



EU SHIPSAN ACT Joint Action - Agreement Number: 2012 2103

The impact on maritime transport of health threats due to biological, chemical and radiological agents, including communicable diseases

Interim guidance on maritime transport and Zika virus disease

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Summary

The role of maritime transport in Zika virus disease spread

The introduction of human cases of Zika virus disease (crew or passengers, symptomatic or asymptomatic) through ship travel is considered very low since most travelers in the affected countries return to European Union Member States (EUMS) through air travel. Moreover, it is unlikely that ships can introduce Zika virus disease to the population in the EU through Zika virus infected mosquitoes from affected areas. However, it is certainly known that specific types of imported goods including used tyres and ornamental plants (e.g. *Dracaena sanderiana* - lucky bamboo) introduce invasive mosquito species (IMS) to EU, usually at the egg life stage that is able to survive transportation. These two categories of imported goods can be infested with mosquitoes including *Aedes aegypti* and *Aedes albopictus*. Since imported symptomatic and asymptomatic human cases are continually arriving in EUMS through air transport, and *Aedes albopictus* mosquito, which is competent to transmit Zika virus has been established in a number of areas in EUMS, the possibility for local transmission of the disease in the future, especially in the summer months cannot be excluded. Further information for risk assessment can be found in the updated risk assessment published by ECDC. Imported used tyres, and ornamental plants (mainly plant cuttings requiring water during transportation) can: a) re-introduce *Aedes aegypti* in Europe, which is the main vector of Zika virus disease and other diseases such as yellow fever and dengue fever; b) introduce *Aedes albopictus* and other IMS in areas not currently present or established; c) import additional *Aedes albopictus* mosquito populations and other mosquito species in areas where are currently established and influence the mosquito population dynamics and density.

Recommendations for health measures

Integrated Pest Management Plans should be implemented at ports by the competent authorities and on board ships by ship operators routinely and efforts should focus in this direction. Disinsection of all sea freight and ships from affected countries is not recommended. Special treatment and rules for transporting and handling specific imported goods including used tyres and ornamental plants requiring water during transportation (e.g. *Dracaena sanderiana* - lucky bamboo) is recommended as follows.

Used tyres

Regulations for treatment of imported used tyres before shipment and requirement to be kept dry during transportation and additionally special storage condition thereafter could be implemented in EU, provided that all EUMS enforce the same regulations effectively.

The measure of treatment of imported used tyres should be combined with measures and regulations within EU concerning all the means of transportation between EUMS to prevent dispersal from the areas that *Aedes albopictus* is present to areas in EU that has not been introduced. This requires the capacity of the points of entry – ports in the EUMS to inspect

representative samples of used tyres and to implement control measures to the imported goods at the port facilities, in case of deficiencies. Moreover, it requires regulation enforcement and inspections at the storage facilities of tyres at destination. Limitations in the enforcement of such regulation are the challenging and time consuming inspection process of containers and the practical difficulties in implementing disinsection in a potentially large number of wet or infested tyres, as well as the low effectiveness of methods for the suppression of mosquito eggs.

Ornamental plants requiring water during transportation

Regulations for the transportation of imported ornamental plants that require the presence of water containerised or in a sealable hold space and disinsection of the container or the sealable hold space at least ten days after shipment and before opening, could be implemented in EU, provided that all EUMS enforce the same regulations effectively for all imported ornamental plants that require water during transport.

Measures would be also needed to be applied within EU to prevent dispersal from the areas that *Aedes albopictus* is present to areas in EU that has not been introduced. This requires the capacity of the points of entry – ports in the EUMS to disinsect the imported goods at the port facilities. Limitations in the enforcement of such regulation are the challenging and time consuming inspection process of containers and the practical difficulties in implementing disinsection.

Enforcement of special regulations for disinsection before shipment of used tyres and ornamental plants and for standards about the transportation of used tyres dry has not been effective in preventing IMS dispersal in the US and other countries, but has been effective in New Zealand (an islands country) to prevent their introduction.

1. Introduction

After a request from the European Commission (EC) and queries received by partners of the European Union joint action “The impact on maritime transport of health threats due to biological, chemical and radiological agents, including communicable diseases” (EU SHIPSAN ACT) in regards to maritime transport and Zika virus disease, an ad hoc working group was established to produce this document and the names and affiliations of the working group members are listed on the first page.

The document was produced based on the currently available information published by World Health Organization (WHO) and European Centre for Disease Prevention and Control (ECDC) in regards to epidemiology and knowledge for Zika virus disease, as well as previous risk assessments and work about mosquitoes conducted by ECDC.

Reported cases in the EUMS are imported cases, but local transmission of Zika virus disease is reported in several of EU Overseas Countries and Territories and Outermost Regions in the Americas and the Caribbean: French Guiana, Guadeloupe, Martinique, Saint Martin and Sint Maarten (ECDC, 2016a). *Aedes aegypti* mosquito that are considered the main vector of Zika virus disease are present in several EU Overseas Countries and Territories and Outermost Regions, while there are reports of its presence in Madeira, the Netherlands and the north-eastern Black Sea coast (southern Russia and Georgia). - See more at: <http://ecdc.europa.eu/en/healthtopics/vectors/mosquitoes/Pages/aedes-aegypti.aspx#geo> (ECDC, 2012). Detailed information is available at the ECDC (ECDC, 2016a).

