	42
2.22.5.	Preparing areas for fumigation	43
2.22.6.	Arrangements for operation of fans	43
2.22.7.	Placing of gas introduction lines/sampling tubes	43
2.22.8.	Sealing of stores/cargo holds to render gas-tight	43
2.22.9.	Introduction of gas into ship holds	44
2.22.10.	Monitoring gas concentrations in ship holds	45
2.22.11.	Aeration of ship holds & safety aspects	45
2.22.12.	Issue of gas-free test certificate	46
	Appendix-I: Fumigation Record	47
	Appendix-II: Check Sheet of Fumigation Treatment	48
	Appendix-III: Conversion tables	49
	Appendix-IV: Quarantine Treatment Schedules	50
	Appendix-V: Methyl Bromide Ready Reckoner	55
	Appendix-VI: Fumigation Certificate	56
	Chart-1: Concentration over time (48g/m <sup>3</sup> ) initial dosage of fumigation	57
	Chart-2: Calculation of top-up procedures provided for in this standard	58
	Chart-3: Graphical illustration of use of top-up procedure provided in this Standard (Concentration over time-24 hour top-up)	59
	Chart-4: Graphical illustration of use of top-up procedure provided in this Standard (Concentration over time-12 hour top-up)	60
	Figure 1: Finger manifold in operation with a container	61
	Figure 2: Finger Manifold (Close-up view)	62
	Figure 3: Finger Manifold (Construction & Design)	63

## Endorsement

This standard entitled '*Quarantine Treatments and Application Procedures: I. Methyl bromide fumigation*' is prepared by the Directorate of Plant Protection, Quarantine & Storage (Dte of PPQ&S), Faridabad-121001 for undertaking all quarantine treatments of goods by all the accredited fumigation operators and the supervising PQ officers to ensure that the treatment activities are performed strictly in accordance with the guidelines and procedures laid down in this standard. This standard provides guidance on proper application of Methyl Bromide treatments to eliminate quarantine pests to minimize the risk associated with import/export of agriculture commodities and other regulated articles. This standard replaces the '*Manual for Fumigation Operators, Directorate of Plant Protection, Quarantine & Storage, N.H-IV, Faridabad (India)*'.

This standard is duly approved for adoption on the 22<sup>nd</sup> day of **February 2005**.

\_\_\_\_\_  
-Sd-

(P.S. Chandurkar)

Plant Protection Adviser of India

Dte of Plant Protection, Quarantine & Storage,

NH-IV., **Faridabad-121001.**

## Review & Amendment

This standard will be subject to amendment/modification as may be decided upon by the Plant Protection Adviser. This standard will be updated and revised if necessary and circulated to the standard holders. The holders of this should ensure that the current edition of this standard is being used.

## Control & Distribution of the standard

The master copy of this standard will be held with Plant Protection Adviser, Dte of Plant Protection Quarantine & Storage, Faridabad and controlled copy will be distributed by Joint Director (PQ) to all the Plant Quarantine Stations and approved fumigation agencies (pest control operators). Any clarifications/enquiries regarding this standard should be made to the Joint Director (PQ), Dte of PPQS, Faridabad-121001.

Controlled Copy Holder	Copy No.
Joint Director (PQ), Dte of PPQ&S, N.H.IV., Faridabad-121001	1
PQ Division, Dte of PPQ&S, N.H.IV., Faridabad	2
Dy Director (PP/Ent), National Plant Quarantine Station, Rangapuri, New Delhi-110037	3
Dy Director (Ent/PP.), Regional Plant Quarantine Station, Amritsar	4
Dy. Director (Ent./PP), Regional Plant Quarantine Station, Kolkata	5
Dy. Director (Ent/PP), Regional Plant Quarantine Station, Chennai	6
Dy Director (PP/Ent.), Regional Plant Quarantine Station, Mumbai	7
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Visakhapatnam/Kakinada	8
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Cochin	9
Plant Protection Officer (Ent/Path), Plant Quarantine Station. Tuticorin	10
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Trivandrum	11
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Kandla/ Bhavnagar	12
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Bangaon	13
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Gede	14
Plant Protection Officer (Ent/Path), Plant Quarantine Station, Panitanki/Kalimpong	15
Officer-in-charge of Plant Quarantine Station, Hyderabad	16
Officer-in-charge of CIPMC, Bangalore.	17
Officer-in-charge, Plant Quarantine Station, Patna/Raxual	18
Officer-in-charge, Plant Quarantine Station, Tiruchy	19
Officer-in-charge, Plant Quarantine Station, Varanasi	20
Officer-in-charge, Plant Quarantine Station, Sonauli	22
Officer-in-charge, Plant Quarantine Station, Jogbani	23
Officer-in- charge, Plant Quarantine Station, Gowahati	24
Officer-in-charge, Plant Quarantine Station, Banbasa	25

## INTRODUCTION

### Scope

This standard outline the guidelines and application of treatment procedures for quarantine purposes consistent with the phytosanitary regulations aimed at preventing the incursion of exotic pests in imported goods. Further this standard help in adaptation of correct treatment practices to ensure the export of goods in pest-free condition.

### Purpose of this Standard

The purpose of this standard is:

- to clearly outline and explain the minimum standards that apply to treatments carried out to meet the phytosanitary regulatory requirements;
- to provide approved fumigation agencies access to information to the quarantine requirements so that they can effectively treat consignments for allowing import into India; and
- to facilitate pest-free exports from India confirming to the current phytosanitary requirements of importing country

For current information on quarantine treatments and application procedures, the user may contact Plant Protection Adviser (0129-2413985, 2412125 (fax), e-mail: ppa@mail.nic.in) or Joint Director (Plant Quarantine) (0129-2418506, e-mail: jdpq@mail.nic.in), Directorate of Plant Protection, Quarantine & Storage at N.H.IV, Faridabad-121001 or the PQ website: <http://www.plantquarantineindia.org>, or contact Deputy Director (Ent/PP) of NPQS, New Delhi/RPQS, Amritsar, Chennai, Kolkata & Mumbai.

The user of this standard must ensure that relevant provisions of Customs Act, Environment Protection Act, Indian Explosives Act, Insecticides Act and Prevention of Food Adulteration Act and other local regulations are complied with. Also the user of this standard should ensure to consult the phytosanitary regulations of country to which commodity being exported for current information on quarantine treatment schedules in respect of export consignments.

### References

ACIAR. 1989. *Suggested Recommendations for the Fumigation of Grain in the ASEAN Region. Part-1: Principles and general practice: 131pp*, Australian Centre for International Agricultural Research, Canberra ACT, Australia.

AQIS. 2002. *Quarantine Fumigation and Treatment Standard: Part A & B*, Australian Quarantine Inspection Service, Department of Agriculture, Fisheries & Forestry, Australia.

Bond, E.J. *Manual of Fumigation for Insect Control*. FAO Plant Production and Protection Paper No. 54:432 pp, Food & Agriculture Organization, Rome.

*DPPQS. 1997. Manual for Fumigation Operators, Directorate of Plant Protection, Quarantine & Storage, N.H-IV, Faridabad (India).*

*USDA. 1998. Treatment Manual. United States Department of Agriculture, Animal & Plant Health Inspection Service, USA.*

## **Definitions & Terms**

Ambient temperature	air temperature immediately surrounding the fumigation enclosure
Authority	An individual or organization entrusted with the responsibility for regulating the pest control operations including the fumigation.
Cargo container	A container used for transporting cargo, which has rigid roof, side walls and a floor and one side fitted with lockable doors lined with gasket and provided with roof vents on sides
C X T product	Concentration X time product expressed as $\text{gh/m}^3$ .
Commercial pest control operation	any application or dispersion of insecticide (s) including fumigants in household or public or private premises or land and includes pest control operations for commercial purposes but excludes private use.
Disinfestation	any treatment measure applied to control insect infestation and shall include chemical and non-chemical methods
Disinfection	any treatment measures applied to control infection by pathogenic organisms and shall include both chemical and non-chemical methods.
Dosage	A calculated amount of fumigant applied to a fumigation enclosure for treatment of commodity and usually expressed as $\text{g/cu.m}$ or $\text{mg/l}$
Dunnage	Any material used for supporting or protecting cargo during transport and voyage
Fumigant	Any chemical at a particular temperature and pressure can exist in gaseous state in sufficient concentration and for sufficient time to be lethal to insect and other pests
Fumigation	Application of any chemical in a gaseous state in a gas tight enclosure to kill insect and other pests
Fumigation certificate	A certificate issued as evidence that a fumigation treatment has been applied to a given commodity to control insect infestation.
Fumigation enclosure	Any gas-tight enclosure for the purpose of carrying out fumigation and shall include containers, gas-proof covers, chambers, silos, ship holds and other structures that can be made gas-tight.

Fumigation agency	An individual, company or an organization, who is authorized by an appropriate authority for undertaking fumigation operations to control insect infestation
Hazard area	Any area in close proximity to fumigation enclosure into which lethal amount of fumigant may escape to cause health hazard.
MRL	Maximum residue limits
NTP	Normal temperature and atmospheric pressure
Pallet	Any platform used to support cargo during storage, transport and shipment for easy stacking usually made up of timber or ply wood etc.
Pest	Any organism which may be injurious to the plant and animal life and natural environment.
Pest control operator	Any person who undertakes pest control operations and includes the person or the firm or the company or organization under whose control such a person (s) is operating.
Quarantine Pest	A pest of potential economic and/or environmental importance to an area where it is not yet present, or is present but not widely distributed and being officially controlled
Quarantine treatment	Any kind of treatment that is applied for quarantine purpose for elimination of pest in accordance with phytosanitary regulations of the importing country.
Sorption	A physico-chemical process by which a fumigant adsorbed or absorbed by the commodity. This may be reversible (adsorbed fumigant may be released on aeration of commodity) or irreversible (chemically bound by the commodity leading to residue of fumigant in treated commodity).
Sorptive commodity	means any commodity that adsorb or absorb the fumigant during fumigation operation and retained by the commodity or slowly released into air during airing.
Thresh hold limit value	Maximum concentration of gas, which a person can with stand when continuously exposed for a period of eight hours
Treatment	Any treatment applied to a commodity to eliminate the pest and shall include fumigation, irradiation, hot-water, hot air, vapour-heat and cold treatments

## **Outline of Requirements**

This standard outlines the need for effective treatment of the consignment to meet the specific quarantine requirements related to the import of specific commodity to reduce the risk of introducing potentially hazardous pests. There are limited range of treatments are available to meet the quarantine requirements, which are aimed at cent percent killing of pests without affecting the commodity. Further these treatments are required to be performed in precise manner and some treatments such as fumigation involve complex procedures. Any failure of treatment may lead to incursion of pest and repeated fumigation may end up with residue problems in treated commodities and further extended fumigations may greatly affect the sorptive commodities. Some times inadequate treatments may lead to build up of pest resistance. Further India being signatory to Montreal Protocol, there is a need to use methyl bromide in judicious manner, which can be achieved through optimizing the fumigation success by meeting the requirements of this standard

This standard describes the requirements and procedures for carrying out fumigation treatments with methyl bromide in an effective manner.

## 1.0. GENERAL REQUIREMENTS

### 1.1. Background

This standard provides guidance on quarantine treatments and application procedures for the approved fumigation agencies (pest control operators) in compliance with Indian phytosanitary regulatory requirements. The approved fumigation agencies (pest control operators) should ensure that the guidelines/procedures prescribed in this standard are strictly followed, whenever any fumigation is performed.

The section on ‘general requirements’ deals with quarantine & insecticide regulatory requirements on restricted use of fumigants and other relevant regulations; responsibilities of authority and fumigation agencies and all those involved in the treatment of commodity and specific quarantine treatment requirements with import/export of agriculture commodities.

The section on ‘specific requirements’ deals with specific aspects of methyl bromide fumigation and approved treatment schedules by the Plant Protection Adviser. The Plant Protection Adviser based on documentary evidence regarding the effectiveness of treatment may consider any other equivalent treatments.

The Directorate of Plant Protection, Quarantine & Storage would issue separate treatment standards for alternatives to methyl bromide fumigation as and when they are duly established and approved by the Plant Protection Adviser.

Further the use of methyl bromide for the purposes other than quarantine treatments strictly requires the written approval of Plant Protection Adviser and which shall be granted subject to critical use exemptions (CUEs) by the United Nations Environmental Protection Agency. Any such uses of methyl bromide other than quarantine treatments without the permission of Plant protection Adviser is liable to prosecution under the provisions of Insecticides Act, 1962 and amendments issued there under.

### 1.2. Authority

The Directorate of Plant Protection, Quarantine & Storage, established under the Ministry of Agriculture is the regulating authority for granting approval for restricted use of Methyl Bromide and accreditation of fumigation agency.. The Directorate of Plant Protection, Quarantine & Storage, N.H-IV, Faridabad-121001, shall establish a central register of such accredited fumigation agencies, as per the ***‘Guidelines of assessment, accreditation and auditing of fumigation agencies’*** prescribed by the Plant Protection Adviser. The Director of Agriculture of respective State Governments will be responsible for granting license for stock, sale, distribute and use of restricted pesticides such as fumigants to those accredited fumigation agencies. Such license shall be issued only after necessary verification of certificate of registration of fumigation agency with accredited fumigation operator, issued by the Plant Protection Adviser

### **1.3. Regulations governing fumigation treatments**

#### **1.3.1. Quarantine Regulations**

As per Clause 3 (17) of the Plant Quarantine (Regulation of Import into India) Order 2003 issued under the Destructive Insects & Pest Act, 1914, all the fumigation, disinfestations or disinfection of the consignment shall be carried out through an agency approved by the Plant Protection Adviser under the supervision of an officer duly authorized by the Plant Protection Adviser in that behalf

#### **1.3.2. Insecticides Act /other relevant Acts & Regulations**

The use of methyl bromide is restricted under the Insecticides Act, 1968 and subject to the following conditions viz., (a) to be used by the Government Departments/Agencies, who have necessary trained man power to supervise the operations (b) Plant Protection Adviser to the Government of India to approve the commercial pest control operators for stock and use of these fumigants and to recognise expertise for undertaking fumigation.

The relevant provisions of The Insecticide Rules, 1971 issued under the Insecticides Act, 1968 as amended in 1999 briefly summarized below:

- (i) The Rule 10 (3A) pertaining to licensing for sale, stock, distribution and use of insecticides including fumigants; Rule 19 pertaining to manner of labeling; Rule 35 pertaining to packing and storage while transporting, Rule 36 pertaining to storage of insecticides; Rule 37 related to medical examinations; Rule 38 relating to first aid measures; Rule 39 related to protective clothing; Rule 40 related to respiratory devices, Rule 42 related to training of workers in observing safety precautions and handling safety equipments; and Rule 44 related to disposal of used packages.

The other relevant Acts and regulations applicable to the use of fumigants include:

- (ii) Gas Cylinder Rules, 1981 issued under the Indian Explosives Act, 1884 shall apply to specification of cylinders and valves for storing the gases such as Methyl Bromide, storage and transport of cylinders etc.
- (iii) Rule 65 of the Prevention of Food Adulteration Rules, 1955 issued under the Prevention of Food Adulteration Act, 1954 about the prescribed tolerance limits of residues of insecticides including fumigants, which are to be strictly adhered to.

Also the relevant Bureau of Indian Standards applicable for code of safety and fumigation practices for aluminum phosphide, methyl bromide; welded and seamless steel gas cylinders for methyl bromide filling; methyl bromide retention valve; specifications of fumigation covers; gas masks; and package requirements.

#### **1.4. Organizations/Agencies Responsible for Fumigation Treatments :**

Any success or failure of treatment primarily rests with the pest control operator (treatment provider). Besides this there are several parties involved in the treatments viz.,

- the person or organization seeking the treatment (client)
- the importer/exporter of the consignment
- the regulatory agencies (Central/State Governments)
- the transport providers
- other agencies such as customs, port authorities, shipping agents etc.

