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UNSEEN DANGERS IN FREIGHT CONTAINERS

by

Evert Wijdeveld

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STRANG

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No. 5 Container Terminal Safety (*revised*)
No. 6 Guidance on the Preparation of Emergency Plans (*revised)*
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This publication is one of a series developed by the International Safety Panel ("Safety Panel") of ICHCA International Limited ("ICHCA"). The series is designed to inform those involved in the cargo-handling field of various practical health and safety issues. ICHCA aims to encourage port safety, the reduction of accidents in port work and the protection of port workers' health.

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Evert Wijdeveld was employed by the Rotterdam Port Authority for more than 17 years. His first job was as Dangerous Cargo Inspector. After seven years he became Vessel Traffic Manager in the Rotterdam Europort, becoming Duty Officer a few years later. Five years on he became Head of the Dangerous Cargo Department of the Rotterdam Port Authority.
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Contents

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UNSEEN DANGERS IN FREIGHT CONTAINERS

1 Introduction

1.1 This briefing pamphlet is intended to make the cargo-handling world aware of the dangers that may exist in freight containers. Workers should be aware not only of the danger of poorly stowed cargo inside a container that can fall as the container's doors are opened but also the potential of being overwhelmed by toxic fumes from fumigants or other gases inside the container.

2 Experiences

2.1 A risk assessment Carried out in the Port of Rotterdam in the late 1990's indicated that freight containers from certain parts of the world (India, Pakistan, Vietnam, Indonesia, China, Philippines, Thailand, Malaysia and also South America, Africa and Japan) containing many different products, such as rice, rice paper, wooden furniture and other wooden articles, handicrafts, ornamental frames, shells, textile, coconut fibre, coffee and pots and pans, were often fumigated with phosphine, methyl bromide or sulphuryl fluoride.

2.2 The dangers from fumigants in containers are a threat to anyone who inspects or unloads cargo from containers. Some dockworkers and inspectors in Rotterdam who had come in contact with these fumigants had to be hospitalised, primarily for observation, but such precautions may not always be taken..

2.3 Inspections of 303 randomly chosen freight containers in Rotterdam during 2002 were carried out by taking gas samples through the rubber seals of the closed container doors (see figure 1). These inspections showed that, 10 of these containers (around 3.5 %) were under fumigation and, as such, were UNSAFE TO OPEN! More importantly, only four of these containers were marked and declared as under fumigation. Cargo Transport Units under fumigation are required to be declared as IMDG-code class 9, UN no. 3359.

Fig: 1

2.4 An even larger percentage of freight containers were found to contain detectable and potentially hazardous amounts of fumigants, disinfectants or flammable gasses. In addition, there was a high percentage of freight containers with a high level of carbon monoxide (CO) or carbon dioxide (CO_2), an additional potential health hazard.

2.5 Similar percentages were found in other Northern European ports.

2.6 Workers opening and unloading containers need to recognise that only a proportion of all freight containers under fumigation are reported and marked as required. One should be conscious of the potential for fumigants being in containers! Is Figure 2 an old sign that has not been completely removed? Or does it show that the container is treated and if so with what? In cases such as this it is prudent to treat as if 'under fumigation'.

Fig: 2

3 Why are freight containers fumigated?

3.1 Transporting goods between countries using containers and ships is an economic and well-established practice. However, cargo in containers, and the containers themselves, are a potential means of introducing serious pests and diseases. Timber insects pose a significant quarantine risk and, accordingly, in several countries, all timber in containers, including exposed timber components, must be treated before the container can be considered for import. It is not only the cargo inside the container that can carry exotic pests and diseases to a part of the world where those pests and diseases do not exist. An example is termites that have been imported into a country in a container fitted with an untreated plywood lining. The attempt to eliminate the importation of unwanted pests is where the problem starts for shippers, port operators, ship owners, ships' crews and many others.

3.2 To exclude exotic pests and diseases, several countries have introduced quarantine requirements and procedures. To comply with quarantine and phytosanitary rules, special treatment of certain goods, packaging and freight containers themselves is necessary. 'Permanent treatment' of the lining of freight containers and 'heat treatment' of dunnage and/or non-manufactured wooden packing (kiln drying) are examples of treatments that do not pose a risk. Although these two treatments could solve many problems for ports, they are not always applied. A third and frequently used treatment is fumigation. Typical fumigants that are used and the fumigation process are discussed in chapter 4.