The hypothetical ways for the introduction of Zika virus to EUMS through the maritime transport is analysed.

Moreover, the document discusses the options for health measures and their effectiveness. The second part summarizes the available guidance and routine measures that should be implemented on a regular basis at the points on entry-ports according to the International Health Regulations (IHR 2005) and the guidelines provided by WHO, to prevent transnational vector-borne diseases and vector dispersal.

This is an interim guidance document incorporating some initial comments received by WHO (EURO regional office, Lyon office and legal department in the WHO HQ) and is currently under further review and will be revised as appropriate. Therefore, the legal issues described are very preliminary and undergoing consultation.

2. Options for health measures on ships and sea freight in response to public health emergency of international concern (PHEIC) concerning Zika virus and observed increase in neurological disorders and neonatal malformations

There are three hypothetical ways that sea-travel and sea-trade could introduce Zika virus in the EUMS: a) introduction of human cases of Zika virus disease travelling with ships; b) transportation through ships or sea freight of infected *Aedes* adult mosquitoes with Zika virus; c) transportation of infected *Aedes* mosquito immature stages (eggs, larvae, pupae) with Zika virus.

2.1. Risk for introduction of human cases of Zika virus diseases travelling with ships and options for health measures

2.1.1. Risk for introduction of human cases of Zika virus diseases travelling with ships

The introduction of human cases of Zika virus disease (crew or passengers, symptomatic or asymptomatic) through ship travel might be possible, but considering the distance of the European ports from the affected areas and the fact that the majority of travelers visiting affected areas return to EU through air transport, it seems unlikely based on the current epidemiological situation.

In particular, the incubation period of Zika virus disease is likely to be a few days (though, it is not clear yet) and symptoms normally last for 2-7 days (WHO, 2016b). The time of viral RNA detection in blood is 2-3 days before the onset of symptoms until 11 days after the onset of symptoms (ECDC, 2016a). The duration of a sea travel from a port in the Americas to a port in continental Europe could be about 10-20 days, while the lifespan of the adult mosquito is two to four weeks. Therefore, the possibility of importation of human case being in the viremic phase is low, but cannot be excluded and is related more to crew members of ships than passengers, since tourists return from holidays by airplanes. Sexual transmission of the virus by an affected traveler (crew or passenger), who arrived in the EUMS through ship travel could occur, since Zika viral RNA has been reported in semen up to 62 days after clinical disease (ECDC, 2016a).

There is also a low possibility for transatlantic cruises departing from the affected countries in the Americas to introduce human symptomatic or asymptomatic cases in Europe. The same possibility exists for cruise ships coming from the Americas (without passengers, but with crew members on board) to Europe for the spring and summer cruise season.

2.1.2. Options for health measures to reduce the risk of introduction of human cases of Zika virus disease travelling with ships

Any case of infectious nature on board must be reported to the next port of call by the ship master according to Article 28 of IHR 2005 (WHO, 2008). Directive 2010/65/EU on reporting formalities for ships arriving in and departing from ports of the EUMS requires the electronic submission of the Maritime Declaration of Health (IHR 2005 article 37 and annex 8) from the ship captains to the EUMS. The ship's captain, or the ship's doctor if one is carried, shall supply

any information required by the competent authority as to health conditions on board during an international voyage.

Travelers including crew and passengers on ships calling at ports in affected areas should be advised by ship operators to follow the ECDC (<http://ecdc.europa.eu/en/publications/Publications/zika-virus-rapid-risk-assessment-11-april-2016.docx.pdf>) and US Centers for Diseases Control and Prevention (<http://wwwnc.cdc.gov/travel/page/zika-information>) guidance for travelers. In particular, seafarers who are European citizens and work on board ships calling at the affected countries, as well seafarers working on ships with a European flag that is calling affected countries should be informed about the risks in regards to Zika virus diseases according to updated advice published by ECDC. Information to seafarers can be given by the occupational health authorities and associations as well as the employing companies. Travel companies and travel agencies should advise travelers visiting affected areas in regards to Zika virus disease.

Ship operators should be advised applying measures to prevent mosquito bites (use of anti-repellents, use of bed nets and long sleeved shirts and long trousers, etc.) to travelers that develop symptoms compatible with Zika virus disease during the sea voyage and at least the first week of illness (ECDC, 2016a).

2.2. Risk for transportation through ships or sea freight of infected *Aedes* mosquitoes with Zika virus and options for health measures

2.2.1. Risk for transportation through ships or sea freight of infected *Aedes* adult mosquitoes with Zika virus

Aedes adult mosquitoes infected with Zika virus could be passively transported and arrive in EUMS on board ships or with freight carried on ships. This requires a series of unlikely situations where an infected adult mosquito survives on board the ships in locations protected from weather conditions or inside shipments for the duration of the voyage, then flies from the ship to the port area or is passively transported with shipments and then bites humans at the port area or around the port area or at the destination of a shipment/container at the time it is unpacked and opened. Weather conditions at both departing and arriving areas should be appropriate for the survival of adult mosquitoes (Tatem, Hay, & Rogers, 2006).

The risk for ships to carry mosquitoes differs depending on the type of freight carried on board the ship and the presence of potential breeding sites (stagnant water). Potentially infested cargoes include: used tyres, ornamental plants (mainly plant cuttings), stone fountains, repatriated construction and military material and vehicles, as well as other goods and equipment that can retain water and are stored outdoors in their country of origin (ECDC, 2012). Specifically, used tyres that are stored in open areas before transportation pose a risk. Retreaded or new tyres do not pose a risk because they are not stored in open areas, as sunlight damages the tyre gum.