Each of the above parties are responsible for themselves and to one another for the successful conduct of fumigation operations.

Failure of treatments due to factors beyond the control of pest control operator (treatment provider), but lies within the control of other parties involved in the treatment process.

It is important that the client (customer) presents the consignment to the pest control operator in appropriate state for treatment and the treatment provider should be given sufficient time and resources to perform treatment in effective manner.

Further treatments such as fumigation involve complex process and require careful planning and clear understanding of the process by all of the parties involved. To ensure successful conduct of treatment by treatment provider, every one involved in the treatment process understand their individual responsibilities and comply with all relevant guidelines, industry safety codes and national and international requirements

##### **1.4.1. Role of Regulating Agencies**

The regulatory agencies may include any local, national and international agencies with an interest in the way a treatment is performed. They have an important role to play in:

- setting national guidelines that establish safe working environments where fumigation agency can perform effective treatments. This may be through legislation, regulation and licensing;
- ensuring that fumigation agency meet the requirements for performing safe and effective treatments. Such as, licensing fumigation agency, who have demonstrated their ability to meet the legal requirements for performing the relevant treatment;
- establishing international requirements for treatment of goods that are practical and can be undertaken with confidence by fumigation agency;
- establishing standards for specialized treatment applications, and enforcing quality assurance programs to ensure they are maintained;
- publishing information, such as national and international legislation, industry codes, and requirements for certification, to help fumigation agency aware of the standard of competence at which they must work; and,

- providing training and certification to allow fumigation agency to achieve, maintain and demonstrate their ability to work at an established standard of competence

#### **1.4.2. Responsibilities of Client**

This standard recognizes the client to be any person or organization requesting the treatment from the fumigation agency. This could be the owner of the commodity; an agent; a warehouse manager; an agent representing buyer; an exporter or importer.

The client should:

- choose a fumigation agency, who is holding valid license issued by State Government and accredited by the Plant Protection Adviser of the Government of India, Directorate of Plant Protection, Quarantine & Storage, Faridabad.
- inform the fumigation agency before commencing the treatment, about the quarantine treatment requirements of the commodity, the composition of consignment; storage condition and place of the commodity; end use of the consignment; package conditions and specific market requirements ( fumigant residue limits, where applicable) and other contract or agreement requirements, where applicable;
- ensure sufficient time is available to perform treatments to meet the quarantine requirements;
- inform the transport contractor not to move the fumigated consignment or container until the degassing and release of the commodity or container; and
- ensure proper stocking of consignment or placing container on the ground to facilitate carrying out proper treatment.

#### **1.4.3. Responsibilities of Fumigation Agency**

The fumigation agency should:

- hold valid license and certificate of registration granted by the Plant Protection Adviser;
- be technically competent to perform relevant treatment to meet the quarantine requirements;
- perform fumigation operations always under supervision of accredited fumigation operator;
- advise the client on stocking of consignment for carrying out effective treatment;
- advise the client about the time requirements for successful treatment of consignment;

- seek from the client any specific conditions attached to the treatment of consignment;
- inform the client of any other factors that affect treatment of commodity such as impervious package or sorptive nature of commodity;
- ensure adopting right fumigation practices and follow safety precautions, while undertaking treatment operations;
- maintain proper records on stock/use of fumigants and issue fumigation certificates after ensuring fumigations are carried out in effective manner;.
- follow the guidelines and abide by instructions issued by PPA; and.
- ensure not to undertake fumigation in forbidden places or of forbidden commodities.

#### **1.4.4. Responsibilities of Transport/ Container/Shipping Agencies**

The transport contractor may include freight agents, rail/road transporters, shipping and container agents

The transport contractor should:

- secure from their clients and the fumigation agency any relevant information concerning the consignment viz., name of fumigant used, date and time when fumigation was performed and the time and duration of aeration of commodity
- be aware the treatment of consignment
- ensure not to transport or ship the container without degassing and understand the hazards associated with in-transit treatments
- comply with local, national and international regulations concerning transportation of treated commodity, where applicable

#### **1.4.5. Other relevant agencies**

The list of other relevant agencies involved in overall treatment process include the customs/port authorities, which regulate shipments and health services concerned with safety of workers engaged in fumigation operations and fumigant residues in treated commodities. .

### **1.5. Treatment of Import Consignments**

As per PQ regulations, the commodities covered under Schedule-VI of PQ Order 2003 except propagative plant material such as sprouts/saplings/cuttings/bud wood/flowers etc., will be allowed import subject to offshore (at the port of shipment) treatment and where as commodities covered under Schedule-VII, except timber/wooden logs, will be allowed import subject to inspection and if necessary after treatment at the port of entry (on-shore treatment). While considering offshore treatment, the clients (exporter) should check with Dte PPQS or consult PQ web site to ensure that the offshore treatment is valid for their

specific commodities. However equivalent treatments will be considered as per established sliding scale of methyl bromide to meet different temperature regimes. Non-compliances will be communicated to the foreign authorities concerned for taking effective action against the fumigation agency, where there is evidence that the treatment and/or certification have not been completed in accordance with phytosanitary regulations prescribed under PQ Order 2003.

#### **1.5.1. Offshore treatment**

Dte PPQS considers offshore treatments to be an important part of dealing with potential quarantine risks. The effective treatment of some commodities prior to export to India is an increasingly important part of this approach of management of pest risk at bay. Dte PPQS will only accept offshore treatments if performed by a fumigation operator (treatment provider) that can meet Indian plant quarantine requirements. To facilitate entry into India, a correctly completed fumigation certificate should accompany any consignment treated offshore. The Dte PPQS will conduct inspections on goods that arrive at Indian port accompanied by a treatment certificate. If PQ inspectors detect infestation during an inspection, Dte PPQS will consider the consignment as having failed treatment and the consignment will be ordered for re-fumigation before the same given quarantine clearance and report of non-compliance will be communicated.

#### **1.5.2. On-shore treatments**

Goods subject to quarantine may arrive in India without a valid treatment certificate. In some cases the importer must have these consignments treated on arrival by an accredited fumigation operator. In other instances the importer may choose between having the consignment fully inspected and if necessary treated. If the consignment is infested or contaminated with materials of quarantine concern it must then be treated by an accredited fumigation operator under the supervision of PQ officer.

### **1.6. Treatment of export consignments**

Many countries require particular goods exported from India to be treated prior to shipment in order to satisfy their own quarantine requirements. As a result, Dte PPQS is often requested to issue phytosanitary certificate for certain consignments endorsing that quarantine requirements, such as fumigation, have been met with. Further that wood packaging material including dunnage shall be required to be appropriately treated with methyl bromide and marked in compliance with ISPM-15

### **1.7. Documentation of Treatments**

The fumigation operator must document and maintain the record of fumigation treatment in prescribed format (**Appendix-I**) at the end of each treatment and ensure that check sheet of fumigation (**Appendix-II**) is completed at the site of fumigation, whenever any fumigation performed.

## 2.0. SPECIFIC REQUIREMENTS

### 2.1. Properties and Use of Methyl Bromide

#### 2.1.1. Physico-chemical properties

Methyl bromide is the most widely used fumigant for quarantine purposes. It is favoured in many countries for plant quarantine because of its reputation for having:

- good penetrating ability
- rapid action
- ovicidal
- high toxicity to a broad spectrum of insects and similar pests.

The basic properties of Methyl Bromide are as follows:

Formula	CH <sub>3</sub> Br
Molecular Weight	95 g
Boiling Point	3.6 <sup>0</sup> C
Specific Volume at 30 <sup>0</sup> C (at 1 atm)	0,256 m <sup>3</sup> /kg
Specific gravity (gas) [air = 1.0]	3.40
Gas density at 30 <sup>0</sup> C (at 1 atm)	3.908 kg/m <sup>3</sup>
Vapour pressure at 30 <sup>0</sup> C	2.5 atm
Conversion factor, g/m <sup>3</sup> to ppm (at 30 <sup>0</sup> C, 1 atm)	260
Flamability limits in air (% v/v)	13.5-14.5.
Solubility in water (v/v)	3.4
Specific gravity at 30 <sup>0</sup> C, 60%R.H. (liquid, kg/L)	1.7
Thresh hold limit	5 ppm (0.02 g/ m <sup>3</sup> )

#### 2.1.2. Safety & formulation

Methyl bromide is an extremely toxic, odourless gas. The Indian insecticide regulations specify that methyl bromide used in fumigation treatments must contain a warning agent, typically 2% chloropicrin. However, importers should aware that methyl bromide with chloropicrin is phytotoxic to live plants, cut flowers, fresh fruit and vegetables and seeds.

**Note:** - In some situations the chloropicrin may condense and pool, adding to the health and safety hazards associated with the use of methyl bromide .For the purposes of quarantine treatments, and where permitted, 100% methyl bromide should be used when ever possible. This is an extremely toxic substance. Its use should be subject to strict occupational health and safety standards to protect the people that are working with it as well as those who may be inadvertently exposed to it. While using the methyl bromide mixed with 2% chloropicrin, the fumigation operator must do the dosage calculations on the actual methyl bromide content only.

### **2.1.3. Storage & transport of fumigant**

The methyl bromide must be stored/transported in steel cylinders/cans as specified here under. Separate storage place for storing of methyl bromide cylinders/cans and the storage place should be well ventilated and secured. The cylinders should be properly labeled and valves should be securely tightened and well protected with a cylinder cap in place, while transporting. The cartons of methyl bromide should be securely stored/transported away from heavy packages and sharp-edged things so as to prevent causing any damage to the cans.

**Note:** - No transfer of methyl bromide from big cylinders to small cylinders shall be permitted outside the manufacturing plant, except with the written approval of the Plant protection Adviser. All the steel cylinders must be subjected to hydraulic test before each filling of the fumigant at the manufacturing plant.

### **2.1.4. Specification of cylinders/cans**

The steel cylinders used for filling and storage of methyl bromide must be of welded low carbon seamless steel cylinders confirmed to the specification of ISI: 7682-1975 and should be fitted with MB retention valve confirming to the specification of ISI: 3224-1979. If MB cans are used, they should be made up of a good quality steel, which should be adequately painted and lacquered at the joining to prevent any leakage of gas and should be securely sealed and confirm to the packaging and labeling requirements specified under the Insecticide Rules notified under the Insecticides Act, 1968.

**Note:** - The imported steel cylinders used for methyl bromide must require the approval of the Plant Protection Adviser

## **2.2. Fumigation forbidden commodities**

Some commodities are unsuited to methyl bromide treatment. Problems with taint or excessive sorption (causing safety hazards) may occur. The fumigated product may not be suitable for its intended use. If there is any concern that a commodity may be adversely affected by methyl bromide, importers, exporters and fumigators should seek expert advice regarding its effects or conduct tests on that commodity. Methyl bromide is readily adsorbed by oils, fats and finely ground materials. In some cases this may cause tainting, excessive bromide residues and phytotoxicity. The fumigation forbidden commodities are listed in Table-1.

**Table-1: Goods for which problems can occur when fumigated with Methyl Bromide**

<b>1. Foodstuffs</b> a. Butter, lard and fats b. Iodised salt stabilised with sodium hyposulphite c. Full fat soybean flour, whole wheat flour, other high protein flours and baking powders d. Nuts with high oil content e. Certain baking sodas, cattle licks (ie, salt blocks), or other foodstuffs containing reactive sulfur compounds f. Bone meal	<b>2. Leather Goods</b> (Particularly kid or other leather goods tanned with sulfur processes.)
<b>N.B: Never exceed the recommended dosage or exposure periods for food or foodstuff commodities. Prior to repeated fumigation, have the food commodity analyzed for inorganic bromide residues.</b>	<b>3. Woollens</b> (Extreme caution should be used in the fumigation of Angora woollens. Some adverse effects have been noted on woolen socks, sweaters, shawls and yarn.)
	<b>4. Viscose rayon</b> Those rayons processed or manufactured by a process in which carbon bisulfide is used.
<b>6. Paper</b> a. Silver polishing papers. b. Certain writing and other papers cured by sulfide processes. c. Photographic prints and blue-prints stored in quantity d. “Carbonless” carbon paper. e. Blueprint papers	<b>5. Photographic chemicals</b> (Not camera film or X-ray film)
	<b>7. Rubber Goods</b> a. Sponge rubber b. Foam rubber, as in rug padding, pillows, cushions, mattresses, and some car seals c. Rubber stamps and other similar forms of reclaimed rubber
<b>9. Furs</b>	<b>8. Vinyl</b>
<b>11. Rug Padding (Foam rubber, felts etc)</b>	<b>10. Feathers (especially in feather pillows)</b>
<b>13. Horsehair articles</b>	<b>12. Charcoal, cinder blocks and activated carbon</b>
<b>15. Sulfur-based paint</b>	<b>14. Oil artworks</b>
	<b>16. Cellophane</b>

**Note.** Some living plant material (for example fresh fruit and vegetables, seed, bulbs and cut flowers) is fumigated with methyl bromide for quarantine purposes. Fumigation dosage rates specified by Dte of PPQS are designed to minimize damage whilst addressing the quarantine risk.

### **2.3. Fumigation of commodities with impervious packing/shrink wrapping**

Unless specifically exempted by Dte PPQS, the goods covered with or packed in gas impervious materials (such as plastic wrapping or laminated plastic films, lacquered or painted surfaces, aluminium foil, tarred or waxed paper) must have the coverings or

packaging opened, cut or removed, prior to fumigation. This must be sufficient to allow adequate gas penetration into the consignment and subsequent airing.

**Note** -Materials with painted or lacquered surfaces may not be effectively fumigated. Fumigators must make every effort to check the goods for impervious materials prior to fumigation. If the consignment has been checked and found suitable for fumigation the fumigation certificate can be endorsed with the following statement. **“This consignment has been verified free of impervious surfaces/layers that may adversely effect the penetration of the fumigant, prior to fumigation”**

## **2.4. Fumigation of perishable commodities**

Perishable commodities fall into several broad categories. They are live plants, cut flowers, fresh fruit and vegetables and some seeds. The minimum acceptable temperature for fumigation of perishable commodities is 10°C, unless specifically exempted by Dte of PPQS. When temperatures are below 10°C some form of artificial heating must be used. Unless otherwise specified by Dte of PPQS, the fumigation usually of two hours duration, at least 60% of the original fumigant must be retained at the end of the treatment.

### **2.4.1. Nursery stock/bulbs/cut-flowers fumigation**

Dte of PPQS does not accept treatment of nursery stock by offshore treatment providers. It must be treated onshore. Living plants are likely to be damaged if fumigated at temperatures above 30°C.

### **2.4.2. Fresh fruits/vegetables fumigation**

When fumigating fresh fruit and vegetables, the fumigator must use the fruit pulp temperature for dosage calculations, not the minimum ambient temperature as with other treatments. The pulp temperature must be measured and included on the Fumigation Certificate. As a minimum, the fumigator must sample from at least one place in each of the bottom, centre and top of the consignment. Each temperature probe should be placed into the centre of a piece of fruit situated in the center of the carton (where appropriate).

**Note:** - For more information on treatment of nursery stock, cut flowers or seeds contact Dte of PPQS directly or at <http://www.plantquarantineindia.org>. Also contact Dte of PPQS for more information on specific fresh fruit and vegetable commodities.

## **2.5. Timber and timber products fumigation**

Dte of PPQS will only accept fumigation of timber and timber products if:

- individual planks, rounds or articles have at least one physical dimension, which is less than 200mm (8 inches) thick
- the consignment is vertically separated every 200mm (8 inches)

- there is adequate physical distance (at least 50mm) between the timber and both the base and roof of the fumigation enclosure.

**Note:** - There is no requirement for the separators to be a specific horizontal distance apart. However, they must maintain a continuous gap along the length of the timber.

This is because effective methyl bromide concentrations will only penetrate 100mm (4 inches) from the surface into the timber within the fumigation period. It also assists in getting adequate circulation on the fumigant around and throughout the consignment.