3.3 The Food and Agriculture Organization of the United Nations (FAO) in Rome has prepared an International Standard: "Guidelines for regulating wood packing material in international trade" ISPM 15. Ninety countries have agreed to the guidelines on wood packaging material that may contain dangerous wood eating insects. Several countries have made rules and have published interesting documents dealing with quarantine and pre shipment measures. A lot of guidance relating to containers is available on the internet. (See the Annex for the FAO-site where the ISPM 15 can be found and some other relevant sites.)

4 How and where is fumigation done and by whom?

4.1 Fumigation is the process of dispersing fumigants in a given area, such as a freight container. Fumigants are used where contact insecticides will not control insects and pests. Fumigants act in the gaseous phase. Some fumigants are applied as solid or liquid formulations from which the toxic gases emanate.

4.2 Fumigation can be carried out by using a number of very toxic gases like *methyl bromide*, *sulfuryl fluoride* (Vikane), *formaldehyde, chloropicrin* or *phosphine*. Solid formulations like aluminium phosphide or magnesium phosphide are widely used because they can release phosphine. These formulations are in tablets, plates, strips, and blankets or-sleeves.

Methyl bromide

Solid formulations releasing phosphine

Vikane

4.3 Carbon dioxide (CO_2) is used but specifically to displace oxygen and asphyxiate living vermin, not poison them.

4.4 Further possibilities that are not often mentioned, because they are not broadly applicable to containers are the application of CO_2 or nitrogen under pressure and irradiation.

4.5 Fumigation can be carried out in the place where the goods are stored (for example in silos for bulk cargo). and/or where the goods are packed (for example at the manufacturer's premises) or in container freight stations (see Figure 3). They may also be fumigated in container terminals.

Fig: 3

4.6 Freight containers are sometimes fumigated during transport, including the sea voyage. This is known as in-transit fumigation. Typically, after packing or loading the container, plates or strips of plates, sleeves, blankets or pellets of aluminium or magnesium phosphide are put on top of, or within, the cargo.

4.7 The air temperature, in combination with atmospheric humidity, causes the aluminium or magnesium phosphide to react with the water molecules in the air to form phosphine, a toxic gas that does its work during the voyage and leaves a harmless white powder as a silent witness that fumigation has taken place. This method of fumigation holds great dangers. At temperatures below 10^{o} C and/or with low humidity, the reaction stops completely even though there are still chemicals waiting to react. This may also be caused by using an excessive quantity of fumigant. This form of fumigation may take weeks and can often be re-initiated when a container is opened. For importing countries, especially, these freight containers should be checked before opening! After opening one needs to be aware that the phosphine creating formulations may still be present. If they are, they should be taken away by specially trained and equipped persons in order to avoid injury, or even death. While this manner of fumigation is not preferable, it is not forbidden by the transport regulations and is widely applied!

5 What are the dangers during transport and what can be done about them?

5.1 If you are warned by someone (the cargo owner, the shipper, the freight forwarder or others) or something (transport documents, fumigation warning signs, etc) you will know there are dangers present and be able to react appropriately to ensure a safe situation. It is the dangers that you do NOT know about or are NOT aware of that are the real concern. If you do not take adequate precautions you may become ill or even be poisoned by the fumigant, especially in an enclosed space such as a freight container or a ships hold. Simply because nothing goes wrong during the first hundred occasions, it should not be assumed that occasion one hundred and one will be safe! Where a container has ventilation holes that are blocked (figure 4) be suspicious. This may be an indication that fumigation has taken place.

Fig: 4

5.2 The person who controls the opening and entry of containers should always check the chemical properties and the threshold limit value (TLV) of the relevant chemical, referring to their own national standards and guidelines where they exist. The TLV is the time-weighted average concentration for a normal eight-hour working day (8 hour TWA) to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. Often, but not always, a higher concentration is permitted for exposure for a shorter period (typically 15 minutes). Alternatively, the TLV can also be the ceiling-value or maximum exposure limit. If this applies, never enter a space where the value is above that value without appropriate protection for the detected gas.