Potential areas on board ships for the presence of adult mosquitoes are: lifeboats (open type not allowing draining), mooring rope areas, safe valve opening points, containers, lifeboat covers, bilges, scuppers, awnings and gutters, fan rooms, any plastic sheets or open drums, paint drums, manifolds (tankers) and free space between deck and containers, laundry areas if window openings or doors to open deck exist, toilets and bathrooms, galleys, standing water around recreational water facilities and others (WHO, 2011). However, ships that implement an effective Integrated Pest Management Plan, that maintain low indoor temperature, clean frequently the open deck areas and prevent water stagnation reduce significantly the risk of mosquito presence on board at any stage of life cycle.

It should be noted that there is evidence for finding alive adult mosquitoes on board ships or inside containers transported by ships (Craven et al., 1988; Laird et al., 1994; Lounibos, 2002; Rubin, Nunberg, & Rishpon, 2005), but it is not clear if those adult mosquitoes were transported in the adult stage of mosquito from the departing area to the destination or if they developed from eggs/larvae to adults during the sea voyage. Moreover, mosquito eggs and larvae have been found on board of ships and/or sea freight. Craven RB et al. has reported in the US that “*between May 18 and December 4, 1986, 79 seagoing containers and their contents of 22,051 used tyres were inspected for mosquitoes. Of the total inspected, 5,507 tyres (25%) contained significant amounts of water. No adults or eggs were found. Fifteen tyres contained mosquito larvae that were identified as Ae. albopictus, Ae. togoi, Culex pipiens complex, Tripteroides bambusa and Uranotaenia bimaculata. The infestation rate for all species was 6.8 infested tyres per 10,000 tyres (wet and dry) inspected. Aedes albopictus larvae were most frequently collected, occurring at a rate of 20 infested wet tyres per 10,000 inspected*” (Craven et al., 1988). *Aedes aegypti* larvae and pupae were collected live from a tank container offloaded from a ship in Australia (Nguyen, Whelan, Finlay-Doney, & Ying Soong, 2010).

Moreover, there is no published evidence for cases of autochthonous arboviral disease transmission such as Chikungunya or Dengue fever to habitants around ports or workers at ports, attributed to imported infected mosquitoes with ships. On the contrary, there are five published reported cases of port malaria among people who had no recent travels or blood transfusions, but worked or lived close to harbours in Italy, France, Belgium and Israel (Anselmo et al., 1996; Delmont et al., 1995; Peleman et al., 2000; Rubin et al., 2005). However, malaria is transmitted by the *Anopheles* mosquitoes that have much higher flight range than the *Aedes* mosquitoes, which can transmit Chikungunya or Dengue fever and can fly up to 400 meters. On the other hand, malaria is rarely asymptomatic in non-endemic areas, unlike Chikungunya and Dengue fever.

Considering the above, the possibility of Zika virus infected adult mosquitoes transported with ships to transmit Zika virus disease to EUMS in the European continent is considered very low.

2.2.2. Risk for transportation of immature stages of mosquitoes infected with Zika virus

Vertical transmission of Zika virus from the adult mosquito to eggs may be possible (Diallo et al., 2014), but little evidence has been published to date. However, it should be mentioned that vertical transmission of Dengue virus is possible in *Aedes aegypti* and *Aedes albopictus* mosquitoes. Although *Aedes albopictus* has been introduced and established in some areas in continental EUMS, there is no evidence to support the possibility that imported infected immature stages of mosquitoes have played a role in the introduction of Dengue or Chikungunya fevers to EUMS.

2.2.3. Options for health measures to reduce the risk for transportation through ships or sea freight of infected *Aedes* mosquitoes with Zika virus or IMS

Legal issues to be considered for health measures implementation (this is currently under further review by WHO IHR/Legal and will be revised as appropriate)

The WHO statement on the 2nd meeting of IHR Emergency Committee on Zika virus (WHO, 2016b) includes official IHR Temporary Recommendations to States Parties on vector control which generally apply including in the context of international ship traffic:

- Vector surveillance, including the determination of mosquito vector species and their sensitivity to insecticides, should be enhanced to strengthen risk assessments and vector control measures.
- Vector control measures and appropriate personal protective measures should be aggressively promoted and implemented to reduce the risk of exposure to Zika virus.
- Countries should strengthen vector control measures in the long term, and the Director-General of WHO should explore the use of IHR mechanisms, and consider bringing this to a forthcoming World Health Assembly, as means to better engage countries on this issue. These are subject to revision by the Director-General on advice of the IHR Emergency Committee going forward.

Currently, there are no official IHR temporary or standing recommendation from WHO for health measures focusing specifically on ships or their freight (as compared to aircraft¹) disembarking from Zika affected areas.

There are specific provisions under the IHR which authorise and regulate inspections of ships (and other conveyances) and application of follow-up control measures including specifically disinsection under certain circumstances. Under Article 27 for example, based on certain information/evidence there is authorization to disinsect ships subject to various requirements; Article 39 and Annex 3 provide the framework for Ship Sanitation Certificates and related inspection/measures relating to conveyances also potentially involving disinsection. As described below, there are numerous other provisions in the IHR which address elements of these inspections and control measures. Together these and additional provisions constitute the IHR framework to be followed for the context of disinsection.