**Note:** -The above conditions will not be applicable in the case of logs imported for extraction of veneer /plywood manufacturing.

## **2.6. Performance of fumigation operations with Methyl Bromide**

### **2.6.1. Accredited Fumigation Agency**

When performing a fumigation treatment for quarantine purposes it is the responsibility of the fumigation agency to comply with the relevant legislation or safety codes applicable, while performing the fumigation treatment. Dte PPQS will only consider methyl bromide fumigation valid for quarantine purposes, if performed by a registered fumigation agency with accredited fumigation operators. However fumigation treatments performed by non-accredited fumigation agencies shall be supervised by a specified officer of Dte PPQS, if treatments are carried out for quarantine purposes or required to be endorsed on phytosanitary certificate or where the fumigation certificates required to be endorsed.

### **2.6.2 Selection of site for fumigation**

The fumigation enclosure must be in a well-ventilated and sheltered area. The site must be protected from adverse weather conditions such as high winds and low temperatures. High winds can be a major cause of fumigant loss. The use of ropes or belts may assist in holding fumigation sheets in place, preventing them from flapping loose.

## **2.7. Requirements of fumigation enclosures**

Fumigation treatments for quarantine purposes must be carried out in a tightly sealed enclosure. Where it can be demonstrated by pressure decay test that the containers are gas tight, the use of sheeting is not necessary. Where it cannot be demonstrated that the container is gastight, fumigation sheets must be used. The floor of any fumigation enclosure must be impervious to gas so that it is capable of maintaining the minimum fumigant concentrations for the duration of the treatment. The floor of any site used for sheet fumigation must be:

- flat and free of stones and other sharp objects so that a gastight seal
- can be made between the sheets and the surface
- free of cracks and drains or any other openings that will compromise the gastight nature of the enclosure.

Intact (well sealed and in good condition) concrete and asphalt are generally good floor surfaces for effective fumigation. Surfaces such as soil, sand, base rock and paving are not suitable as a fumigation enclosure floor. To achieve effective fumigation on these surfaces they must be covered by gastight ground sheets. **(See also 2.11.2. Procedure for pressure testing)**

## **2.8. Temperature Relationship to fumigation**

The treatment dosages are based on the anticipated average temperature the enclosure is expected to experience during the fumigation period. This is important as the treatment dosages prescribed in the Plant Quarantine Order, 2003 are based on the ambient temperature (21<sup>0</sup> C or above) the fumigation enclosure will experience during the fumigation period. When fumigations are performed below the ambient temperature, the dosage of fumigant applied should be increased proportionate to the drop in temperature up to 10<sup>0</sup> C, the lowest minimum temperature considered for successful methyl bromide fumigation. When fumigations required to be performed at temperatures below 10°C some form of artificial heating must be used to heat the space of fumigation enclosure. At temperatures below 10°C the fumigant has decreased effectiveness against pests, and increased sorption of the gas will occur. Excessive fumigant uptake can pose an increased safety risk, as the gas is very difficult to remove again from the commodity **(See Section 2.13. Calculation of the dosage of fumigant/CT Products and Section 2.19. Measuring and monitoring fumigant levels)**

For fumigation treatments carried out overnight the fumigator must determine the average minimum ambient temperature expected for the duration of the treatment. This can be done using the estimated temperature for that region supplied by the Department of Meteorology & Weather Forecasting. The fumigation operator should record the temperature information on the Fumigation record **(Appendix-I)**

## **2.9. Specification of Fumigation Chambers**

Chamber fumigation refers to fumigation treatment carried out within a specifically designed chamber. Before performing any chamber fumigation the fumigation operator should::

- visually inspect the door seals of the chamber;
- ensure that no damage is done to the chamber and that there are no objects coming between the chamber and the chamber door, impairing the seal; and,
- perform a pressure test on the chamber to ensure that it is gastight. The pressure decay value from 200-100 Pascals must be at least 10 seconds.

<b>Note:</b> - The pressure decay values for Dte of PPQS standards are for effectiveness only – occupational health and safety issues should be considered separately.
--

### **2.9.1. Specifications of Atmospheric chambers**

This standard provides general guidance on specifications of atmospheric chambers, which include:

- chambers should be constructed of steel or masonry structure, the interiors of which painted with epoxy resin, vinyl plastic, or asphalt base paints;
- The doors of chamber should be hinged from top or side, or on a davit. A chamber door hinged at the top is less apt to sag. Refrigerator type hinges should be used if the door hinged at the side;
- The chamber should be provided with a high quality gasket such as neoprene along the entire perimeter of chamber facing. And the door must be uniformly fastened against the gasket;
- The chamber should be provided with efficient circulating exhausting system. The equipment provided with chamber should be capable of circulating air at the rate of at least one third the volume of chamber per minute (one complete air change per minute). For small chambers, suitable circulating fan will be sufficient to provide necessary air movement. For larger chambers, a circulating or squirrel cage fan, which picks up air /gas mixture from a duct reaching near the floor and blowing it near the top of the chamber will be sufficient.
- The exhaust blowers should be capable of changing the air in 3 min will be sufficient and the exhaust stack should extend well above the structure of building in which chamber is housed.
- The chamber should be fitted with a graduated dispenser to dispense the fumigant. The dispenser should be located in the gas introduction line between the supply cylinder and volatilizer
- the chamber should be provided with suitable fittings to facilitate a pressure leakage test and gas sampling
- The chamber should be provided with a temperature recorder for recording the product temperature at varying intervals

### **2.9.2. Specifications of Vacuum chambers**

- The vacuum chambers should be constructed of welded steel with chamber body reinforced by means steel ribs so as to withstand the difference in pressures, when vacuum is drawn. A rectangular chamber may be preferred for more effective use of space.

- The doors must be either concave or convex in the case of cylindrical chambers and flat with suitable reinforcement in case of rectangular ones. The doors may be hinged at the side, or at the top and counter balanced. The doors should be fitted with durable gasket so as to provide a gas-tight seal.
- The chamber must be designed to provide the loading of commodities on pallets to provide circulation of air/gas mixture
- each chamber should be fitted with a vacuum pump having capacity to reduce the chamber pressure to 1-2 inches (25-51 mm) of mercury (28-29 inch or 711-737 mm vacuum in 15 minutes or less and fitted with vacuum retention valve
- The smaller chamber should be fitted with a graduated dispenser for dispensing the fumigant. For larger chambers the gas supply cylinder will be mounted on a platform type scale and the amount of gas is measured by weight.
- the chamber should be fitted with a volatilizer located between the gas cylinder or dispenser and introduction port of the chamber
- The chambers should be provided with efficient circulation and exhaust system (A minimum of two fans are required for chambers of over 1000 cu ft capacity and the fans should be located at the opposite side
- Chambers should be fitted with a vacuum gauge and vacuum pressure recorder and also fitted with temperature recorder

## **2.10. Fumigation under gas-proof covers (sheets)**

### **2.10.1. Specification of fumigation covers (sheets)**

Prior to every treatment the fumigation operator must visually inspect all the fumigation sheets. The sheets must be free from any defects (for example faulty seams/welds, tears or holes). The sheets shall be made up of low-density polyethylene films, with a minimum thickness of 200 GSM, multi-layered, cross-laminated confirming to ISI 4508-1963 and tested to have a permeability of less than 0.02 g/m<sup>2</sup>/day for methyl bromide. Tears, holes, and abrasions are a major contributing factor in significant gas loss. Thinly coated, widely woven materials are unsuitable as fumigation sheets. Pool liners or annealed polypropylene sheets are unsuitable as they transmit methyl bromide excessively.

### **2.10.2. Placement of fumigation sheets**

The use of floor sheets is essential for sheet fumigation on porous surfaces.

For any sheet fumigation:

- a gastight seal must be made between the sheets and the floor using material such as loose heaped sand or sand or water snakes/flumes;
- corners and areas where ropes, cords or sampling lines emerge from between or under the sheets must be tightly sealed;
- loose sheet on corners of stacks should be secured to prevent blowing out in the wind;
- sheets must be weighed down and sealed to the floor using two rows of sand snakes sealed side by side like brickwork and laid flush against the consignment;
- sheets must be positioned to avoid any sharp corners or objects that might damage them. This may require protection by covering problem areas with a suitable cushioning material;
- sheets must be arranged so that there is at least 500mm of sheet extending beyond the limit of the seal;
- chains and timber are unsuitable for sealing sheets and therefore should not be used

### **2.10.3. Specifications of sand and water snakes**

Sand snakes must be filled only 65% - 75% with sand so that they lie flat on the floor. If water snakes are used, the sheets must be weighed down and sealed using a single, continuous water snake laid flush against the consignment. Particular attention must be given to ensure a complete seal where the ends of the water snake meet.

## **2.11. Fumigation of cargo containers**

All containers must be fumigated under gas proof sheets unless it can be shown that they comply with the specified pressure test standard for gas-tightness. This process must be undertaken every time before any container is fumigated. The gas tightness should be determined using a pressure decay test. This corresponds to a pressure halving (or decay) time from 200-100 Pa of 10 seconds or more. Containers that cannot be pressurised to 250 Pa (the starting pressure for the test) are deemed to have failed the test and must be enclosed under gas proof sheets before being fumigated with methyl bromide.

### **2.11.1. Container selection**

If it is possible to select a container before cargo is loaded into it the selection procedure below should be followed. The containers should be positioned to allow easy access to all four sides and the roof. They should stand on a flat, horizontal surface to avoid twisting (or racking), which may prevent the doors from closing properly.

### 2.11.2. Procedure for pressure testing

The fumigation operator must determine the gas-tightness (pressure decay value) of the enclosure prior to the introduction of any fumigant. The result should be documented on the fumigation record and incorporated into the certificate issued

### 2.11.3. Inspection of container

All containers should be inspected before pressure testing. They should be structurally sound with their sides and roofs free of significant holes, and free of obvious distortion. Containers that are obviously damaged, (for example where large holes and gaps are present in the roof and walls, or where the doors, door seals and locks do not fit and function properly), should not be pressure tested. The container identification number should be recorded on the fumigation certificate. The exterior of the container should be inspected to ensure it is structurally sound and in good condition – with no significant distortion. Its sides and roof must be sound and free of significant holes, tears or gaps. Where rust is present the affected areas should be closely inspected and probed for holes. Containers with holes, gaps or those that are badly rusted are not suitable for pressure testing. The doors must make firm contact with each other, the door frame and floor sill so that their seals function effectively. The rubber seals around the doors should be unbroken, leaving no obvious gaps. Containers with faulty doors and door seals are unsuitable for pressure testing. The interior of the container should be inspected from inside, with the doors closed.

**Note:** -For safety reasons, at least two people should be involved in the inspection – one person must remain outside the container at all times

With the doors closed any gaps or holes should be visible as they will allow light to enter the container. Containers with any holes and gaps are unsuitable for pressure testing. Containers with wet or damaged floors are unsuitable for pressure testing. The floor should be dry, in good condition and have no signs of extensive damage. Make sure the area around each ventilator is dry and free from grease, then completely cover and seal all ventilators to make them gastight. The pressure inside the closed container must be raised to 250 Pa using high-pressure compressed air supplied from a portable compressor or gas cylinders.

### 2.11.4. Measure the pressure halving time

As the pressure inside the container reaches 250 Pa, turn off the compressed air supply. Allow the pressure to decay to 200 Pa. Start measuring the time (in seconds) when it reaches 200 Pa. Stop measuring the time (in seconds) when it reaches 100 Pa. Record the pressure decay time on the fumigation certificate/report.

**Note:** - Containers that give a pressure halving time (from 200 to 100 Pascals) of 10 seconds, or more than 10 seconds, may be fumigated with methyl bromide without enclosing them under gas proof sheets.

Dte of PPQS considers a container with a pressure decay value, of 10 seconds or more than 10 seconds to be gas tight. If the pressure decay value does not meet this minimum

requirement, the fumigator must choose another container (where appropriate) or perform sheet fumigation.

**Note:** - Both container doors must be opened up against the sides of the container when containers are fumigated under gas tight sheets.

#### **2.11.5. Materials and equipment for pressure testing containers**

The most effective way to close ventilators is to completely cover them with plastic sheeting (polyethylene or PVC) attached to the container using masking tape. Ventilators may also be sealed directly with masking tape, or plastic duct tape.

**Note:** - Because plastic tapes stretch when they are unrolled, care should be taken to allow them to contract before attaching them to the container walls otherwise a good seal will not be achieved.

It is important to open all ventilators at the end of the exposure period and always before the container is loaded onto any form of transport (trucks, ships etc).

**See also 2.10 Sheet fumigation and sheet specifications**

#### **2.11.6. Specifications of finger manifold**

A finger manifold should be used for pressurizing the container without drilling holes through the walls of the container. The 'finger manifold' is designed to deliver compressed air into a container, pressurise it and allow the pressure decay to be measured. The manifold has twelve 'fingers', nine of which deliver compressed air into the container while three measure the pressure within it. The 'fingers' are made of soft copper tubing of 3mm outer diameter that can be bent to shape as necessary. In use the manifold is bent to fit over the front of the sill so that it can be sealed between the right hand door and the sill and removed after the pressure test has been completed.

### **2.12. Laying down gas supply/distribution lines and sampling lines**

#### **2.12.1. Laying down gas supply/distribution lines**

Fumigation operators must position fumigant supply lines in a manner that allows for effective introduction and distribution of the methyl bromide into the fumigation enclosure. The fumigant must be introduced into the headspace above the consignment. Using multiple supply lines may assist in dispersing the fumigant for very large consignments under treatment. Where multiple line systems are used the entire system must be balanced in order to achieve even distribution throughout the enclosure. Where the system is balanced it is possible to effectively deliver all of the fumigant through the entire system simultaneously. Each arm of the system must contain fumigation supply lines that are equal in total length and diameter. Where the fumigator cannot balance the system, they must dispense the right amount of fumigant through each supply line in turn until they have applied the total amount

**Note.** - Fumigation operator using methyl bromide formulations containing chloropicrin should be vigilant as some condensation and pooling of chloropicrin may occur.

To prevent leakage from supply lines the fumigation operator must make a gastight seal around every supply line exit point (from the enclosure) and seal the exposed ends after the fumigant has been introduced into the enclosure.

### **2.12.2. Laying down gas sampling lines**

In containers and other small fumigation enclosures the sampling lines should include internal tubes of crushproof nylon (2mm ID) hydraulic hose is effective). For fumigation treatments requiring long supply lines, fumigation operators may use other types of plastic hose. They should take care to ensure that free flow of gas/air mixtures can be maintained. It is important for fumigators to make sure that no kinks or blockages are present in the hosing for this reason.

Where practical and possible there should be at least three sampling lines within the fumigation enclosure; one line in each at the front base (mandatory), at the top back and in the centre of the commodity being fumigated.

**Note:-** For multiple containers being fumigated in one stack, under the same sheets, each container must be treated as a separate enclosure – ie three sampling lines should be used for each container.

Fumigation operator must make the sampling lines identifiable from each other through the use of tags or individually coloured tubes and ensure that sampling line intakes are placed away from of the supply line outlets. Ideally, they will be equidistant from any outlet.

### **2.13. Calculation of dosage/CT Products**

Fumigant dosage rates and the duration requirements of a fumigation treatment will differ according to the nature of the goods being fumigated. Dosage rates will be stated on the import permit issued by the Dte of PPQS relevant to that consignment. The fumigation operator may consult the conversion table (Appendix-III) for converting various factors for calculation of dosage and determination of actual amount of fumigant used. Where the consignments are not covered by the import permit, it is the responsibility of the importer to obtain the correct dosage information from Dte of PPQS. Some of the more common standard dosage rates specified in the Plant Quarantine Order, 2003 are listed in Appendix-IV. The dosage rates expressed, as g/ m<sup>3</sup> is equal to mg/l is equal to oz/1000 ft<sup>3</sup>. The fumigation operator must determine the ambient temperature for dosage calculation based on the daily average minimum and maximum temperatures provided by the Meteorological Department on the day of fumigation and further he should record the temperature in °C.