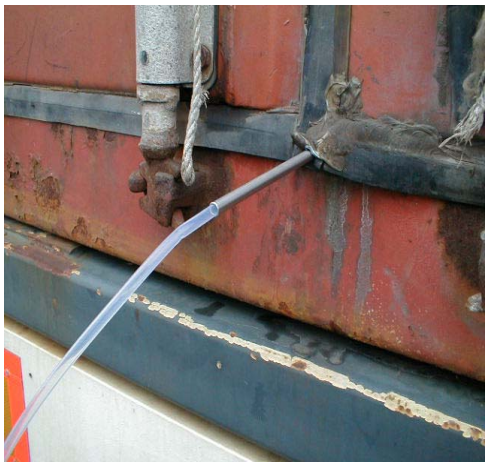
5.3 If the concentration of a gas in a work area is above the relevant TLV, then the area should be considered unsafe.

5.4 How can you know if or when the concentrations are too high?
Unfortunately, one cannot rely on ones sense of smell as most of these gases will be well above their TLV by the time they can be detected! The only practical way is to take air samples. In the open this is very difficult. Initially, a device that identifies the gas is required before the concentration of the gas can be measured.

Different measuring devices are available for different gases.

5.5 The simplest and easiest measuring devices to use are probably the well-known detection tubes like those from Dräger, MSA or Auer.

5.6 Do not open the doors without having taken the appropriate precautionary measures.



5.7 The best way is to take the first samples through the rubber seals of the closed container doors, using a suitable, strong pipe or tube. Be aware of the (potentially fragile) cargo behind the doors.

5.8 If the concentration is too high, stay out and do not enter the container unless you are wearing appropriate respiratory protective equipment breathing apparatus.

5.9 If the container is under fumigation, natural or mechanical ventilation will be necessary. Further samples should be taken after ventilation and even periodically after that. Some cargoes absorb the fumigant and, therefore, it may take a long time before the fumigant is completely dispersed.

5.10 Containers fumigated with tablets or plates that generate phosphine may have residues that can still be active or could re-activate after the container has been ventilated. Only specially trained people should be permitted to remove and neutralize the remains of the fumigant.

5.11 Fumigants should be handled with great respect as they pose a serious risk.

5.12 Fumigants diffuse rapidly, a property that is essential to their function. Some will readily penetrate rubber and neoprene personal protective equipment, as well as human skin. Even special adsorbents in respirator canisters may not provide complete protection when air concentrations of fumigants are high.

5.13 The most commonly used fumigants for treating stored goods and cargo in freight containers include methyl bromide and phosphine producing materials. In structural fumigation, chloropicrin and sulfuryl fluoride are used. Brief descriptions of exposure symptoms for each of these fumigants are set out below.

5.13.1 METHYL BROMIDE**.** Exposure to methyl bromide is severely irritating to the lower respiratory tract, sometimes causing fluid build-up in the lungs, haemorrhage or pneumonia. The onset of respiratory distress may be delayed 4 to 12 hours after exposure. Early symptoms of acute poisoning include headache, dizziness, nausea, vomiting, tremor, slurred speech and unsteady movements. If liquid methyl bromide contacts the skin, severe burning, itching and blistering occur.

5.13.2 PHOSPHINE**.** Like methyl bromide, phosphine is severely irritating to the respiratory tract. Most severe acute exposures have involved ingestion of solid aluminium phosphide, and mortality rates following severe exposure range from 50 to 90 percent. Onset symptoms of poisonings are fatigue, nausea, headache, dizziness, thirst, coughing, shortness of breath, chest tightness and jaundice.

5.13.3 CHLOROPICRIN**.** This fumigant is severely irritating to the upper respiratory tract, eyes and skin. Inhalation sometimes leads to vomiting. Ingestion could be expected to be corrosive to the gastrointestinal tract.

5.13.4 SULFURYL FLUORIDE. Death due to oxygen deficiency may follow when persons enter a structure too early after treatment. Early symptoms of exposure include nose, eye and throat irritation, weakness, nausea, vomiting, difficult breathing, coughing, restlessness, muscle twitching and seizures.