¹ Standard WHO recommendations regarding vector control at airports should be implemented in keeping with the IHR (2005). Countries should consider the disinsection of aircraft.

One part of this framework under the IHR 2005, relates to requirements for application of “additional [health] measures” to international traffic to respond to public health emergencies of international concern as well as the wide range of international public health risks. Under Article 43 and related provisions (including Articles 27.1, 23.2 and 28.2) State Party determinations whether to apply a range of major health measures to international traffic including those significantly interfering with international traffic, must be based upon: (a) *scientific principles*; (b) *available scientific evidence of a risk to human health*, or where such evidence is insufficient, the available information including from WHO and other relevant intergovernmental organizations and international bodies; and (c) *any available specific guidance or advice from WHO*. If the implementation of additional health measures including disinsection of ships, containers, cargoes, etc. cause significant interference with international traffic, then a State Party implementing these additional health measures shall inform WHO, within 48 hours of implementation, of such measures and their health rationale (unless covered by a Temporary Recommendation). WHO shall share this information with other States Parties and shall share information regarding the health measures implemented. Significant interference with international traffic generally means the refusal of entry or departure of international travelers, baggage, cargo, containers, ships, goods, and the like, or their delay, for more than 24 hours (IHR article 43).

Based on the text of Article 43 (and others concerning additional measures), vector control measures such as disinsection may under some circumstances constitute “additional measures”. However, in the specific context of disinsection, as noted a number of IHR provisions specifically provide for implementing vector control measures such as disinsection in certain circumstances. At present, where these and the other requirements in the IHR are specifically followed, and standard measures applied on a routine basis, the separate requirements under Article 43 concerning additional measures are generally not expected to present concerns in most cases as they would in any event be based on scientific principles, scientific evidence and related information, and available WHO advice. However, under some circumstances concerns under Article 43 may arise, such as where the other IHR requirements or temporary recommendations are not followed, measures applied are not routine or standard and where the effect is significant interference with international traffic. These same issues would apply to the related provision in Annex 5 concerning application of vector control measures to ships arriving from an area affected by a vector-borne disease if those vectors are present in the countries of arrival.

All health measures taken pursuant to IHR shall be initiated and completed without delay, and applied in a transparent and non-discriminatory manner (IHR Article 42).

The competent authority at the port is responsible for the supervision of any disinsection of baggage, cargo, containers, ships, goods, postal parcels, as appropriate under these Regulations. They are also responsible for advising ship operators, as far in advance as possible, of their intent to apply control measures to a ship, and shall provide, where available, written information concerning the methods to be employed (IHR Article 22).

Goods, other than live animals, in transit without transshipment shall not be subject to health measures under IHR or detained for public health purposes unless justified as additional health measures in accordance with Article 43 authorized by applicable international agreements (IHR Article 33).

States Parties shall ensure, as far as practicable, that a) container shippers use international traffic containers that are kept free from sources of infection or contamination, including vectors and reservoirs, particularly during the course of packing; b) container loading areas are kept free from sources of infection or contamination, including vectors and reservoirs; c) whenever, in the opinion of a State Party, the volume of international container traffic is sufficiently large, the competent authorities shall take all practicable measures consistent with IHR, including carrying out inspections, to assess the sanitary condition of container loading areas and containers in order to ensure that the obligations contained in IHR are implemented; d) facilities for the inspection and isolation of containers shall, as far as practicable, be available at container loading areas; e) container consignees and consignors shall make every effort to avoid cross-contamination when multiple-use loading of containers is employed (IHR Article 34).

Charges for application of health measures to baggage, cargo, containers, conveyances, goods or postal parcels are regulated as per IHR Article 41.

According to IHR Annex 4, States Parties shall indicate in writing the measures applied to cargo, containers or conveyances, the parts treated, the methods employed, and the reasons for their application. This information shall be provided in writing to the person in charge of a ship, on the Ship Sanitation Control Certificate. For other cargo and containers, States Parties shall issue such information in writing to consignors, consignees, carriers, or their respective agents.

In regards to the disinsection methods, according to IHR Annex 5, when there are methods and materials advised by WHO for vector control measures, these should be employed by the State Parties unless others are as safe and reliable. WHO has not issued ship specific measures in response to the PHEIC, but general advice by WHO for vector control can be found at <http://www.who.int/whopes/en/>. Moreover, WHO guidance for vector surveillance and control at ports, airports, and ground crossings is available at: http://apps.who.int/iris/bitstream/10665/204660/1/9789241549592_eng.pdf (WHO, 2016a). It is generally for each country to decide on the technique used to obtain an adequate level of control of the public health risk at issue as provided in the IHR; where specific methods or materials are advised by WHO these should be used unless other methods are as safe and reliable. (Article 27.1; Annex 5.2), provided that are applied according to IHR article 22, *“disinsection... and other sanitary procedures shall be carried out so as to avoid injury and as far as possible discomfort to persons, or damage to the environment in a way which impacts on public health, or damage to baggage, cargo, containers, conveyances, goods and postal parcels”*. If vectors are found on board a ship, then this fact and the control measures applied should be noted to the Ship Sanitation Control Certificate.