All the standard dosage rates of fumigation specified in the PQ order 2003 are for 21°C or above. The fumigator must alter the dosage rate by 8g/m<sup>3</sup> for every 5°C drop in temperature between 21°C and 11°C.

For example, the acceptable range would be: 32g/m<sup>3</sup> for 2 hours at 21°C or above (standard dosage) 40g/m<sup>3</sup> for 2 hours at 16°C-20°C 48g/m<sup>3</sup> for 2 hours at 11°C-15°C 56g/m<sup>3</sup> for 2 hours at 10°C. For temperatures above 21°C no dosage compensation is allowed.

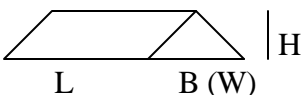
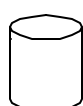
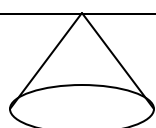

For the purpose of calculation of volume, the total space contained in the fumigation enclosure should be considered and not the actual volume of commodity

The volume of the enclosure in case of cubicle structure could be calculated using the following:

$$\text{Volume} = \text{Height} \times \text{Width} \times \text{Length}$$

Where an **enclosed chamber** is used for fumigation the volume of any gas circulation equipment external to the chamber must also be included in the calculation of the enclosure volume.

The volumes of the fumigation enclosures other than cubicle structure could be calculated using the following:

Type	Geometrical Structure	Formulae
Triangular		$0.5 \times H \times L \times W \text{ (B)}$
Cylindrical		$3.2 \times R^2 \times H$ ( $R = \frac{1}{2} D$ )
Conical structure		$1.6 \times R^2 \times H$
Semi-circular structures (curved roofs)		$1.6 \times R^2 \times H$

## **2.14. Use of safety equipments, emergency aid and safety measures**

In accordance with **The Insecticide Rules, 1971**, the fumigation operator including the workers should always use proper respirator (gas mask) fitted with appropriate canister or cartridge, whenever any fumigation operation is carried out in order to have respiratory protection from such exposure. Before starting any fumigation operation, the fumigation operator & the assisting workers must check the whether the respiratory equipment (gas mask and canister) provided is suitable for the MB fumigation and is of right kind and should have under gone regular training and demonstration regarding correct fitting of face piece, checking for gas tightness of the fitting and regular maintenance, care, repair of gas mask and should record the date and time of use of the canister. The air inlet/outlet openings of the canister should be properly closed, if not in use. The fumigation operator should not attempt any emergency rescue operations without wearing self-contained breathing apparatus (SCBA). At least one additional person trained in the use of respirator (gas mask) in situations, where workers may be overcome by a toxic or oxygen deficient atmosphere.

### **2.14.1. Specifications of gas mask & canister**

Draeger or equivalent full vision face mask, non-aging, chemical resistant with double reflex sealing flaps, five point harness, panoramic replaceable visor, speech diaphragm, self demisting facility, inhalation and exhalation valves having provision for holding corrective glasses and thread connection to EN 148-1. Screw-in, organic type canister (with organic vapours up to a concentration of 5000 ppm for use in surrounding atmospheres with a minimum concentration of 16% oxygen as per IS:8523/1977.

### **2.14.2. Specification of self-contained breathing apparatus**

Full vision face mask, non-aging, chemical resistant with a double reflex sealing flaps, five point harness panoramic replaceable visor with self demisting facility, inhalation and exhalation valve having coupling with high pressure withstanding rubber tube reinforced with nylon threads connected to a compressed air cylinder fitted with pressure guage and regulator valve.

### **2.14.3. Fitness test of face mask**

The wearer of the gas mask must check fitness of the face-piece (mask) each time the respiratory protection used. This can be carried out in the following manner namely:

- **Negative pressure test:** The wearer of gas mask should close the air inlet opening of the face piece or the canister or the cartridge by covering with the palm of hand and inhale gently so that the face-piece collapses slightly and hold his breath for 10 seconds. If the face piece remains in a slightly collapsed condition and no inward leakage of air, the fitting of the respirator (gas mask) is satisfactory.
- **Positive pressure test:** The wearer of gas mask should close the exhalation valve and exhale gently into the face piece. The fitting of face-piece is considered satisfactory, if a slightly positive pressure can be built up inside the face-piece

without any evidence of outward leakage of air along the seal. For most gas masks (respirators), this method of leak testing should require that the wearer must remove the exhalation valve cover and then be sure that the cover is replaced correctly to prevent damaging of rubber valve after the test.

For wearer of corrective eyeglasses, a prescription spectacle kit for respirator is available to overcome this problem. All personnel must use this kit, who has to compulsorily wear corrective eyeglasses, whenever wearing a full vision face-piece.

**Note:** Wearing of contact lenses in contaminated atmospheres with a respirator is prohibited

#### **2.14.4. Maintenance and care of respirators (gas mask & SCBA)**

The fumigation operator must properly maintain the respirators (gas masks, SCBA and other respiration protection devices) to retain its effectiveness. The maintenance program of respirators should include the following basic services:

- Inspection for defects (including leakage checks)
- Cleaning and disinfecting
- Repairs
- Storage in dust free condition
- Prompt replacement of canister or cartridge (on expiry)
- Respirable (fresh) air for SCBA

The user should inspect the respirator (gas mask or SCBA) before and after each use. respiratory equipments such as SCBA, which is not routinely used, but is kept ready for emergency use or standby respirators should be inspected at monthly intervals to ensure their working condition is satisfactory. The air cylinders should be fully charged according to manufacture instructions.

The inspection should include:

- Checking of tightness of connections
- Checking the conditions of facepiece, head bands, valves, connecting tube, any canister or cartridges
- Checking rubber or other elastic parts for pliability and signs of deterioration
- Checking the regulator and the warning device fitted to SCBA to determine proper functioning before each use
- Checking for leaks

**Note:** The Fumigation operator should keep a record of inspection dates and findings and repairs undertaken and changing of canister or cartridges in a record book kept in the unit carrying case and the record shall be subject to auditing by the Plant Quarantine Officer.

The fumigation operator should clean and disinfect routinely used equipment after each use and those such as SCBA that are not routinely used as necessary to ensure that proper

protection is provided for the wearer. The following is the recommended procedure for cleaning and disinfecting respiratory protection devices:

- Removing any filters, cartridges or canisters
- Washing facepiece and breathing tube with a mild cleaner-disinfectant or detergent and brushing to facilitate removal of dirt
- Rinsing completely in clean and luke warm water
- Air-drying in a clean area
- Cleaning other parts as recommended by manufacturer
- Replacing defective valves, head strips and other parts with new parts and stretching to maintain elasticity of rubber parts to keep them pliable and flexible and to prevent them from warping or sticking during storage
- Inserting new filter, cartridge or canister in the unit and making sure the seal is intact

**Note:** The fumigation operator should avoid using strong and disinfecting agents as they can damage parts and also should avoid using hot water above 45<sup>0</sup>C and cautious use of solvents., which affect elastic or rubber parts. All the repairs should be carried out with experienced personnel and reducing or inlet valves and regulators should be sent for repair by a trained technician.

The fumigation operator must store the respirators after inspection, cleaning and necessary repair in clean cabinet to protect against dust, sunlight, heat, extreme cold, excessive moisture and away from fumigants. Respiratory equipments used for emergency operations such as SCBA or standby respirators should be stored in separate compartments. Respirators should not be stored in lockers or toolboxes unless they are in carrying cases or cartons and plainly marked. Respirators should be packed or stored so that the facepiece and exhalation valve will rest in a normal position to prevent functional impairment and SCBA usually mounted inside the carrying case lid as per “use and care” instructions.

#### **2.14.5. Emergency aid**

If exposed to fumigant, the fumigation operator should immediately move well away from the contaminated area and he should immediately notify his co-worker of the danger and that he (operator) has been exposed and inform your supervisor of all the details. It should be noted that onset of symptoms may be delayed in mild exposures

If any liquid fumigant spilled on skin or clothing, he (operator) should immediately remove contaminated clothing and gently wash the skin with large quantities of water and mild soap and no abrasive clothes or brushes should be used and be sure to include areas under fingers and toe nails. Contaminated skin should be rubbed with alcohol or rectified spirit and contaminated clothes should not be reused.

If coworker affected by the chemical intoxication due to exposure immediately move the victim out of the area to fresh air

**Note:** The fumigation operator should not enter contaminated areas without a proper respirator even to effect rescue

If there is any evidence of respiratory weakness, give artificial respiration and oxygen can be beneficial..

**Note:** Artificial Respiration through resuscitation (rescue breathing) takes precedence over all other first aid.

A physician should be called, when symptoms of methyl bromide poisoning persists and suggest immediate care is needed and until such time physician arrives, the patient should be kept warm, comfortable and as quite as possible. If convulsions occur, gentle restraint should be used to prevent injury.

The fumigation operator should familiarize with the following are the signs and symptoms of **Methyl Bromide** poisoning, emergency aid and medical treatment:

- **Signs and symptoms :** Central nervous system depression, nausea, fever, dizziness, confusion, delirium, staggering, visual disturbances, abdominal pain, mania, tremors, pulmonary edema, convulsions, coma. Onset may be delayed 4-12 hrs. On skin, severe irritations, skin blisters and dermatitis. Chloropicrin, which is used as warning gas (mixed with MB (@ 2%) cause laceration.
- **Emergency Aid:** Artificial respiration. Oxygen if available. No mechanical resuscitation. If on skin, wash 15 min with large amounts of water. If on clothing, vapours may be released in toxic quantities
- **Medical Treatment:** Symptomatic-Artificial respiration, oxygen without mechanical resuscitation. Analysis of breath and blood may help in diagnosis and prognosis. Nausea accompanied by vomiting. Give intravenous glucose drip.

#### 2.14. 6. Safety Precautions

Specific precautions to be followed when using methyl bromide fumigant are listed on the label and labeling accompanying the cylinders or cans. However the following general safety procedures must be applied in all cases of fumigation:

- Make sure the fumigation enclosure is air tight
- Wear protective clothing such as plastic apron, plastic gloves and full vision gas mask fitted with organic vapour canister or cartridge
- The area surrounding the fumigation enclosure should be well aerated and the operator should be located upwind direction of the treatment
- If it is necessary to stay in the area of a treatment, the air should be monitored to determine if harmful levels of the fumigant are present
- Under no circumstances should a PQ officer be exposed to concentrations above minimum safe standards
- A self-contained breathing apparatus (SCBA) should always be kept readily available at fumigation site to meet any exigency (Use of SCBA is mandatory, when within.10

metres of sheet (tarpaulin) fumigation or whenever TLV exceeded (5 ppm for methyl bromide).

- A first-aid kit equipped with the proper materials should be readily available at the fumigation site
- Do not eat, drink, smoke in an area where fumigation is carried out
- Should have a regular blood tests and physical examination of personnel attending to fumigation operations by a qualified physician
- Should display danger sign boards at the fumigation area indicating skull with cross bones with the information on 'AREA UNDER FUMIGATION. DO NOT ENTER' get printed.
- Cordon of the fumigation site by fixing a rope or partition boards around to prevent unauthorized persons entering the fumigation site.
- Familiarize with signs and symptoms of methyl bromide poisoning, emergency aid and medical treatment
- Should have emergency telephone numbers of local hospitals, doctors, police etc., prominently displayed
- Should always undertake fumigation operations by the approved fumigation operator at least in the presence of experienced and trained co-worker. Supervisors should avoid undertaking fumigation work by fatigue workers as they prone for risk of accidents.

## **2.15. Application of correct quantities of fumigant**

When Methyl Bromide gas is applied from a cylinder, a graduated dispenser should be used to measure correct volume of liquid or alternatively the cylinder is mounted on a platform scale for measuring the gas by weight.

## **2.16. Application of methyl bromide in gaseous state**

Whenever any fumigation is performed, a vaporizer or volatilizer should be used to ensure application of methyl bromide in gaseous state and even in warm or hot climates fumigators cannot rely on ambient temperatures to adequately vaporize liquid methyl bromide during the gassing process. Liquid methyl bromide has the potential to taint and damage certain products, such as seeds (loss of viability), aluminium (breakdown), foodstuff and other products (accumulation of residues). It may also alter the processing quality of some products and in some cases react with materials present in the enclosure. The use of a vaporizer when introducing methyl bromide into the fumigation enclosure will ensure that the fumigant enters as a gas and is well distributed throughout the enclosure. Complete fumigant vaporization ensures more effective distribution and penetration of the fumigant and reduces the possibility of product injury and pest survival.

### **2.16.1. Specifications of Vapourizer**

A vapourizer consists of a inner stainless cylindrical vessel with a diameter of 270 mm and a height of 340 mm with a stainless steel cowling (outer jacket)) up to 250 mm made out of stainless steel sheet of 1.6 mm thickness. The cowling extend up to a minimum of 100 mm

at the bottom with air inlets for housing the burner. The cowling is needed to direct the heat produced by the burner up and around the sides of the water container and protect the flame against gushing wind. A 12 metres length of copper pipe with outer diameter of 12 mm should be used as heat exchanger. The pipe should be twisted into a double coil for this purpose and whole coil provide a heat transfer surface of about 0.1 m<sup>2</sup> for each kilogram of fumigant to be vapourized per minute. The heat exchanger should be fitted into inner vessel with the help of brass and copper fittings such that one end of the pipe can be connected to the MB cylinder and the other end is connected to gas distribution line to deliver hot gas into the fumigation enclosure. A three-ring gas burner with adjustable knobs should be used for heating. A suitable dial type thermometer should be fitted to the inner container to measure the temperature of water. The edges of the inner container top should be folded inside and also the cowling (outer jacket to avoid injury. A suitable lid for closing the container to prevent escape of heat and handle should be provided to facilitate carrying the container.

### **2.17. Distribution of gas within fumigation enclosure**

An effective methyl bromide fumigation treatment requires a suitable system for distributing the fumigant within the fumigation enclosure. Where practical some form of forced distribution, such a fan, must be used to ensure adequate and rapid distribution of fumigant throughout the enclosure. Fumigation operators can determine, if the methyl bromide has been effectively distributed by monitoring gas concentrations at all monitoring points at set times after the introduction of the gas. If concentration levels cannot be achieved within 15% limit of readings, the fumigation should be discontinued and the gas exhausted and the consignment should be re-fumigated after ensuring that the mixing device (fan) is working. For methyl bromide fumigation in small enclosures (such as shipping containers) at least one axial fan with a minimum of 70m<sup>3</sup>/min (2500 CFM) should be used. For fumigation of larger enclosures, at least two axial fans should be used. They should be run for 15 minutes after the introduction of the methyl bromide (See also 5 Measuring and monitoring fumigant levels). When two fans are used, one should be placed on the floor facing the centre of the consignment. Under ideal conditions the other fan should be placed at the top of the opposite end, facing the consignment. Additional fans should be used for consignments longer than 10m.

**Note:** - For fumigation of multiple containers under the same sheets each container requires its own fans to effectively distribute the fumigant.

Where high velocity and high volume fans are used they must not run for longer than for 15 minutes after the introduction of the gas. This is because they may force the fumigant out of the chamber.

### **2.18. Gas monitoring equipment/leak detector/detector tubes**

There is a variety of equipment available for measuring methyl bromide concentrations. The equipment used should be suitable for the monitoring of fumigant concentrations and leaks.

### 2.18.1. Specifications and use of gas monitoring equipment

A Riken Gas Indicator or a thermal conductivity meter (Fumiscopes or Gow-Mac) or any other standard gas monitoring equipment should be used to measure methyl bromide concentrations within the fumigation enclosure. The monitoring equipment should be capable of measuring methyl bromide concentrations within the fumigation enclosure should have a measuring range between 0-200 mg/l. or g/m<sup>3</sup>.