5.14 To treat victims of fumigant exposure, remove them to fresh air immediately, keep them quiet and in a semi-reclining position. Anyone attempting to rescue a person suffering from fumigant exposure should be properly equipped with self-contained breathing apparatus. Minimum physical activity limits the likelihood of pulmonary oedema, a medical emergency characterized by the accumulation of abnormally large amounts of fluid in the lungs. If skin is contaminated, flush with water for at least 15 minutes. Seek medical attention immediately.

6 What international standards and rules apply?

6.1 An important document is the International Maritime Organization (IMO)'s **"Recommendations on the Safe Use of Pesticides in Ships"**. This should be available to and read by all involved in sea transport. Ship owners should incorporate the Recommendations in their Safety Management System under the International Safety Management Code. The Recommendations cover both fumigated bulk cargo and other cargo under fumigation such as in containers. It is mandatory to comply with the requirements of the IMDG Code when containers under fumigation are carried and handled.

6.2 Cargo Transport Units (CTU's) includes containers. Containers under fumigation, are covered in the **International Maritime Dangerous Goods (IMDG) Code,** Class 9, UN no. 3359. The proper shipping name is FUMIGATED UNIT. These units are exempt from placarding , but they must have the approved warning sign affixed to the access door(s) identifying the type and amount of fumigant used and the date and time of fumigation. They shall also be marked with the appropriate class or division of any other dangerous goods that might be carried within the containers. Further properties and observations in the IMDG Code are:

"A Fumigated Unit is a closed transport unit loaded with cargoes under fumigation. The fumigant gases used are either poisonous or asphyxiant.
The gases are usually evolved from solid or liquid preparations distributed within the closed transport unit.
In addition:

1 A closed cargo transport unit, which has been completely ventilated after fumigation, either by opening the doors of the unit or by mechanical ventilation, to ensure that no harmful concentration of gas remain, is not subject to the provision of this Code. Such a unit should also have the warning sign(s) removed.
2 Cargo transport units shall be fumigated in accordance with the Recommendations on the Safe Use of Pesticides in Ships, as amended.
3 Only cargo transport units that can be closed in such a way that the escape of gas is reduced to a minimum shall be used for the transport of fumigated cargo.
4 The transport documents for a closed cargo transport unit shall show the date of fumigation and the type and amount of fumigant used. In addition,

instructions for disposal for any residual fumigant, including fumigation devices if used, shall be provided.

5 When the cargo transport units under fumigation are stowed under deck, equipment for detecting fumigant gas or gases shall be carried on the ship, with instructions for its use.

6 Fumigants shall not be applied to the contents of a cargo transport unit once it has been loaded aboard the ship."

6.3 Since1st January 2004 the provisions of the IMDG Code have been mandatory for all IMO Member States who are signatories to its SOLAS Convention!

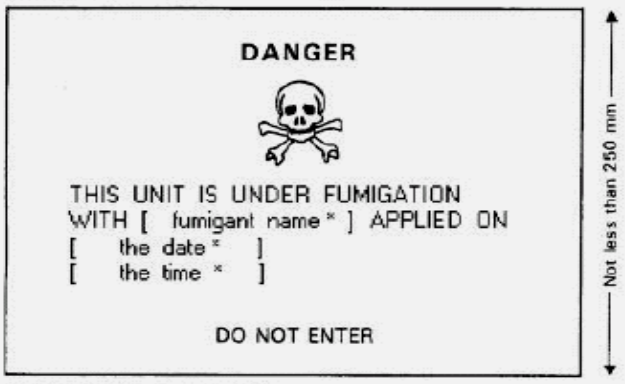
6.4 In ADR/RID, the European regulations on the transport of dangerous goods by inland-modes of transportation, special provisions are set out in Chapter 5.5.2:

"5.5.2 Special provisions for fumigated containers and vehicles

5.5.2.1 Transport documents associated with containers and vehicles that have been fumigated shall show the date of fumigation and the type and amount of the fumigant used. These particulars shall be drafted in an official language of the forwarding country and also, if the language is not English, French or German, in English, French or German, unless agreements, if any, concluded between the countries concerned in the transport operation provide otherwise. In addition, instructions for disposal of any residual fumigant including fumigation devices (if used) shall be provided.