Subject to the relevant IHR provisions disinsection of freight could be applied to the departing area, as part of the shipment procedures or during the sea voyage. However, the State Party

should have the capacity to apply the requested disinsection measures, once the ship or the cargo container arrives at the point of entry, since according to IHR Article 28 ships shall not be refused free pratique by States Parties for public health reasons; in particular, they shall not be prevented from embarking or disembarking, discharging or loading cargo or stores, or taking on fuel, water, food, and supplies. States Parties may subject the granting of free pratique to inspection and, if a source of infection or contamination is found on board, the carrying out of necessary disinfection, decontamination, disinsection or deratting, or other measures necessary to prevent the spread of the infection or contamination. Consequently, countries requesting ship or cargo or container disinsection must also have the capacity to implement or supervise such measures at their port.

Issues about methods and means for disinsection

In addition to the above-mentioned provisions, methods and means for disinsection should be in accordance with the European legislation (Commission Delegated Regulation (EU) No 1062/2014; Commission Delegated Regulation (EU) No 1078/2014; Regulation (EC) No 1272/2008; Regulation (EC) No 1907/2006; Regulation (EU) No 528/2012; Regulation (EU) No 649/2012).

Any application of pesticides on board ships should also comply with the International Maritime Dangerous Goods Code including the Maritime Organisation Recommendations on the Safe Use of Pesticides in Ships (IMO, 2010), and the International Maritime Fumigation Organisation Code of Practice (International Maritime Fumigation Organisation (IMFO), 2010).

The following are indicative substances/products that are used in European countries: for adult mosquito control Pyrethrin (1%), Pyrethroids; for larval control Spinosad, diflubenzuron, *Bacillus thuringiensis* serotype israelensis, S-methoprene, Pyriproxyfen, Aquatain; for pupal control Aquatain. For egg suppression, there are no effective methods available.

The disinsection methods targeting to kill adult mosquitoes are not necessarily effective to kill eggs. It should be noted that *Aedes albopictus* invaded EU countries through eggs that were laid in imported used tyres and probably not through the other life cycle stages. Larvae and pupae need different disinsection methods from adult mosquitoes. Certain types of goods such as ornamental plants (mainly plant cuttings), would need special disinsection methods to avoid damage.

Examples of other treatments employed in other countries are the following: according to the laws of New Zealand used vehicle parts (containerized), including those imported for dismantling and used tyres (deflated or not on rims) must be fumigated prior to receiving biosecurity clearance with: a) heat (60°C / 20 minutes in the coldest location on the vehicle); or b) methyl bromide (48gm/24hrs/10-15°C or 40gm/24hr/16-21°C) and c) break bulk cargo must be treated no more than 48 hours prior to shipment; d) containerised cargo must be treated either prior to shipment, or within 24 hours on arrival at the port of discharge (Zealand, 2014).

In the US the following methods have been applied to used tyres as reported by Reiter P: *“fumigation with at least two pounds (0.9 Kilogrames) of methyl bromide per 1,000 ft.3 (28.3 m3) for 24 h; application of dry heat at 120°F (48.9°C) for more than 30 min; steam cleaning; or cleaning with a pressurized spray of detergent/water solution at 88°C (190°F). The exporter is required to sign a certificate, specifying the method of disinsection that was used and the date of the treatment. This certificate must be cosigned by the importer or the importer's agent during clearance by the U.S. Customs Service. The cargo cannot be released unless accompanied by a certificate validated according to these rules. Shipments without correct documentation are transported to a holding site and treated at the shipper's expense”* (Reiter, 1998).

In EU according to the Regulation No 1005/2009 on substances that deplete the ozone layer methyl bromide is no longer allowed as a biocide to be used for fumigation in the EU, except *“in an emergency, where unexpected outbreaks of particular pests or diseases so require, the Commission may, at the request of the competent authority of a Member State, authorise the temporary production, placing on the market and use of methyl bromide, provided that the placing on the market and use of methylbromide are allowed respectively under Directive 91/414/EEC and Directive 98/8/EC. Such authorisation shall apply for a period not exceeding 120 days and to a quantity not exceeding 20 metric tonnes and shall specify measures to be taken to reduce emissions during use”* (Regulation (EC) No 1005/2009).

Certain options for health measures and issues to be considered

The following paragraphs analyze certain options for health measures and issues to be considered in conjunction with the legal requirements mentioned above.

- Inspection of all ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter: this would require identification of ships that have called an affected area. The updated WHO situation reports can be found at: <http://www.who.int/emergencies/zika-virus/situation-report>. Moreover, this requires available trained personnel for inspection of ships, containers, and cargoes, as well as capacity to apply or supervise control measures in case of evidence of public health risk including vectors exists. Identification of vectors during an inspection is a difficult process and would require a thorough examination of the high-risk ship places or the presence of mosquitoes at any stage. Inspection can identify conditions supporting mosquito growth and breeding sites on board. The inspection should check the presence and implementation of an effective Integrated Pest Management Plan on board the ship. Control measures would be implemented based on the result of the inspection.
- Inspection of all freight carried on ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter: this would require identification of ships that have called an affected area. The updated WHO situation reports can be found at <http://www.who.int/emergencies/zika-virus/situation-report>. Moreover, this requires available trained personnel for inspection of containers and cargoes, as well as capacity to apply or supervise control measures in case of evidence of public health risk exists. However, it is not justifiable to

inspect all freight on ships that have called an affected area, since calling at a port does not mean that the freight carried has been infested with the local vectors of the port of call. Infestation of goods with mosquitoes normally occurs before or during shipment and is associated with certain types of goods.