An annual calibration of monitoring equipment is a must to ensure effective operation and trouble free service. It is particularly important to maintain the CO<sub>2</sub> and moisture absorbers fitted to the instruments (if applicable). Monitoring equipment must be maintained and calibrated according to the manufacturer's specifications. The approved fumigation operator should ensure proper use of the monitoring equipment in all cases of fumigation and record the gas concentrations as per the requirements of this standard as specified in Section 2.19.

### 2.18.2. Specifications and use of gas leak detector

A portable Riken gas leak checker or equivalent with a detection range from 0-200 ppm should be used. The standard equipment is fitted with a Red LED illuminated lever meter and buzzer sound; high sensitive and long life semi-conductor sensor; and battery operated with airflow rate of 300 ml/min.

Alternatively halide gas detector should be used to indicate the presence and approximate concentration of methyl bromide gas. Each consists of a fuel tank, a valve assembly to regulate fuel flow, a burner head assembly where the fuel and the air mixture unite and the copper plate or cone assembly, where the visible flame reacts in colour to the halogen fumigants. The air mixture to be tested is fed to the burner assembly by an attached search hose. The colour and intensity imparted to the flame indicates the presence of halide gas and approximate gas concentration of methyl bromide:

**Approximate concentration of Methyl Bromide associated with Flame colour**

Approximate gas concentration (ppm)*	gm/m <sup>3</sup>	Flame colour
0	0.0.	No colour change**
25	0.1	Faint fringe green
50	0.2	Moderate green
125	0.5	Green
250	1.0	Strong green
500	2.0	Strong green with blue fringe
800	3.2	Strong blue green
1000	4.0	Blue

\* Thresh hold limit value for MB for exposure for 8 hours is 5 ppm;

\*\* Propane gas burns with a light blue flame, when MB is not present.

The burner head orifice is extremely small and therefore must be kept free from clogging with dust or other debris and also the reaction plate or cone needs replacement, when it becomes heavily corroded or burned. Since the operating halide leak detector contains an open flame, the fumigation operator must strictly adhere to the safety principles. Further the operator should be familiar with flame colours produced for various concentrations of Methyl bromide.

## **2.19. Measuring and monitoring gas concentrations**

### **2.19.1. Options for ensuring maintenance of correct fumigant concentrations**

<b>Fumigation duration</b>	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>
Less than 12 hrs	Pressure testing and correct dosage application	Initial and endpoint monitoring - with top-up option at the end;	
Greater than 12 hrs	Pressure testing and correct dosage application	Initial and endpoint monitoring - with top-up option at the end	Continuous monitoring with top-up options

### **2.19.2. Option 1 - Pressure testing and correct dosage application**

No monitoring is required after the fumigation has begun, provided:

- the fumigator performs a pressure test on the enclosure;
- the pressure decay value is within the limit specified in this standard; and,
- the correct amount of fumigant is introduced into the chamber.

**Note:** - All of these details must be recorded and included on the Fumigation Certificate.

See also 2.11, Procedure for pressure testing

### **2.19.3. Option 2 – Initial and endpoint monitoring with top-up option at the end**

The person monitoring the treatment must measure the methyl bromide concentrations within the fumigation enclosure at two specific times during the fumigation period. See table 3 below.

**Table 3: Monitoring times**

<b>Treatment length</b>	<b>Initial monitoring time</b>	<b>Final monitoring time</b>
Up to 6 hours	20-30 minutes after start	End of treatment
Greater than 6 hours	30-60 minutes after start	End of treatment

**Note:** - In the case of fumigation treatments of 48 hours duration, an additional measurement must be taken 24 hours into the treatment. This allows for the implementation of remedial action if required.

Measurements from all sampling lines should be within 15% of each other at the set initial monitoring times. Where this is not reached at the initial monitoring time, the period must be extended or other action taken to resolve the problem.

#### **2.19.4. Problems with methyl bromide concentrations and sampling lines**

If measurements from the sampling lines are not within 15% of each other at the set initial monitoring time there may be a problem with:

- inadequate fumigant distribution throughout the enclosure
- blockages in the sampling lines;
- other sampling problems;
- monitoring equipment;
- gas-tightness;
- fumigation sheets;
- enclosure seals; and,
- adequate circulation (fans etc).

If the fumigator can determine the cause and subsequently rectify it without compromising the fumigation enclosure, the fumigation can continue as normal. If a top-up is required it must be performed as per Option 3. Fumigators should keep a record of the problem and solution. Where the fumigator cannot readily identify the cause (particularly in smaller fumigation enclosures, such as containers) they should stop treatment and vent the fumigant from the enclosure (**See also 2.17, Distributing fumigant within the enclosure**).

Once the area is safe (free of fumigant levels hazardous to humans) the fumigator should inspect the consignment and enclosure for possible causes. If the cause can be identified and rectified, the fumigator and client should discuss their options for re-treatment.

#### **2.19.5. Minimum fumigant concentrations for initial and endpoint monitoring**

Unless otherwise prescribed by Dte of PPQS, the percentage concentration of methyl bromide in the enclosure at the end of the treatment must fall within the values in table 4 below.

**Table 4: Standard concentrations required at specific monitoring times.**

<b>Monitoring times</b>	<b>Concentration of the original fumigant required</b>
0.5 hours	75% or more
2 hours	60% or more

4 hours	50% or more
12 hours	35% or more
24 hours	30% or more
48 hours	25% or more

The information in Table 4 could also be expressed in g/m<sup>3</sup> for the range on quarantine fumigation dosage rates given in Methyl Bromide Fumigation Ready Reckoner (Appendix-V). The Methyl Bromide Fumigation Ready Reckoner provides a list of standard specifications, the maximum methyl bromide top-up concentration and the minimum acceptable concentration of methyl bromide below which the fumigation will not be effective for different fumigation initial dosages at appropriate monitoring times. The **Chart-1** appended to this standard depicts the theoretical progress of methyl bromide treatment of initial dosage of 48 g/m<sup>3</sup> during a well-sealed sheeted fumigation. Also the graph clearly depicts upper boundary and lower limit around the standard specification line, outside of which the fumigation will not be acceptable. The upper boundary corresponds to the Maximum top up line (value 'A' on the *Methyl Bromide Fumigation Ready Reckoner*) and the lower limit is the minimum concentration limit (value 'C' on the *Methyl Bromide Fumigation Ready Reckoner*) and the mid Standard line (value 'B' on *Methyl Bromide Fumigation Ready Reckoner*).

**Note:** - Table 4 shows only standard retention rates - some retention rates may differ for specific commodities. If you have any doubts about the commodity you are treating contact Dte of PPQS directly. The fumigation operator must record all monitored concentrations on the fumigation certificate.

#### 2.19.6. Final monitoring above the standard line

If the concentration of fumigant remaining at the final reading is on or above the standard, Dte of PPQS will consider the fumigation to have been completed successfully. For example, for fumigation with an initial dosage of 48g/m<sup>3</sup> and for 24 hours duration the minimum concentration required at the end of the 24 hours would be 14.4g/m<sup>3</sup> (see **chart 2**).

#### 2.19.7. Final monitoring between the standard and the lower limit

If the final reading falls between the standard and the lower limit the fumigator has the option of topping up the fumigant level. The fumigant can only be topped up to the corresponding value on the top-up limit line and no more. The fumigation period must also be extended for further 4 hours duration.

**Note:** - For fumigations less than 12 hours in duration top-up is not an option.

For example, say a final reading of 13g/m<sup>3</sup>, in a 24-hour treatment with an initial dosage of 48 g/m<sup>3</sup>, which is between the standard line and lower limit line top-up should be performed (see **chart 3**).

**Note:** - The lower limit and the top-up limit are 5g/m<sup>3</sup> below and above the standard line respectively.

For initial dosages above 60g/m<sup>3</sup> they are 8g/m<sup>3</sup> above and below the standard line respectively. The amount of fumigant the fumigator can add is the difference between the highest top-up limit and the reading below the standard .multiplied by volume of enclosure.

For example, at 24 hrs of the treatment the concentration is 13 g/m<sup>3</sup> and the standard concentration required is 14.4g/m<sup>3</sup>. The maximum top-up point is 19.4g/m<sup>3</sup>.

The amount of fumigant for the top-up would be 6.4g/m<sup>3</sup> in total (ie 19.4 – 13 = 6.4) (see chart 3)

#### **2.19.8. Final monitoring below the lower limit line**

If the final reading is below the lower limit (ie more than 5g/m<sup>3</sup> below the standard line or for fumigations with dosage rates greater than 60g/m<sup>3</sup>, 8g/m<sup>3</sup>) the fumigation is considered to have failed. The fumigator should vent off all of the remaining fumigant. Once they can ensure the area is free from hazardous levels of fumigant they can then inspect the fumigation enclosure for the possible cause. When the cause is rectified the fumigator may then re-fumigate the consignment (if appropriate) at the required concentration in accordance with this standard.

#### **2.19.9. Option 3 – Continuous monitoring with top-up options**

Fumigators must measure the fumigant concentrations at intervals during the treatment. monitoring at the set times as for option 2 must still be done.

However, fumigators may elect to monitor at intervals not greater than 6 hours apart throughout the fumigation if they suspect that the relevant final concentration will not be achieved. For example, where large fumigation enclosures are being used and some leakage is expected, or under circumstances where there are highly sorptive commodities, it may be necessary to add additional fumigant to ensure the desired treatment concentrations can be maintained. Dte of PPQS will only allow for one top-up during any given fumigation treatment.

Where fumigant level checks indicate that the fumigant concentration has dropped or is likely to drop below the standard and provided it is still above the lower limit the fumigation operator can top-up the fumigant. The fumigation operator should first inspect the fumigation enclosure for possible causes of fumigant loss. After they have identified and rectified the problem they can then top-up the fumigant level. Top-ups must be performed the same way as for option 2.

For example, if the concentration at 12 hrs after start of treatment is 14g/m<sup>3</sup> and the standard required is 16.8g/m<sup>3</sup> then the maximum amount the fumigator could add would be 2.8g/m<sup>3</sup> (the difference) + 5 = 7.8g/m<sup>3</sup>. Therefore top up of fumigation at 12 hrs start of treatment will be at 7.8g/m<sup>3</sup> (see chart 4).

## **2.20. Degassing/aeration of commodity/container**

On completion of any fumigation treatment the fumigator must vent the fumigant from the fumigation enclosure to below 5ppm v/v (the current Threshold Limit Value (TLV) for methyl bromide). They can do this through either natural airing or forced ventilation. Before anyone is allowed access to the fumigation enclosure the fumigator has the responsibility to take precautions to ensure that the area is free from hazardous levels of fumigant. Inadequately aerated goods threaten the health of workers involved in their unpacking and inspection. Where there is no documentation showing that an enclosure or container has been vented, handlers should treat it as still 'under gas' until an approved fumigation operator has cleared it as safe.

## **2.21. Issue of fumigation certificate and release of commodity**

At the end of successful fumigation, the approved fumigation operator should issue a fumigation certificate in the prescribed format (Appendix-VI) in conformation with this standard

## **2.22. Fumigation of ship holds**

Fumigation of ship holds all together a different kind of problems unlike the other type of fumigations, since a large quantity of gas is required to be released into the ship holds and further the space configuration will vary from ship to ship. Therefore it is essential that the fumigation operation should be performed by approved fumigation operator under the strict supervision of plant quarantine officer, who have considerable experience in undertaking ship fumigation. The safety issue is of prime concern, while undertaking ship fumigation both at the time of gassing as well as at the time of aeration of ship holds.

### **2.22.1. Safety aspects of ship fumigation**

The most important safety aspects of ship fumigation is the protection of ship's crew. The approved fumigation operator has the following safety responsibilities when undertaking fumigation of ships/vessels:

- observe all safety precautions, while fumigating/degassing of ship;
- prevent access of unauthorized personnel including the ship's crew to the fumigated area
- carry out fumigation in accordance with provisions of this standard to ensure effective treatment;
- evacuate the gas completely from ship holds and aerate the ship, when fumigation period is completed; and
- ensure freedom from methyl bromide gas from all the areas of the ship by testing with the help of gas detector before allowing crew members access to the ship.

The approved fumigation operator must abide by the following guidelines when fumigating the ship/vessel:

- have an approved and experienced technical expert present on board throughout the entire fumigation. He should be familiar with the directions regarding the use of fumigant, warnings, antidotes etc., shown on the label affixed on the gas cylinder;
- have adequate safety equipments such as gas masks fitted with appropriate canisters, self air breathing units and first aid equipment available on board;
- have all the areas of the ship tested with gas detector for the presence of methyl bromide prior to allow the crew re-entry and in particular the fumigated areas, crew cabins and engine rooms; and
- have contact with the responsible ship's officer to seek information and access to areas of the ship, which may be needed to ensure a safe and effective fumigation.

#### **2.22.2. Selection of ship**

The following criteria should be taken into account, while selecting the ship for undertaking fumigation:

- have a steel bottom with bilges that can be rendered gas-tight
- have preferably fitted with artificial ventilators or forced air injection and air re-circulation system;
- have phantom (hatch) covers that are provided with gaskets to render sufficiently gas-tight, when closed; and
- preferably have cargo holds with no common connectivity with ship's crew cabins and engine room

#### **2.22.3. Prior notification of shipping Agent/Captain**

When planning ship fumigation, the plant quarantine officer should organize meeting with the ship's captain, agent and the approved fumigation operator to discuss about the details of fumigation; cargo required to be fumigated, if present; determine if any materials might be adversely affected by the methyl bromide fumigant. The plant quarantine officer should notify the ship's agent of possible effects and if conditions permit, allow removal of the material from the concerned hold for alternative treatment. Also discuss plans for evacuating all crew from the ship.

It shall be the responsibility of approved fumigation operator to comply with all State, local and the Indian Maritime regulations. Under no circumstances the ship shall be allowed to leave the port unless all the areas tested by a gas detector and declared to be gas-free.

#### **2.22.4. Inspection of ship holds**

The plant quarantine officer should inspect the ship holds in association with the approved fumigation operator and the responsible ship's officer to determine the type of pest infestation and the commodity present for selecting appropriate treatment schedule. The fumigation operator should prepare a plan of fumigation and get it approved by the plant quarantine officer. The plan of fumigation should include hatch diagram indicating the position of fans, distribution of gas introduction lines and sampling tubes. During the

inspection of ship holds, the fumigation operator should identify the possible areas requiring sealing to make the holds gas tight. .

#### **2.22.5. Preparing areas for fumigation**

Prior to undertaking ship fumigation, the approved fumigation operator, should open all storage bins in ship's store and have the hatch covers between decks (applicable in case of the twin decks) opened in such a manner as to permit adequate distribution and circulation of gas.

#### **2.22.6. Arrangements for operation of fans**

The fumigation operator should ensure to make arrangements for positioning of fans for circulation of gas (Store rooms normally require a minimum of two, 1800 cfm fans one positioned at low level and other at high level. For cargo holds fans capable of 2500 cfm should be used and the total number of fans required will depend upon the total volume of the ship hold in ft<sup>3</sup>). The fumigation operator should make sure that the fans could be turned on and off from area outside the fumigation site and test all fans to ensure that they are in good working condition. The fans should be operated during gas introduction and 30 min after introduction to ensure proper distribution of gas.

#### **2.22.7. Placing of gas introduction lines/sampling tubes**

A minimum of two gas sampling tubes in open space and at least one should be placed within the commodity considered to be most difficult to penetrate in case of ship's store room. Within cargo holds a minimum of two leads for each level of empty hold space (the average size of hold of three levels is approximately 1,25, 000 ft<sup>3</sup> and one additional lead should be used for every 50, 000 ft<sup>3</sup> above 1,25, 000 ft<sup>3</sup>). If cargo present in the hold, two additional gas sampling tubes should be placed in the commodity at each hold level. All the gas sampling lines should be appropriately labeled so that the same can be readily identified, while undertaking gas concentration readings.

At least one gas introduction line should be securely placed near the top of fan and the end of the line should be loosely wrapped with a gunny piece to avoid any liquid directly coming in contact with the commodity.