5.5.2.2 A warning sign as specified in the figure below shall be placed on each fumigated container or vehicle in a location where it will be easily seen by persons attempting to enter the interior of container or vehicle. The particulars concerning the warning sign shall be drafted in a language considered appropriate by the consignor."

Fumigation warning sign



7 Summary

7.1 IMO and ILO have an important role for seafarers and portworkers in connection with "Unseen Dangers in Freight Containers".

7.2 IMO's "Recommendations on the safe use of pesticides in ships" is included in the Supplement volume of the IMDG Code. The pesticides recommendations are not mandatory but many individual IMO Member States have made them law.

7.3 Attention should be drawn to the requirements contained in the IMDG Code relating to the marking and placarding of intermodal containers that are under fumigation. This is important but, it is the awareness of the UNSEEN DANGERS IN FREIGHT CONTAINERS that have been addressed in this pamphlet.

7.4 Before portworkers are permitted to work in an intermodal container under fumigation. The container should be certified clear of fumigants by a competent person.

ANNEX

Relevant World Wide Web addresses

1 www.ilpi.com/msds/search.html - Search for Material Safety Data Sheets (MSDS) information

2 www.ippc.int/ipp/en/ispm.jsp - Search for International Standards for Phytosanitary Measures (ISPM), the ”Guidelines for regulating wood packaging material in international trade”, Publication No. 15 (ISPM 15) on the FAO, International Plant Protection Convention (IPPC) web site:

3 www.ilo.org - International Labour Organization

4 www.imo.org - International Maritime Organization

5 www.europe,osha.eu.int - European Agency for Safety at Work

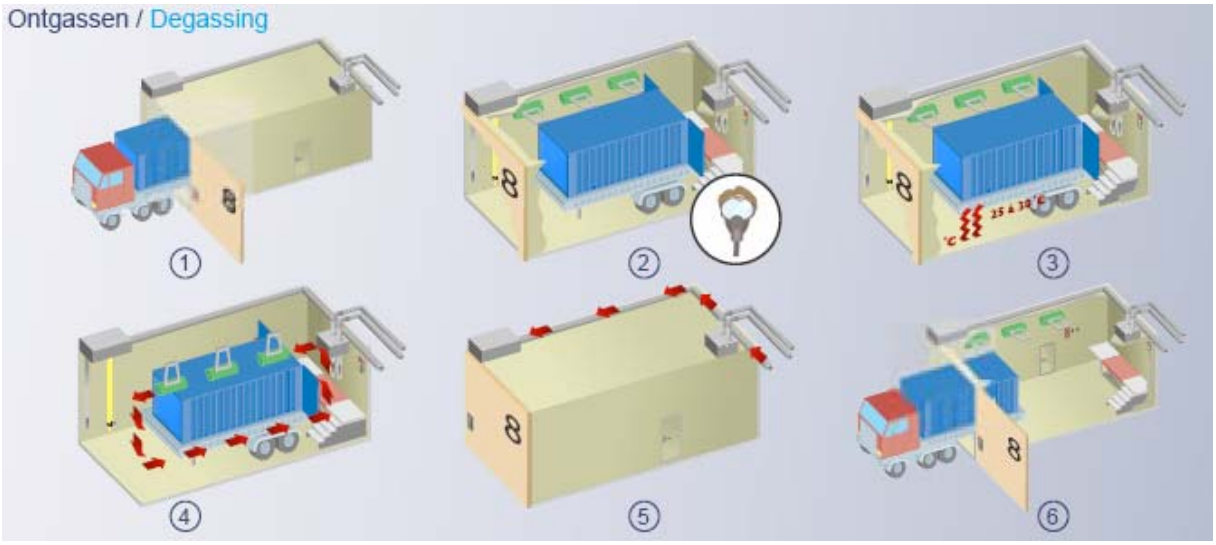
6 www.osha-gov - Occupational Safety & Health Administration of USA

APPENDIX

Experience in the Port of Rotterdam with fumigation

If containers are fumigated on shore, the work should be done by specialists. The Netherlands requires a horizontal safety distance of 100 meters between the outside of the object under fumigation and living quarters (including offices where people are present and ships' accommodation).
These same rules also apply to ventilating / devanning imported containers which are not shown to be being free of fumigants. The required safety distances vary and are typically set out in national or local rules. In some jurisdictions the required safety distance is only 10 meters.