- Inspection of certain ships, which carry high-risk goods originated from and/or shipped in an affected area: this would require identification of ships carrying the high-risk goods and identification of the high-risk goods on board ships or after cargo discharge at the port. Captains could be asked to declare if such goods are carried on board before arrival at the port, though, it would be doubtful that information about the origin of the products carried on board the ship is available to the Captain. Customs and/or importers could help health authorities to identify such goods and their origin. This requires available trained personnel for inspection of containers and cargoes, as well as capacity to apply or supervise control measures in case of evidence of public health risk exists. It should be noted that some high-risk goods are transported in special conditions (e.g. cool temperatures) that minimizes the activity of mosquitoes and the possibility to be found during an inspection.
- The requirement by ship operators for enhanced implementation of the Integrated Pest Management (IPM) plan on ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter (see European Manual for hygiene standards and communicable disease surveillance on passenger ship, (EU SHIPSAN ACT Joint action, 2016)). An effective IPM plan should include the following provisions for mosquitoes:
 - Prevention of access of mosquitoes to the ship. In particular, ships should prevent access to mosquitoes from the ship open spaces including doors, windows, ramp, cabin balconies, etc. Prevention of access can be achieved with keeping openings closed, placement of screens, self-closing doors, air curtains, as well as from implementation of checks of incoming supplies and application of protocols for standards to containers and cargoes conditions.
 - Placement of light sticky traps close to ship openings including windows, doors, etc.
 - Documented passive and active surveillance for mosquitoes and conditions favorable to support mosquitoes infestations, conducted by trained ship board crew.
 - Elimination of standing water indoors and at the open decks. Drying up of all water collections on board that could act as breeding sites for mosquitoes.
 - Application of control measures if mosquitoes are found, follow-up inspections and recording of actions and results.
 - Recording of insect bites and complains from travelers.
 - Training of personnel to implement the IPM plan.
- The requirement for disinsection before the arrival of all ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter. Spray Pyrethrin insecticides would kill only the adult mosquitoes, which do not pose a serious risk for importation of Zika infected mosquitoes in EUMS. Disinsection

could be requested to take place on board the ship especially in the ship high-risk areas described previously at the port of departure and additionally 24 and 6 hours before arrival to the anchorage point. Since the risk for introduction of Zika virus with infected mosquitoes through ships is limited this measure is not recommended.

- The requirement for disinsection to all imported shipments of high-risk cargoes originating from an affected area or from areas where IMS species have been established and agreement with importers about special handling of certain goods (e.g. prevention of water accumulation and outdoor storage of used tyres at the place of origin).

Used tyres

Regulations for treatment of used tyres before shipment and requirement to be kept dry during transportation and special storage condition thereafter could be implemented in EU, provided that all EUMS enforce the same regulations effectively (Takken & Knols, 2007). Measures would be also needed to be applied within EU through all the means of transportation to prevent dispersal from the areas that *Aedes albopictus* is present to areas in EU that has not been introduced. This requires the capacity of the points of entry – ports in the EUMS to inspect representative samples of used tyres and to implement control measures to the imported goods in case of deficiencies, at the port facilities. Moreover, it requires regulation enforcement and inspections at the storage facilities at destination. Limitations in the enforcement of such regulation are the challenging and time consuming inspection process of containers and the practical difficulties in implementing disinsection in a potentially large number of wet or infested tyres, as well as the low effectiveness of methods for the suppression of mosquito eggs.

Ornamental plants requiring water during transportation

Regulations for the transportation of imported ornamental plants that require the presence of water containerized or in a sealable hold space and disinsection of the container or the sealable hold space ten days after shipment and before opening, could be implemented in EU, provided that all EUMS enforce the same regulations effectively for all imported ornamental plants that require water during transport. Measures would be also needed to be applied within EU to prevent dispersal from the areas that *Aedes albopictus* is present to areas in EU that has not been introduced. This requires the capacity of the points of entry – ports in the EUMS to disinsect the imported goods at the port facilities. Limitations in the enforcement of such regulation are the challenging and time consuming inspection.

Enforcement of special regulations for disinsection before shipment of used tyres and ornamental plants and for standards about the transportation of dry used tyres has not been effective in preventing IMS dispersal in the US and other countries, but has been effective in New Zealand (an islands country) to prevent the introduction of IMS.

Table: Summary of considerations for health measures on ships and cargoes

Health measure	Expected outcome					Opinion of the working group			
	Identification of mosquitoes, breeding sites	Elimination of breeding sites	Prevention of egg deposition	Killing of adult mosquitoes	Killing of immature mosquitoes stages	Acceptability by industry	Feasibility	Resources required	Cost effectiveness
Inspection of all ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter and control measures as needed	Partially	Partially	No	No	No	Moderate to low	Low	High	Low
Inspection of all freight carried on ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter and control measures as needed	Partially	Partially	No	No	No	Low	Low to moderate	High	Low
Inspection of certain ships, which carry high risk goods originated from and/or shipped in an affected area and control measures as needed	Partially	Partially	No	No	NO	Moderate	High	Moderate	Moderate
Requirement by ship operators for enhanced implementation of the Integrated Pest Management Plan	Yes	Yes – Partially	Partially	Partially	Partially	Moderate	Moderate	Moderate	High
Requirement for disinsection	No	Partially -	Partially	Partially	Partially				

before arrival of all ships that have called an affected area from commencement of voyage, or within past 30 days, whichever is shorter		No				Low	Low	High	Low
Requirement for disinsection to all imported shipments of high risk cargoes originating from an affected area and agreement with importers about special handling of certain goods before shipment	No	Partially	Partially	Partially	Partially	Moderate	High	Moderate	High