Both gas sampling tubes and introduction lines should be introduced through a small opening of a window or door in respect of store rooms or a man hole in case of ship holds and terminate on the deck.

#### **2.22.8. Sealing of stores/cargo holds**

One of the most important steps in preparing for ship fumigation is the effective sealing all openings and areas, which have the potential for leakage of gas. The primary task of the fumigation operator is to locate all openings (e.g., drain pipes, bilges, air ducts, CO<sup>2</sup> piping etc.). For sealing small spaces, adhesive tapes, should be used. The door and window frames of ship store room, polyethylene sheets of sufficient thickness should be used and the sheets

secured with the help of adhesive tape. The air ventilation ducts, manhole openings and gaps between hatch covers (phantoms) should be sealed externally to facilitate their removal at the time of degassing. It is necessary that the fumigation should ensure proper placement of gas introduction/sampling lines and positioning of fans before the final sealing of manholes.

The fumigation operator should look for and seal off the following ship areas:

- wall plates
- air vents
- bilge drains
- pipe lines & other conduits through decks and bulk heads
- dumb waiter openings
- heating or air-conditioning system and ventilation systems common to or with cargo holds, engine room, crew cabins, stores and other common areas
- engine room - recirculation system controlled from and common with engine room areas
- electric pipelines or other ducting common to cargo holds
- passage ways/galley ways
- speaker openings/smoke detectors
- emergency escape hatches from shaft alley and cargo holds

#### **2.22.9. Introduction of gas into ship holds**

Prior to introduction of the gas, the fumigation operator must ensure to make final check of the following:

- check all sealed areas to ensure they are securely taped and free from any holes
- check the gas introduction line connections are properly secured and tight and all gas sampling lines are properly labeled to indicate the position of lead
- check to ensure all the safety/first aid equipments available and antidotes are stocked in sufficient quantities and in working condition
- check the working condition of fans and electrical connectivity
- check the working condition of gas monitoring equipment and calibration
- switch-on the volatilizer and heat water up to 200°F (93.3°C) or above
- place the gas cylinder, connected to gas introduction line through a volatilizer, on platform scale and take initial reading of the weight of cylinder.

The fumigation operator must ensure correct quantity of gas is introduced into the holds through a volatilizer. The correct quantities of gas should be computed based on the actual volume of the hatch or grain cube (m<sup>3</sup>) multiplied by dosage rate expressed (g/m<sup>3</sup>). At the beginning of fumigation, the operator should slightly open the valve and then quickly close the valve and check with the help of gas detector all connections on the gas introduction line for leaks. If any leaks are noticed, the fumigation operator should tighten the connections and repeat the test. After ensuring no leaks, the fumigation operator should open the valve turn it to a position to apply gas at the rate of 1.5 to 2 kg of gas per minute. After completion of introduction of required quantity of gas the fumigation operator should ensure to remove and

seal the end of gas introduction line with adhesive tape and also the gas sampling lines. The fumigation operator should test for gas leaks around the perimeter of the fumigated area especially the door and window frames, pipes, hatch cover joining, air duct sealing, sealed man holes. The fumigation operator should display danger signboards at the fumigation area indicating skull with cross bones with the information on 'AREA UNDER FUMIGATION. DO NOT ENTER' got .printed.

**Note:** The fumigation operator must wear the self-contained air breathing apparatus (SCBA), while introducing the gas, checking for gas leaks and at the time of aeration of holds.

#### **2.22.10. Monitoring gas concentrations in ship holds**

Depending upon the exposure period, the gas concentration readings should be taken with the help of gas monitoring equipment (such as Riken Gas Monitor, Model 18) or Fumiscope (T/C Unit) or detector tubes at the following specified periods viz, 30 min, 2hrs, 4 hrs, 6 hrs, 12 hrs, 24 hrs, 48 hrs and 72 hrs. The fumigation operator may have the option to add gas at the following rates and extend exposure period, should the concentration readings fall below the minimum viz., 1.6 X number of gms below minimum X volume (m<sup>3</sup>) as per the table listed below:

#### **Determination of Time for adding up the gas and extended exposure periods**

<b>Exposure time</b>	<b>Readings below the minimum by</b>	<b>Extended period of time</b>
Less than 12 hrs	10 gm/ m <sup>3</sup> or less	10 percent of time lapse since the last reading
	11 gm/ m <sup>3</sup> or more	30 min
12 hrs or more	10 gm/ m <sup>3</sup> or less	10 percent of time lapse since the last reading
	11 gm/ m <sup>3</sup> or more	2 hrs or 10 percent of time lapse since the last reading, which ever greater

#### **2.22.11. Aeration of ship holds**

Aeration of ship holds should be carried out in a phased manner. At the beginning all the external sealings of man holes, door/window frames, air ducts should be removed. External blowers connected with portable canvas, plastic or similar ducts should be used for exhausting gas from ship holds. Alternatively compressed air from forced air injection system of ship should be used to evacuate the gas from ship holds and suction type fans with portable ducts should be used to evacuate gas from store room to outside the crew cabin. However the fumigation operator should make sure the forced air injection system will not aid in distribution of exhausted gas to other areas of ship. During the first 10 to 15 min, there should be no people within 20 meters of the exhaust duct out let and while securing the exhaust duct outlet area, the direction of the wind should be considered. The fumigation

operator should ensure to use a physical barrier such as barricades to secure the area from people entering

**2.22.12. Issue of gas-free test certificate.**

After ensuring complete aeration of ship holds and testing for complete gas-freeness of the holds, the specified officer of Dte of PPQS should issue gas-free test certificate .before the ship given clearance.

### Appendix-I

Fumigation Record								
Fumigation Company/Branch						Regd. Number:		
						Date:		
Description of Goods fumigated								
Commodity	Quantity	No of packages	Mode of Packing	Shipping marks	Container Number (s)	Place of Fumigation		
Shipment Particulars								
Vessel Name	Port of loading	Country of Export	Foreign port of shipment	Name of the Exporter		Name of the Importer		
Details of Fumigation Treatment								
Fumigant	Dosage (g/m <sup>3</sup> )	Date/Time of Starting Fumigation	Date/Time of Ending Fumigation	Temp in °C	Quantity Of fumigant	Volume/Type of Fumigation enclosure		
If Containers are not sheeted, the pressure decay (gas-tightness) value for 200-100 Pascal's (in. seconds).								
Record of Monitoring gas concentration				Gas Monitor type Used:				
Date/Time	Time Interval	Readings of Sampling lines						Monitored by
		S1	S2	S3	S4	S5	S6	
	0.5 hr							
	1.0 hr							
	2.0 hrs							
	4.0 hrs							
	12.0 hrs							
	24.0 hrs							
	48.0 hrs							
Particulars of top up of fumigation, if any undertaken								
Name & Signature of accredited Fumigation Operator with date/Accreditation Number								
Supervised by Specified Officer of Dte PPQS (Applicable in case of non-accredited agency)								

## Appendix-II

### Check Sheet of Fumigation

Use this check sheet along with fumigation record to identify procedures and actions before during and after each fumigation.

Item of Activity	Details of check	Status
<b>Inspection of Fumigation site</b>	Intact floor without cracks or drains	
	Floor not undulated, no pebbles or stones	
	Located in a safe working area	
	Well ventilated	
	Sheltered area, rain and wind protected as far as possible	
<b>Preparation of Commodity</b>	Stacked to allow good circulation leaving enough space around (2 m)	
	Impervious wrapping removed or slashed	
	Commodity not impervious to fumigant	
	Not forbidden commodity	
<b>Preparation and installation of equipment</b>	Vaporizer filled with water and heating	
	Sheets of correct size & specification	
	Gas distribution line installed	
	Gas sampling tubes installed (minimum of 3 per enclosure & 1 per container)	
	Fan installed and working checked (one in each container and 2 per enclosure)	
	Cover the enclosure with sheet and make gas-tight sealing at the ground with two rows of sand snakes	
	Measure enclosure volume and calculate dosage	
	Establish and mark out hazardous area and place dangerous signs	
<b>Preparation to gas enclosure</b>	Ensure risk area and surrounds free of unprotected personnel ( up to 3 m)	
	Turn on fans	
	Test leak checker for working	
	Wear and test the respirator for correct fitness	
	Position gas cylinder on scale and connect to inlet of vaporizer and the outlet to gas distribution line	
	Release small quantity of gas and test fittings for gas leak and correct if necessary	
<b>Application of gas to enclosure</b>	Check vaporizer water boiling	
	Release required quantity of gas from the cylinder or dispenser	
	Check for hot gassing	
	Check for gas leakages around enclosure and correct leakages if any	
<b>Initial monitoring</b>	Turn off fan after 30 min	
	Measure gas levels on all monitor lines	
	Check to ensure all readings are above standard	
	Calculate if equilibrium achieved	
	Turn-on fans, if necessary-repeat until equilibrium achieved	
	Ensure levels still above standard-record and document	
<b>End point monitoring</b>	Measure gas levels on all monitor lines	
	Check to ensure all levels above standard	
	Carry out "top-up" procedures, if appropriate	
	Declare fumigation successful or failed, as appropriate-document	
<b>De-gassing</b>	Ensure risk area and surrounds free of unprotected personnel ( up to 3 m)	
	Turn-on fans	
	Wear gas mask and test for fitness	
	Open enclosure and allow ventilation	
	Test for Threshold limit value (TLV)-Continue aeration until gas level below TLV	
	Remove warning signs and risk area demarcation	
<b>Documentation</b>	Complete all documentation and release fumigated goods after ensuring gas-free	

## Appendix-III: Conversion tables

### Temperature

$$\text{Fahrenheit} = \frac{9C}{5} + 32$$

$$\text{Celsius} = \frac{5(F-32)}{9}$$

### Distance Conversion

10 millimetres (mm) = 1 centimetre 12 inches = 1 foot

100 centimetres (cm) = 1 metre 3 feet = 1 yard

1 inch = 2.54 centimetres

1 centimetre = .3937 inches

### Volume Conversion

1 cubic foot = .02832 cubic metres (m<sup>3</sup>)

1 cubic metre (m<sup>3</sup>) = 35.31467 cubic feet

### Mass Conversion

1000 grams (g) = 1 kilogram (kg) 16 ounces = 1 pound

1 pound = .453592 kilograms

1 kilogram = 2.204622 pounds

### Dosage Conversion

$$16 \text{ g/m}^3 = 1 \text{ lb/1000 ft}^3$$

$$1 \text{ g/m}^3 = 1 \text{ mg/l} = 1 \text{ oz/1000 ft}^3$$

**Appendix-IV: Quarantine treatment schedules as prescribed under the PQ Order, 2003 and amendments issued there under.**

S. No.	Commodity	Pest against directed	Schedule of treatment	Remarks
<b>Non-perishable commodities</b>				
1.	Beetle nuts ( <i>Areca catechu</i> )-for consumption)	Internal feeders	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
2.	Barley ( <i>Hordeum vulgare</i> ) -grain for consumption	Granary weevil ( <i>Sitophilus granaries</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
3	Beans ( <i>Phaseolus</i> spp) -grain for consumption	Bean bruchid ( <i>Acanthoscelides obtectus</i> ) & other internal feeders	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
4.	Broad bean & Vetches ( <i>Vicia</i> spp.)- grain for consumption	Stem & bulb nematode ( <i>Ditylenchus dipsaci</i> ); soy bean cyst nematode ( <i>Heterodera glycinea</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
5.	Cocoa ( <i>Theobroma cacao</i> )-dried beans for industrial processing	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> ); Tropical nut borer ( <i>Hypothenemus obscurus</i> )	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
6.	Chick pea ( <i>Cicer arietinum</i> )-grain for consumption	Internal feeders	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
7	Coffee ( <i>Coffea</i> spp) beans for consumption	Coffee berry borer ( <i>Hypothenemus hampei</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
8.	Cotton ( <i>Gossypium</i> spp.) bales for industrial processing	Cotton boll weevil ( <i>Anthonomus grandis</i> )	MB @ 24 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
9.	Cowpea ( <i>Vigna</i> spp.)	Bruchids	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
10.	Coriander ( <i>Coriandrum sativum</i> ) – grains for consumption	External infestation (general)	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
11.	Dates ( <i>Phoenix dactylifera</i> )-dry fruits with for consumption	Internal seed borers	MB @ 16 g/m <sup>3</sup> for 12 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
12.	Figs –dry fruits for consumption	External infestation (general)	MB @ 16 g/m <sup>3</sup> for 12 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
13.	Garlic bulbs	Internal feeders	MB @ 32 g/m <sup>3</sup> for 2 ½ hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
14.	Ginger (Fresh rhizomes)	Internal feeders	MB @ 32 g/m <sup>3</sup> for 2 ½ hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
15.	Hops ( <i>Humulus</i> spp)-dried flower cones for industrial processing	Hop cyst nematode ( <i>Heterodera humuli</i> )	MB @ 16 g/m <sup>3</sup> for 12 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
16	Lentil ( <i>Lens culinaris</i> ) –grains for	Stem & bulb nematode ( <i>Ditylenchus dipsaci</i> ); soy bean	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or	Off-shore treatment

	consumption	cyst nematode ( <i>Heterodera glycinea</i> ) & bruchids	above under NAP or equivalent	
17.	Maize ( <i>Zea mays</i> )-grain for consumption	Weevil ( <i>Sitophilus zeamais</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
18.	Oats ( <i>Avena sativa</i> )-grain for consumption	Grain dermistid ( <i>Togoderma variable</i> )	MB @ 80 g/m <sup>3</sup> for 48 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
19	Peas ( <i>Pisum sativum</i> )-grain for consumption	Stem & bulb nematode ( <i>Ditylenchus dipsaci</i> ); soy bean cyst nematode ( <i>Heterodera glycinea</i> ); bruchids	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
20.	Pigeon pea ( <i>Cajanus cajanus</i> ) – grains for consumption	Bruchids	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
21.	Rice ( <i>Oryza sativa</i> ) –grain for consumption	Granary weevil ( <i>Sitophilus granarius</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
22.	Stone fruits (Apricot, almond, plums, peaches, prunes etc.)-dry fruits for consumption	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> ); Indian meal moth ( <i>Ploidia interpunctella</i> ); Apricot chalcid ( <i>Eryotoma</i> spp)	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
23	Pistachio-dry fruits for consumption	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> ); Indian meal moth ( <i>Ploidia interpunctella</i> )	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
24	Poppy ( <i>Papavera somnifera</i> )-grains for consumption	External feeders (general)	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
25.	Shea nuts -for industrial processing	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> ); Tropical nut borer ( <i>Hypothenemus obscurus</i> )	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
26	Lab lab ( <i>Dolichos lablab</i> )-grains for consumption	Internal feeders	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
	Cashew nuts – with shell for industrial processing	External infestation (general)	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
27.	Hazle nuts- for consumption	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> )	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
28.	Macademia nuts -for consumption	Chacolate or tobacco moth ( <i>Ephestia elutella</i> ); Mediterranean flour moth ( <i>Ephestia kuehniella</i> )	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
29.	Pecan ( <i>Carya illinoisensis</i> ) nuts - for consumption	Peacan weevil ( <i>Curculio caryae</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
30	Sesamum ( <i>Sesamum indicum</i> )-grains for consumption	External feeders (general)	MB @ 16 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
31.	Zarishak ( <i>Berberis vulgaris</i> )-dried berries for consumption	Grape berry moth ( <i>Lobesia botrana</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
32.	Ber ( <i>Ziziphus ziziphus</i> ) – dried	Grape berry moth ( <i>Lobesia botrana</i> )	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or	Off-shore treatment