Containers, which are fumigated in the Netherlands are not allowed to be moved around or put on board a seagoing vessel. After fumigation and ventilation, a certificate is issued and only then can the container be handled. The "degassing" process used in Rotterdam to safely remove all fumigants is described below.



1 The container, which is loaded with products that have been disinfected using a gas, is moved into a special gas-tight chamber. Motion sensors indicate when the container is in the right spot.

2 The chamber is closed once the container is correctly positioned. A staff member, who is protected by a compressed-air mask, then opens the doors of the container and leaves the chamber. The chamber is then hermetically sealed.

3 The chamber is heated to a temperature of 25 to 30 degrees Celsius. At these temperatures gasses become volatile more quickly. Ventilators in the chamber ensure adequate air circulation.

4 An exhaust system is used to draw the gasses out of the container and the chamber.

5 The contaminated air is fed through a closed circuit to a large carbon filter where the air is purified. The various hazardous gasses remain behind in the carbon filter.

6 The degassed container may now be moved outside and opened.

ADDENDUM

By Evert Wijdeveld

Human risks of containers containing dangerous volatile substances

As shown in BP #20 “Unseen Dangers in Freight Containers”, containers sometimes are treated with pesticides like methyl bromide or phosphine and such residues can be remaining when the container is opened for entry. However, such pesticides are not the only “unseen dangers in freight containers” - there also is a chance that some solvents from newly made goods can evaporate and pose a risk to humans and the environment. Recent inspections on imported containers in the Netherlands * showed that sometimes high concentrations of pesticides and solvents can be found.

Investigations show that one out of five freight containers (20%) do contain certain amounts of ‘a strange gas’ which normally is not in the free atmosphere. One out of ten (10%) might contain an amount of gas which endangers the health of people in the short or longer term, working in that environment unprotected. However, only a few containers which were actively fumigated did have the container fumigation warning sign attached on the outside of one of the container doors - the others had no sign attached because they were not actively fumigated.

Fumigants are used to control pests and fight unwanted insects during transport and storage of goods. Solvents are found in products such as shoes or fresh painted goods. The concentrations in a closed freight container increase the longer the goods are in the closed and unventilated container. Therefore this is a risk to people who enter a container without taking precautions.

Dutch authorities monitored the air quality in imported freight containers over several years (2003-2006) looking for a certain trend in the frequency, the type of fumigant used and the concentrations that have been measured. Also the Dutch authorities searched for trends applying to other harmful gases found in freight containers. It showed that the percentage of containers with the pesticide 1, 2-dichloroethane in particular increased. With regard to solvents, benzene and toluene it shows also that more and more often higher concentrations were found. Exposure to such substances may result in serious health risk.

The problem of the unseen dangers in freight containers only can be solved if there is more awareness all over the world. An international approach therefore is necessary.
In October 2009 a seminar was held in the Netherlands to inform Labour inspectorates of the member countries in the European Union of this subject. The problem does not yet seem to be officially recognised.

There are various options for reducing exposure to these substances. One option is to reduce their use. Producers and importers may achieve this by placing additional requirements on the use of such substances in the production process or during transport. It seems also that unnecessary treatments with fumigants are carried out during transportation.

Those who are involved with the handling of cargo out of freight containers or who may be examining or checking the container’s contents must be aware of the possibility of a harmful atmosphere being inside the freight container and appropriate precautions must be taken before any entry is made.