3. Health measures on a routine basis to prevent introduction of invasive mosquitoes in Europe

Measures of EUMS for the surveillance, prevention of introduction and establishment of IMS is a continuing effort. IMS include *Aedes aegypti*, *Aedes albopictus*, *Aedes atropalpus*, *Aedes japonicas*, *Aedes koreicus* and *Aedes triseriatus*. EUMS could be advised to enhance the routine measures and management plans that should be applied at EU ports at all times in accordance with IHR 2005. These efforts must be enhanced considering the PHEIC of Zika virus. In addition, ship operators need to implement an Integrated Pest Management Plan on board and to keep ships in good sanitary conditions.

The introduction and re-establishment of *Aedes aegypti* (and other IMS including *Aedes albopictus*, *Aedes atropalpus*, *Aedes japonicas*, *Aedes koreicus* and *Aedes triseriatus*) through sea freight is possible in EUMS. According to ECDC technical report, *Aedes aegypti* has been found in Russia 2001, Portugal-Madeira 2004, Abkhazia and Georgia 2007, Netherlands 2010 (limited local distribution) (ECDC, 2012). Moreover, *Aedes aegypti* mosquitoes are present in the EU Overseas Countries and Territories and Outermost Regions in the Americas and the Caribbean and local transmission of Zika virus disease is reported in several of them: French Guiana, Guadeloupe, Martinique, Saint Martin and Sint Maarten (ECDC, 2016a). Ports of these areas should be further alerted and carefully apply the measures mentioned above.

Specific guidelines for surveillance of IMS have been published by ECDC at the ECDC Guidelines for the surveillance of invasive mosquitoes in Europe (See more at http://ecdc.europa.eu/en/publications/_layouts/forms/Publication_DispForm.aspx?List=4f55ad51-4aed-4d32-b960-af70113dbb90&ID=673) and for Preparedness planning guide for diseases transmitted by *Aedes aegypti* and *Aedes albopictus* (See more at http://ecdc.europa.eu/en/publications/_layouts/forms/Publication_DispForm.aspx?List=4f55ad51-4aed-4d32-b960-af70113dbb90&ID=1464) (ECDC, 2016b).

Measures that should be implemented on a routine basis at ports are the following:

A) Routine surveillance to commercial trade goods associated with transport of IMS as described in the ECDC guideline (ECDC, 2012), which includes a decision diagram for the implementation of surveillance of IMS. Measures that will be taken differ depending on three different scenarios: a) no locally established IMS, b) locally established IMS, c) widely established IMS (ECDC, 2016b). Potentially infested cargoes include used tyres, ornamental plants (mainly plant cuttings), other goods and equipment at concern risk materials that can retain water and are stored outdoors in their country of origin, repatriation of construction and military material and vehicles, stone fountains.

B) Routine inspections of ships for the issuance of Ship Sanitation Certificate or focused inspection on ships coming from areas where IMS are present at the first EU port to identify

evidence of the presence of IMS at any stage of their life cycle. Inspection of ships should focus on identification of mosquitoes at all stages of their life cycle, as well as potential breeding sites such as areas with standing water (lifeboat covers, bilges, scuppers, awnings, gutters, air treatment plants, etc.). Specific guidance for passenger ship inspections and vector control can be found in the European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships (http://www.shipsan.eu/Portals/0/docs/Manual_October_2011.pdf, (EU SHIPSAN ACT Joint action, 2016)) and for all types of ships in the WHO Handbook for inspection of ships and issuance of Ship Sanitation Certificates (http://www.who.int/ihr/publications/handbook_ships_inspection/en/).

C) Application of vector control measures if an inspection reveals evidence of infestation. See paragraph 2.2.1 for health measures.

D) Implementation of the Integrated Pest Management on board ships, focusing on mosquitoes monitoring, elimination of breeding sites and control measures if evidence is found. Ship operators according to IHR 2005 Article 24 are obliged to keep permanently ships for which they are responsible free of sources of infection or contamination, including vectors and reservoirs. The European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships in Chapter 6 (http://www.shipsan.eu/Portals/0/docs/Manual_October_2011.pdf, (EU SHIPSAN ACT Joint action, 2016)) describes the legal requirements and the recommended standards in regards to the implementation of an Integrated Pest Management Plan for the prevention and control of pests including mosquitoes. The WHO Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates under IHR include the provisions in regards to pest management and control for all types of ships (http://www.who.int/ihr/publications/handbook_ships_inspection/en/). WHO Guide to ship sanitation includes a special chapter related to vector control on ships (http://www.who.int/water_sanitation_health/publications/2011/ship_sanitation_guide/en/).

E) Vector surveillance and vector control at the ports to a minimum distance of 400 metres from the port areas and facilities that are used for operations involving travelers, conveyances, containers, cargo and postal parcels, with the extension of the minimum distance if vectors with a greater range are present (IHR 2005 Annex 5). For *Aedes* mosquito species, 400 meters could be considered as sufficient. Port specific integrate pest management plan including vector surveillance and control is important to be implemented. WHO guidance for vector surveillance and control at ports, airports, and ground crossings is available at: http://apps.who.int/iris/bitstream/10665/204660/1/9789241549592_eng.pdf (WHO, 2016a).