	berries for consumption		above under NAP or equivalent	
33.	Maju phal ( <i>Quercus</i> spp.)-dry fruits for consumption	Internal seed borers	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
34.	Nutmeg and Mace	Internal seed borers	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
<b>Timber &amp; Wood</b>				
35.	Chestnut (wood without bark)	Vectors of chestnut blight	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
36.	Elm (wood without bark)	Elm bark beetle (Scolytidae)	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
37.	Oak (wood without bark)	Oak bark beetles ( <i>Pseudopityophthorus</i> spp.)	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
38.	Pine (wood without bark)	Pine wood nematode ( <i>Bursaphelenchus xylophilus</i> ); cerambicid vector ( <i>Monochamus</i> spp.); Pine beetles (Scolytidae) and Pine weevils ( <i>Pissodes</i> spp.); Sirex wasp ( <i>Sirex</i> spp.)	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
39.	Poplar (wood without bark)		MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
40.	Alder (wood with bark)	Alder borer ( <i>Rosalia funebris</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
41.	Bilinga (wood with bark)	Bark borer ( <i>Orygmophora mediofoveata</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
42.	Birch (wood with bark)	Bronze birch borer ( <i>Agilus anxius</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
43.	Cherry (wood with bark)	Shothole borer ( <i>Scolytus rugulosus</i> ); ambrosia beetle ( <i>Xyleborus dispar</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
44.	Douglass fir (wood with bark)	Douglass fir beetle ( <i>Dendroctonus pseudotsugae</i> ); pine wood nematode ( <i>Bursaphelenchus xylophilus</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
45.	Sapeli (wood with bark)	<i>Hypsipyla robusta</i>	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
46.	Spruce (wood with bark)	Two-toothed pine beetle ( <i>Pityogenes bidentus</i> ), spruce bark beetle ( <i>Ips typographus</i> ); European spruce beetle ( <i>Dendroctonus micans</i> ); pine weevils ( <i>Pissodes</i> spp.); pine beetle ( <i>Tomicus piniperda</i> ); pine wood nematode ( <i>Bursaphelenchus xylophilus</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
47.	Walnut (wood with bark)	Shothole borer ( <i>Xyleborus affinis</i> ); and <i>Xylosandrus germanus</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
48.	Firwood (wood with bark)	Two-toothed pine beetle ( <i>Pityogenes bidentus</i> ), spruce	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or	Off-shore treatment

		bark beetle ( <i>Ips typographus</i> ); European spruce beetle ( <i>Dendroctonus micans</i> ); pine weevils ( <i>Pissodes</i> spp.); pine beetle ( <i>Tomicus piniperda</i> ); pine wood nematode ( <i>Bursaphelenchus xylophilus</i> )	above under NAP or equivalent	
49.	Willows (wood with bark)	Greater poplar long horn ( <i>Saperda carcharias</i> ); poplar borer ( <i>S. populnea</i> )	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
50.	Timber of all species covered under Schedule-VII (wood without bark)	Wood boring pests (general)	MB @ 32 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
51.	Timber of all species covered under Schedule-VII (wood bark)	Wood boring pests (general)	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
52.	Solid wood packaging material (ISPM-15)	Wood boring pests (general)	MB @ 48 g/m <sup>3</sup> for 16 hrs at 21 °C or above under NAP or equivalent	Alternatively heat treatment at 56°C for 30 min.
53.	Package Material (Hay & straw)	Contaminating pests (general)	MB @ 48 g/m <sup>3</sup> for 24 hrs at 21 °C or above under NAP or equivalent	Alternatively steam under pressure treatment at 120°C for 15 min.
<b>Perishable Commodities</b>				
54.	Bulbs/tubers/rhizomes ( <i>Iris</i> , <i>Narcissus</i> , <i>Tulipa</i> )-for proppagation	Stem & bulb nematode ( <i>Ditylenchus dipsaci</i> ), Narcissus bulb flies ( <i>Merodona equesteris</i> , <i>Eumerus strigatus</i> , <i>E.tuberculatus</i> )	MB @ 32 g/m <sup>3</sup> for 2 ½ hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
55.	Cuttings/saplings/budwood etc.	Mealy bugs/thrips/mites (External feeders)	MB @ 32 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	On –shore treatment
56.	Cut flowers & foliage	Japanese beetle ( <i>Popillio japonica</i> ), Gypsy moth ( <i>Lymantria dispar</i> ), bud worms and other external feeders	MB @ 40 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	On-shore treatment
57.	Citrus spp-fresh fruits for consumption	Fruit flies (Mediterranean fruit fly ( <i>Ceratitis capitata</i> ); Natal fruit fly ( <i>C.rosa</i> ); Queens land fruit fly ( <i>Bactrocera tryoni</i> ); <i>Anastrepha</i> spp)	MB @ 32 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment.
58.	Grapes ( <i>Vitis</i> spp)-fresh fruits for consumption	Fruit flies (Mediterranean fruit fly ( <i>Ceratitis capitata</i> ); Natal fruit fly ( <i>C.rosa</i> ); Queens land fruit fly ( <i>Bactrocera tryoni</i> ); <i>Anastrepha</i> spp)	MB @ 32 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
59.	Stone fruits (cherry, plum, peach, prunes etc.)-fresh fruits for consumption	Mediterranean fruit fly ( <i>Ceratitis capitata</i> ); cherry fruit flies ( <i>Rhagoletis</i> spp)	MB @ 32 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
60.	Mangosteen ( <i>Garcinia mangostana</i> ); Rambutan ( <i>Nephelium lappaceum</i> ); and Guava ( <i>Psidium guajava</i> )-fresh	Jackbeardsley mealy bug ( <i>Pseudococcus jackbeardsleyi</i> ); citrus mealybug ( <i>Cataenococcus hispidus</i> )	MB @ 32 g/m <sup>3</sup> for 3 ½ 2 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment

	fruits for consumption			
61.	Kiwi ( <i>Actinidia</i> spp)-fresh fruits for consumption	Medeterranean fruit fly ( <i>Ceratitis capitata</i> )	MB @ 32 g/m <sup>3</sup> for 3 ½ hrs at 21 °C or above under NAP or equivalent	Off-shore treatment
62.	Blackberry/blue berry	Medeterranean fruit fly ( <i>Ceratitis capitata</i> )	MB @ 32 g/m <sup>3</sup> for 2 hrs at 21 °C or above under NAP or equivalent	Off-shore treatment

**Appendix-V**  
**Methyl Bromide Fumigation Ready Reckoner**

Initial Dosage	Value	24 g/m <sup>3</sup>	32 g/m <sup>3</sup>	40 g/m <sup>3</sup>	48 g/m <sup>3</sup>	56 g/m <sup>3</sup>	64 g/m <sup>3</sup>	80 g/ m <sup>3</sup>	128 g/m <sup>3</sup>
<b>Time after start of fumigation</b>									
<b>0.5 hrs</b> (75 % or more of original dosage required)	A	23	29	35	41	47	56	68	104
	B	18	24	30	36	42	48	60	96
	C	13	19	25	31	37	40	52	88
<b>1.0 hrs</b> (70 % or more of original dosage required)	A	21.8	27.4	29	33.8	38.6	43.4	53	81.8
	B	16.8	22.4	28	33.6	39.2	44.8	56	89.6
	C	11.8	14.2	19	23.8	28.6	33.4	43	71.8
<b>2.0 hrs</b> (60 % or more of original dosage required)	A	19.4	24.2	29	33.8	38.6	46.6	56	84.8
	B	14.4	19.2	24	28.8	33.6	38.4	48	76.8
	C	9.4	14.2	19	23.8	28.6	30.4	40	68.8
<b>4.0 hrs</b> (50 % or more of original dosage required)	A	17	21	25	29	33	40	48	72
	B	12	16	20	24	28	32	40	64
	C	7	11	15	19	23	24	32	56
<b>12 hrs</b> (35% or more of original dosage required)	A	13.4	16.2	19	21.8	24.6	30.4	36	52.8
	B	8.4	11.2	14	16.8	19.6	22.4	28	44.8
	C	3.4	7.2	9	11.8	14.6	14.4	20	36.8
<b>24 hrs</b> (30 % or more of original dosage required)	A	12.2	14.5	17	19.4	21.8	27.2	32	46.4
	B	7.2	9.6	12	14.4	16.8	19.2	24	38.4
	C	3**	4.6	7	9.4	11.8	11.2	16	30.4
<b>48 hrs</b> (25 % or more of original dosage required)	A	11	13	15	17	19	24	28	40
	B	6	8	10	12	14	16	20	32
	C	3**	3**	5	7	9	8	12	24

**Maximum top-up Limit (g/m<sup>3</sup>)**

**Standard Line (g/m<sup>3</sup>)**

**Minimum concentration (g/m<sup>3</sup>)**

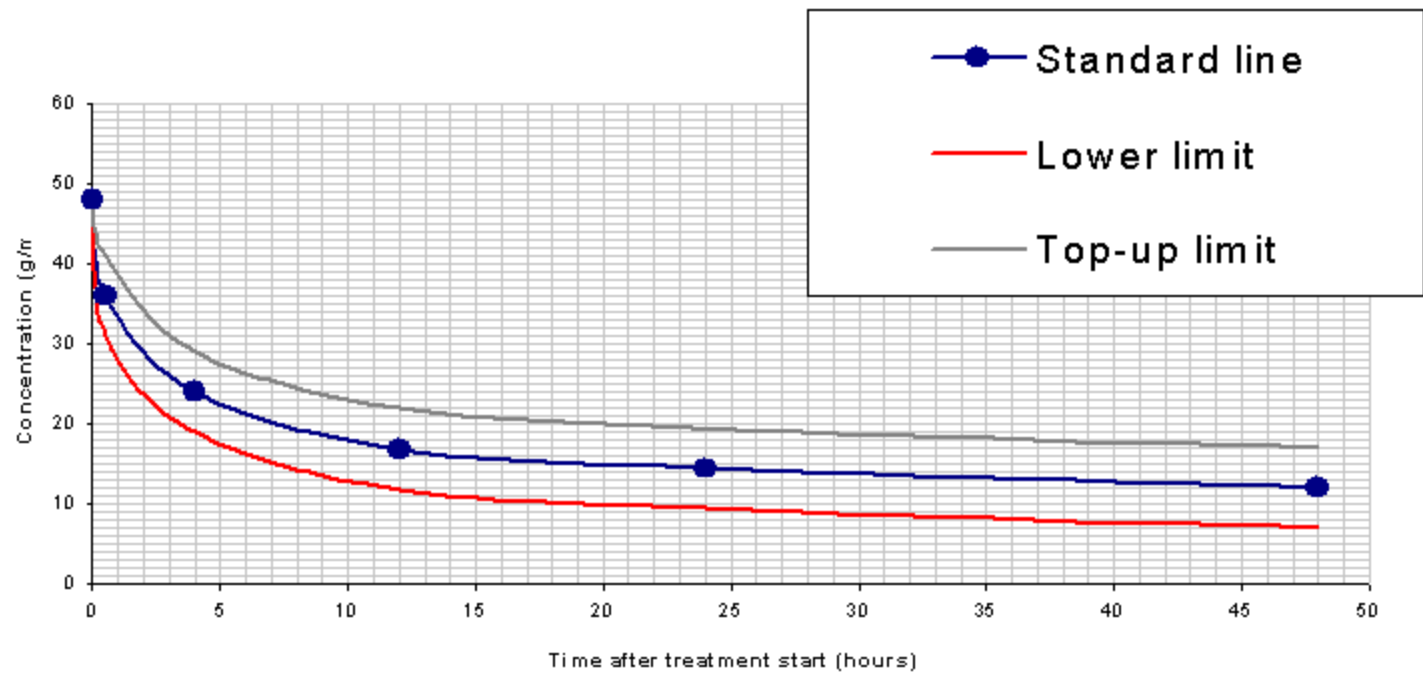
\*

\*\* Methyl bromide concentrations less than 3g/m<sup>3</sup> are below the thresh hold for effectiveness

# Appendix- VI

Fumigation Certificate	
(Company letter head)  (Dte PPQS Regd No. _____ dated _____)	Treatment Certificate Number
	Date of Issue
<i>This is to certify that the goods described below were treated in accordance with the fumigation treatment requirements of importing country (_____) and declared that the consignment has been verified free of impervious surfaces/layers such as plastic wrapping or laminated plastic films, lacquered or painted surfaces, aluminium foil, tarred or waxed paper etc. that may adversely effect the penetration of the fumigant, prior to fumigation</i>	
<b>Details of Treatment</b>	
Name of Fumigant	
Date of fumigation	
Place of fumigation	
Dosage of Fumigant (g/m <sup>3</sup> )	
Duration of Fumigation (hours)	
Average ambient temperature during fumigation (°C)	
Fumigation performed under gastight sheets	Yes/No
If containers are not fumigated under gas-tight sheets, pressure decay value (from 200-100 Pascal's) in seconds.	
<b>Description of Goods</b>	
Container Number (or numerical link)/Seal Number	
Name & Address of exporter	
Name & Address of consignee	
Type and description of cargo	
Quantity (MTs)/ No of packages/No of pieces	
Description of packaging material	
Shipping mark or brand	
Name & Signature of Accredited Fumigation Operator with seal & date/ Accreditation Number	
Endorsed by specified officer of Dte of PPQS(Applicable only in case of non-accredited fumigation agency)	

Chart 1: Concentrations over time (48grams per cubic metre (48g/m<sup>3</sup>) initial dosage fumigation)





**Chart 2: Calculation of top-up procedures provided for in this Standard.**  
**24 hour reading of concentrations over time (48 grams per cubic metre (48g/m<sup>3</sup>) initial dosage fumigation)**

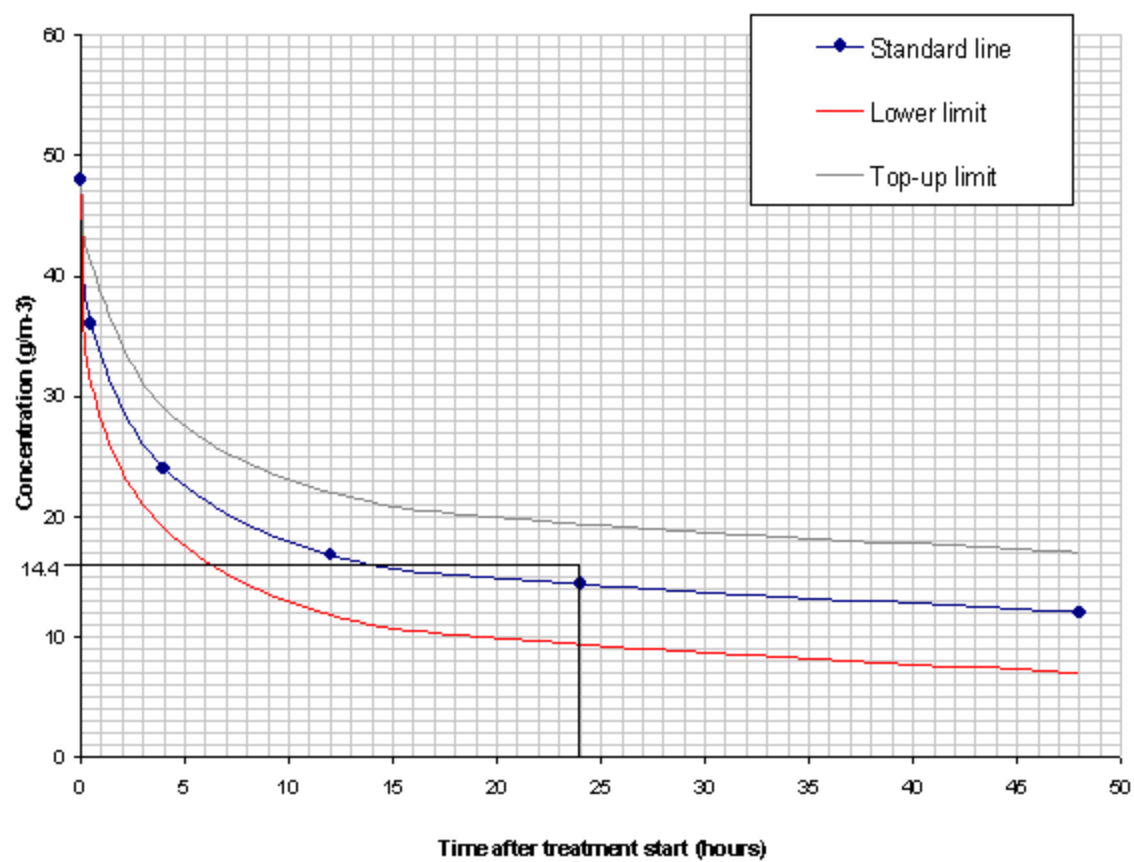


Chart 3: Graphical to illustration use of top-up procedure provided for in this Standard  
Concentrations over time (24 hour top-up)