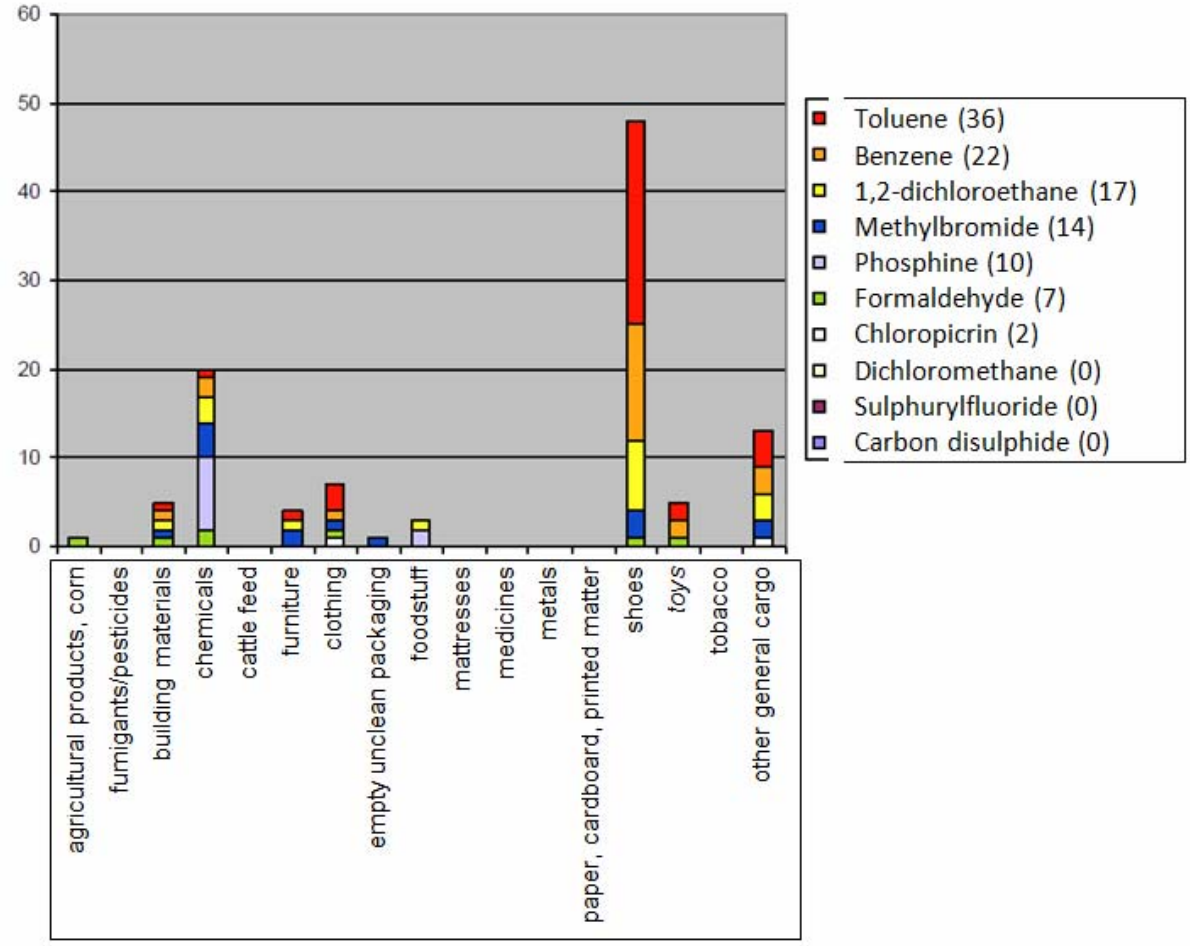
***** The full report can be found on the members’ website of ICHCA International

NOVEMBER 2010

ADDENDUM ANNEX 1

Results of 1053 examinations done by Dutch authorities from October 2008 until October 2009

From October 2008 until October 2009 the Dutch authorities selected 1053 freight containers for inspection and found the following gases in concentrations above the threshold limit value (TLV): toluene, benzene, 1,2-dichloroethane, methyl bromide, phosphine, formaldehyde and chloropicrin. Dichloromethane, sulphuryl fluoride and carbon disulphide were detected but not above the TLV.
High concentrations of toluene, benzene and 1, 2-dichloroethane were found in containers carrying shoes but also in containers with toys. In freight containers carrying agricultural products, building materials, chemicals, furniture, clothing, empty unclean packaging, foodstuff and other general cargo also concentrations were found above the TLV of mentioned gases.