References

Anselmo, M., De Leo, P., Rosone, A., Minetti, F., Cutillo, A., Vaira, C., & Menardo, G. (1996). [Port malaria caused by *Plasmodium falciparum* a case report]. *Infez Med*, 4(1), 45-47.

- Commission Delegated Regulation (EU) No 1062/2014. Commission Delegated Regulation (EU) No 1062/2014 of 4 August 2014 on the work programme for the systematic examination of all existing active substances contained in biocidal products referred to in Regulation (EU) No 528/2012 of the European Parliament and of the Council (Text with EEA relevance).
- Commission Delegated Regulation (EU) No 1078/2014. Commission Delegated Regulation (EU) No 1078/2014 of 7 August 2014 amending Annex I to Regulation (EU) No 649/2012 of the European Parliament and of the Council concerning the export and import of hazardous chemicals Text with EEA relevance.
- Craven, R. B., Eliason, D. A., Francy, D. B., Reiter, P., Campos, E. G., Jakob, W. L., . . . et al. (1988). Importation of *Aedes albopictus* and other exotic mosquito species into the United States in used tires from Asia. *J Am Mosq Control Assoc*, 4(2), 138-142.
- Delmont, J., Brouqui, P., Poullin, P., Pouymayou, C., Faugere, B., Ottomani, A., . . . Bourgeade, A. (1995). [Apropos of 2 cases of severe malaria contracted in the port of Marseille]. *Bull Soc Pathol Exot*, 88(4), 170-173.
- ECDC. (2012). Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: ECDC.
- ECDC. (2016a). Rapid Risk Assessment. Zika virus disease epidemic: potential association with microcephaly and Guillain-Barré syndrome. Fifth update, 12 April 2016. Stockholm: ECDC.
- ECDC. (2016b). Zika virus disease epidemic: Preparedness planning guide for diseases transmitted by *Aedes aegypti* and *Aedes albopictus*: Stockholm: ECDC.
- EU SHIPSAN ACT Joint action. (2016). European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships.
- IMO. (2010). The International Maritime Dangerous Goods Code (IMDG Code). Volumes 1, 2 and Supplement. Including the International Maritime Organisation Recommendations on the Safe Use of Pesticides in Ships revised: IMO Publishing.
- International Maritime Fumigation Organisation (IMFO). (2010). Code of Practice (COP) On Safety And Efficacy For Marine Fumigation: IMFO.
- Laird, M., Calder, L., Thornton, R. C., Syme, R., Holder, P. W., & Mogi, M. (1994). Japanese *Aedes-Albopictus* among 4 Mosquito Species Reaching New-Zealand in Used Tires. *Journal of the American Mosquito Control Association*, 10(1), 14-23.
- Lounibos, L. P. (2002). Invasions by insect vectors of human disease. *Annual Review of Entomology*, 47, 233-266. doi: DOI 10.1146/annurev.ento.47.091201.145206
- Nguyen, H. T., Whelan, P. I., Finlay-Doney, M., & Ying Soong, S. (2010). Interceptions of *Aedes aegypti* and *Aedes albopictus* in the port of Darwin, NT, Australia, 25 January and 5 February 2010. 17(1).
- Peleman, R., Benoit, D., Goossens, L., Bouttens, F., Puydt, H. D., Vogelaers, D., . . . Van de Woude, K. (2000). Indigenous malaria in a suburb of Ghent, Belgium. *J Travel Med*, 7(1), 48-49.
- Regulation (EC) No 1005/2009. Regulation (EC) No 1005/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 on substances that deplete the ozone layer.
- Regulation (EC) No 1272/2008. Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (Text with EEA relevance)
- Regulation (EC) No 1907/2006. Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.
- Regulation (EU) No 528/2012. Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products Text with EEA relevance.
- Regulation (EU) No 649/2012. Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals Text with EEA relevance
- Reiter, P. (1998). *Aedes albopictus* and the world trade in used tires, 1988-1995: The shape of things to come? *Journal of the American Mosquito Control Association*, 14(1), 83-94.

- Rubin, L., Nunberg, D., & Rishpon, S. (2005). Malaria in a seaport worker in Haifa. *Journal of Travel Medicine*, *12*(6), 350-352.
- Takken, W., & Knols, B. G. J. (2007). *Emerging pests and vector-borne diseases in Europe*. Wageningen: Wageningen Academic Publishers.
- Tatem, A. J., Hay, S. I., & Rogers, D. J. (2006). Global traffic and disease vector dispersal. *Proceedings of the National Academy of Sciences of the United States of America*, *103*(16), 6242-6247. doi: 10.1073/pnas.0508391103
- WHO. (2008). International Health Regulations (2005) Second edition.
- WHO. (2011). Guide to ship sanitation (third edition). Global reference on health requirements for ship construction and operation.
- WHO. (2016a). Vector Surveillance and Control at Ports, Airports, and Ground Crossings.
- WHO. (2016b). WHO statement on the 2nd meeting of IHR Emergency Committee on Zika virus and observed increase in neurological disorders and neonatal malformations.
- Zealand, M. o. P. I. o. N. (2014). Import Health Standard for Vehicles, Machinery and Tyres.