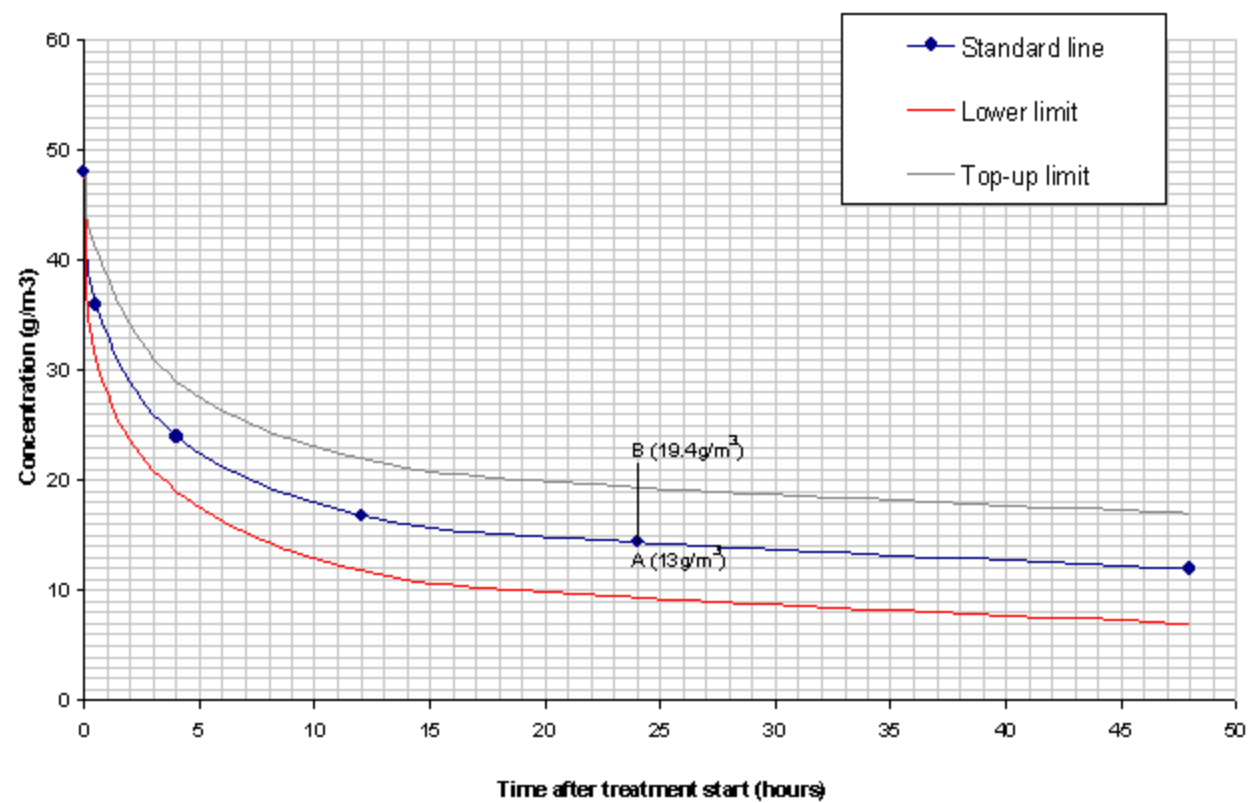
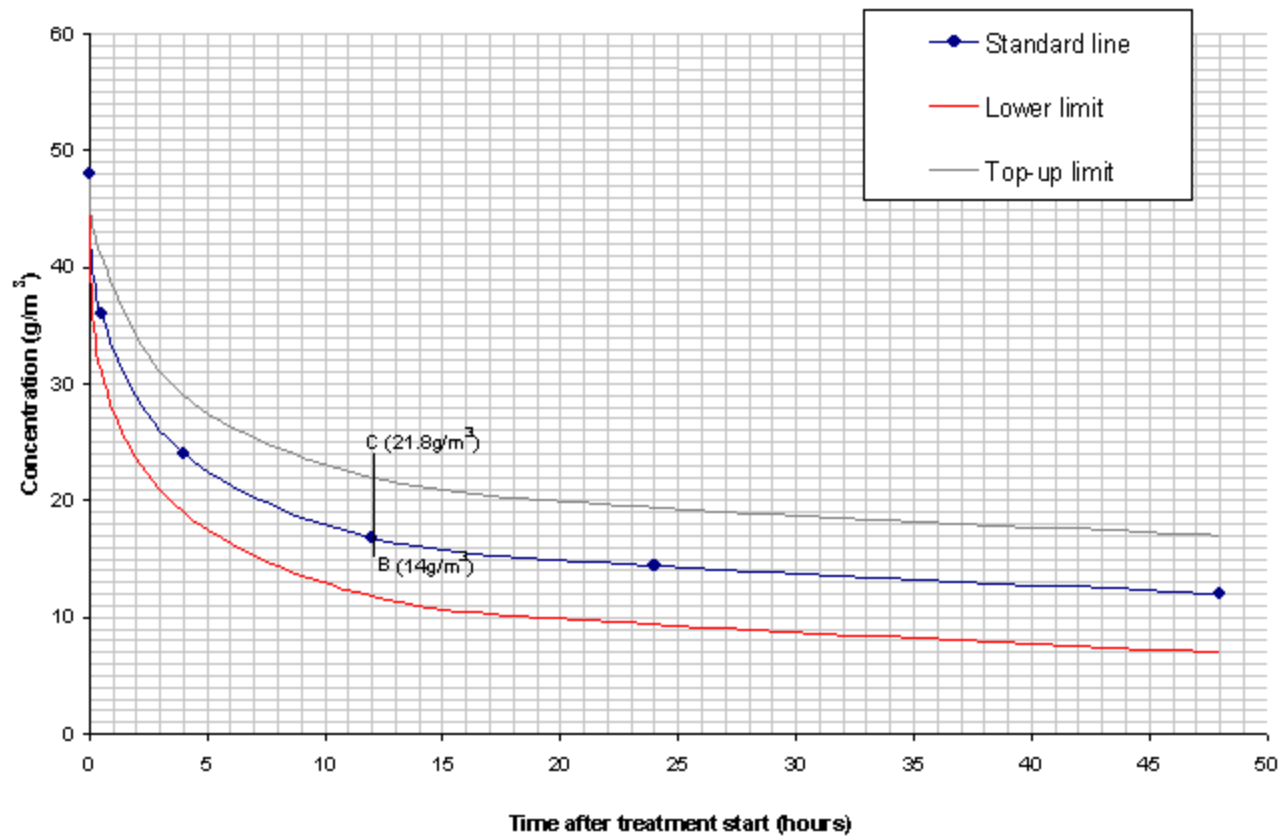
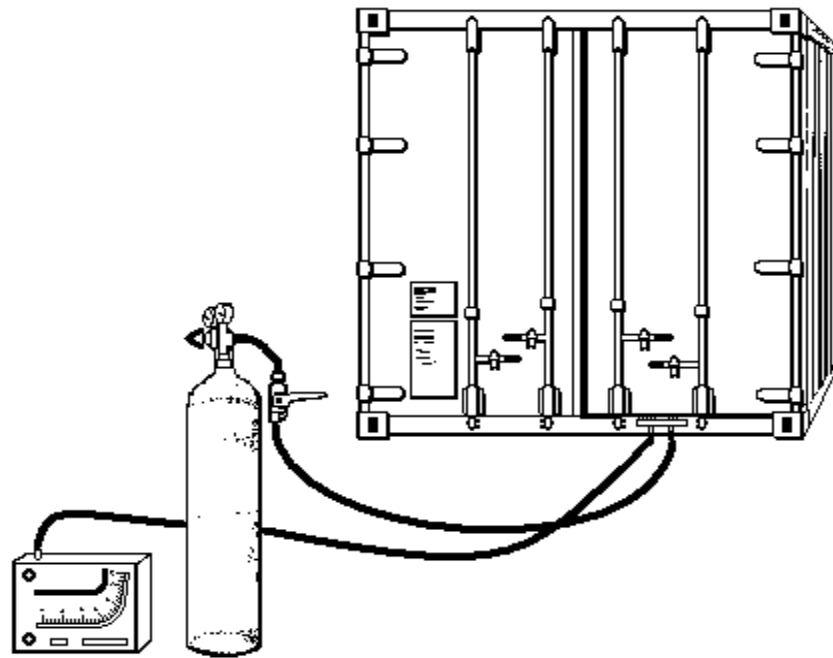


Chart 4: Concentration vs time (12 hour top-up)







**Figure 1: Finger manifold in operation with a container**

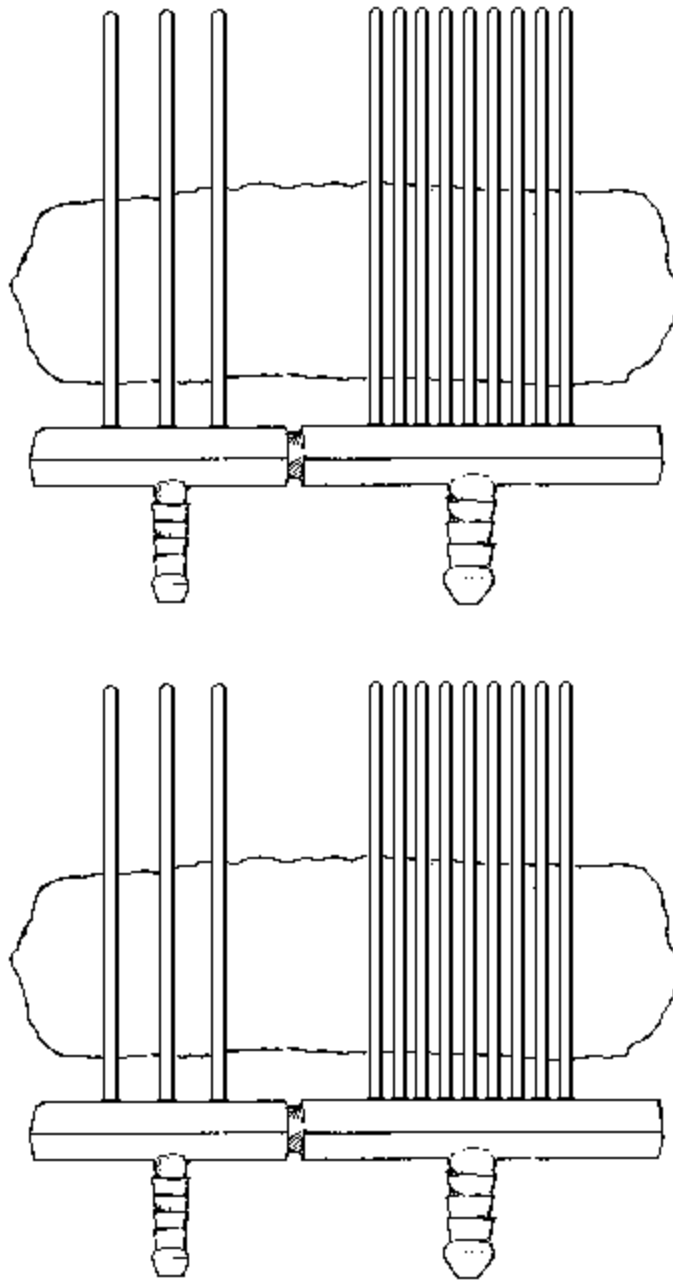


Figure 2: Finger Manifold (Close-up view)

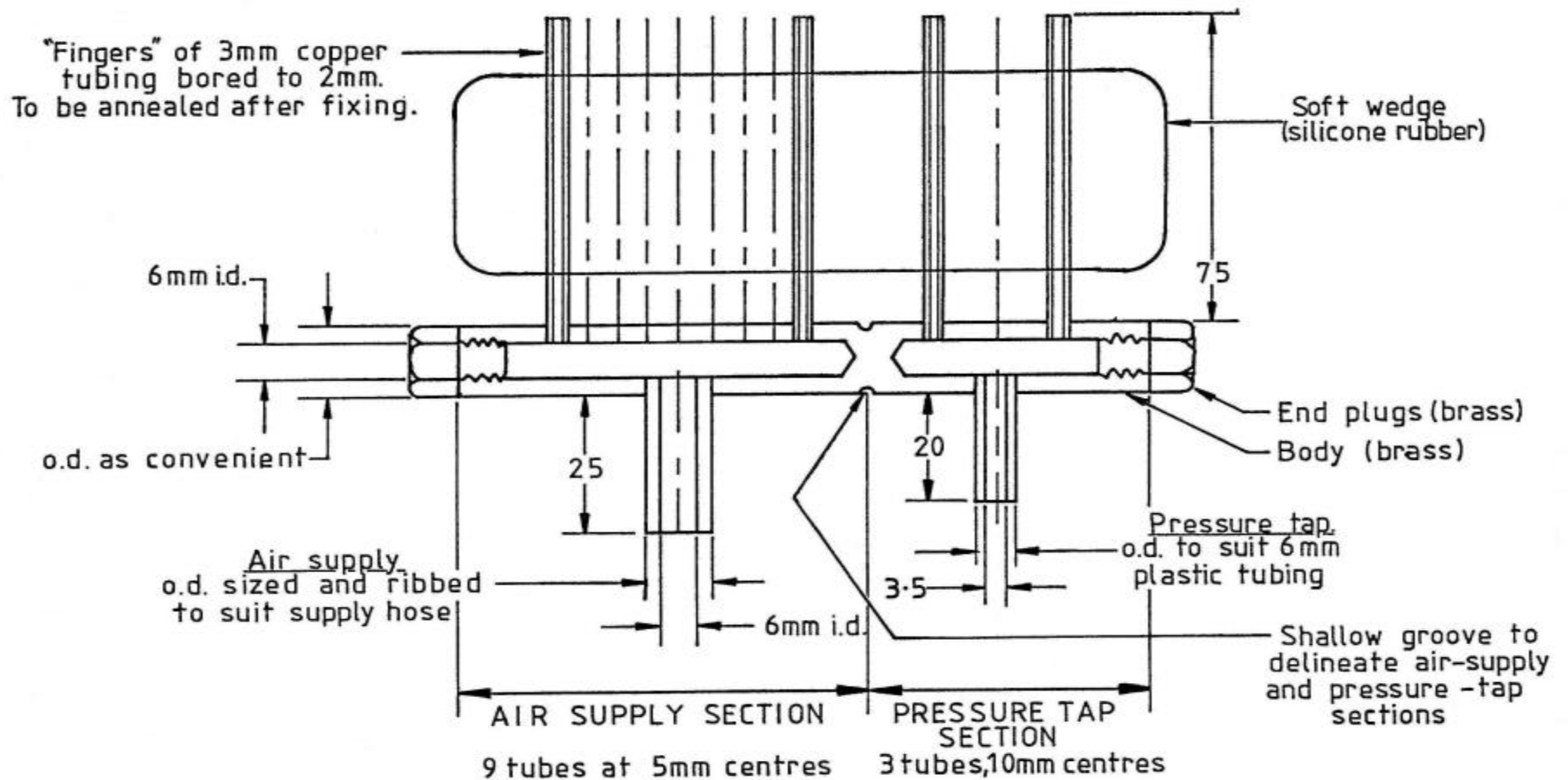


Figure 3: Finger Manifold (Construction & Design)