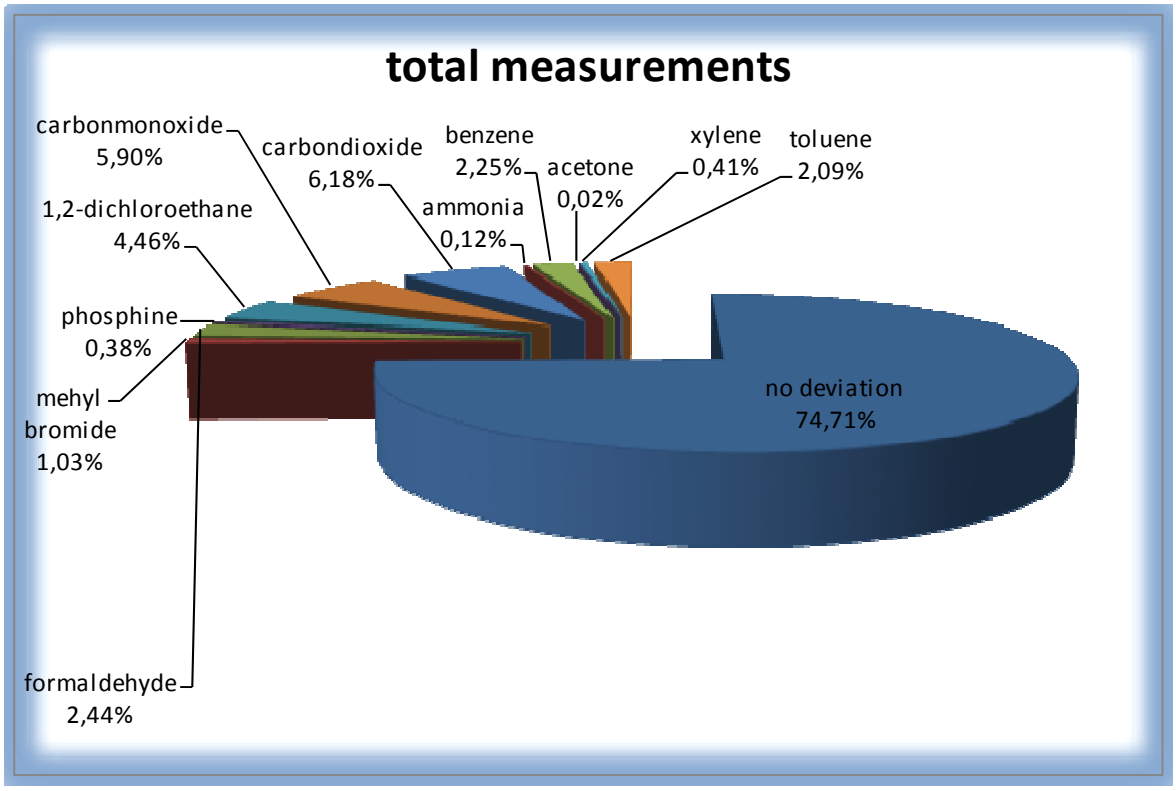


ADDENDUM ANNEX 2

Results of 4172 examinations done by a private company in the Netherlands from October 2009 until June 2010.

From October 2009 until June 2010 4172 freight containers were examined by a private company. Most of these freight containers (75%) were selected by the customs for physical examination. The Dutch customs require a 'gas-free-certificate', issued no longer than two hours before they want to open the container for inspection.
Measurements were done with a Fourier Transform Infrared analyser (FTIR-analyser) and electronic devices with sensors for several gases like oxygen, carbon monoxide, carbon dioxide, phosphine and ammonia. Also tubes were used from the manufacturers Gastec, Kitagawa, Uniphos, MSA, Dräger and a HCHO monitor from Riken Keiki. If a gas was detected, a second check was done with other aperture. The results are:

Nothing detected	3117
Methyl bromide	43
Formaldehyde	102
Phosphine	16
1,2-dichloroethane	186
Carbon monoxide	246
Carbon dioxide	258
Ammonia	5
Benzene	94
Acetone	1
Xylene	17
Toluene	87



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