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**Emission Scenario Document for Wood Preservatives
PART2**

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Emission Scenario Document for Wood Preservatives

[Part 2]

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5. EMISSION ESTIMATION FOR TREATED WOOD IN SERVICE

5.1 Introduction

5.1.1 Background

177. This Chapter proposes an approach to estimate environmental emissions from treated wood in service. Based on the discussions during the Belgirate Workshop [OECD 2000c], the Expert Group agreed on the methods to be used to:

1. estimate the emissions during the service life of treated wood
2. calculate an initial concentration of an active ingredient(s) or any substance of concern in a wood preservative formulation in the primary receiving environmental compartments.

178. This Chapter is restricted to the case where a structure is built of previously industrially treated wood, and potential emissions to the environment result only from leaching of a substance from treated wood. The emissions from treated wood which is treated *in-situ* either 1) preventively, after building of the wooden structure, or 2) for curative purposes after being in service for a certain time, are dealt with in Chapter 6.

5.1.2 Sources relied on

179. Scenarios from the following documents were used during the Belgirate Workshop and the meetings of the Expert Group:

1. *Uniform System for the Evaluation of Substances 3.0 (USES 3.0)*. National Institute of Public Health and the Environment (RIVM), Ministry of Housing, Spatial Planning and the Environment (VROM), Ministry of Health, Welfare and Sport (VWS), The Netherlands. [Reference: RIVM, VROM and VWS 2000].
2. *Guidelines for assessment of the environmental risks associated with industrial wood preservatives*. Danish Environmental Protection Agency, Pesticides Division. 12 February 1997 [Reference: DK EPA 1997].
3. Background document for OECD Belgirate workshop on environmental exposure scenarios from treated wood. Environmental Focus Group. Version 4, February 2000. [Reference: EFG 2000].
4. *A protocol for the environmental risk assessment of wood preservatives*. European Wood Preservative Manufacturers Group. Version 2.3, 28 February 2000 [Reference: EWPM 2000].
5. Emission scenarios used in the Finnish Environment Institute for wood preservatives in treated wood in service. Finnish Environment Institute. 11 November 1999 [Reference: FEI 1999].
6. *Konzept für die Prüfung und Bewertung der Umweltverträglichkeit von Holzschutzmitteln*. Umweltbundesamt Berlin. UBA texte. Bringezu, S. February 1992 [Reference: UBA 1992].

5.2 Selection of representative scenarios

180. Based on the biological hazard classification of the European Committee for Standardisation [CEN 1992], the main uses of treated wood materials have been identified and classified in the so-called 'Hazard Classes'. It should be noted that the hazard being classified in this system is not the environmental

hazard, but the hazard associated with attack by insects and/or fungi to wooden commodities. This hazard is a major criterion for the choice of suitable wood species, wood preservatives and treating methods in order to obtain the optimal protection for a certain commodity. The Technical Committee 165 'Timber Structures' of the International Organisation for Standardisation (ISO) has recently agreed on a similar classification system. Table 5-1 provides the ISO 'Use Classes'.

Table 5.1
Use Classes according to the ISO draft standard 'An international framework for classifying wood products durability based on use classes'

Class	Service Conditions		Typical Uses	Biological Agents		
1	Interior, dry		Framing, roof timbers	Insects	A	wood boring beetles
					B	as A + termites
2	Interior, damp		Framing, roof timbers	As # 1	A	+ decay + mould [allergic potential]
					B	+ termites
3	A	Protected exterior	Exterior joinery	As # 2 + disfiguring fungi		
	B	Unprotected exterior	Deck boards	As # 2		
4	A	In-ground	Fence posts	As # 3 + soft rot		
	B	In-ground, severe, fresh water	Cooling tower	As # 3		
5	Marine		Piles	As # 4	A	Teridinids + Limnoria
					B	creosote tolerant Limnoria
					C	Sphaeroma, Pholads

Note: It may not be necessary to protect against all biological agents listed, as they may not be present or economically important in all geographic regions, in all service conditions.

181. Knowledge of the main uses of treated wood has helped the selection of representative scenarios for each (Hazard or Use¹) Class, based upon the set of scenarios that are already used in different OECD (mainly European) countries (see references in Section 5.1.2). These emissions scenarios are based on timber examples from each Use (Hazard) Class and were inventoried, described and compared in Document 3 'Wood Preservatives and Environmental Exposure: Overview of Emission Scenarios for Treated Wood in Service' of the OECD Belgirate Workshop [OECD 2000e].

182. At the OECD Belgirate [OECD 2000c], the appropriateness of these scenarios was reviewed with respect to treated commodities used and their dimensions. In addition, ratios of surfaces and volumes of treated wood to the receiving environmental compartments were assigned for most of the scenarios recommended. The Expert Group has further refined some scenarios where appropriate.

¹ The term 'Use Classes' is considered more appropriate than the term 'Hazard Classes' to avoid any potential confusion by relating the word 'hazard' with the environmental hazard that a wooden commodity may cause.

183. It is considered that these scenarios would cover the main uses of treated wood in OECD member countries. However, the selection is not meant to be exhaustive and for specific situations, additional scenarios may be needed.

184. A description of the Use Classes is presented in **Table 5.2** together with the corresponding scenarios and primary receiving environmental compartments. No scenarios are presented for wood of Use Classes 1 and 2, since for this wood class the potential emissions from treated wood to the outer environment are considered negligible. However, these emissions are relevant for human exposure assessment. Indoor treatments are also relevant for the exposure assessment of bats in countries where bats are protected animals (e.g. in most European countries) [Chadwick J *et al.*, 1992; Mitchell-Jones AJ *et al.*, 1989]. Bats are exposed to treated wood via contact.

Table 5.2
Use Classes with representative scenarios

Class	Description	Scenarios proposed	Primary receiving environmental compartment
1	Situation in which wood or wood-based product is under cover, fully protected from the weather and not exposed to wetting	<i>no scenario</i>	Indoor/outdoor air <i>(emissions to outdoor air are considered negligible)</i>
2	Situation in which wood or wood-based product is under cover, fully protected from the weather but where high environmental humidity can lead to occasional but not persistent wetting	<i>no scenario</i>	
3	Situation in which wood or wood-based product is not covered and not in contact with the ground. It is either continually exposed to the weather or is protected from the weather but subject to frequent wetting	a. fence b. noise barrier c. house d. bridge	soil
4	Situation in which wood or wood-based product is in permanent contact with the ground or fresh water and thus is permanently exposed to wetting, divided into:		
4a	Wood in contact with the ground	a. transmission pole b. fence post	soil
4b	Wood in contact with fresh water	a. jetty in lake [#] b. sheet piling in waterway	freshwater
5	Situation in which wood or wood-based product is permanently exposed to salt water	harbour wharf	seawater

**It has to be noted that the above water part of jetties and wharf can be made of Use Class 3 wood, whereas the submerged part belongs to Use Class 4 and 5 respectively. For reasons of simplicity, the jetty and wharf scenarios are described under Use Class 4b and 5 respectively.*

5.3 Calculation of the local environmental concentration

5.3.1 General Considerations

185. In this Chapter, methods are provided to calculate the concentration of an active ingredient or any substance of concern in a wood preservative formulation in the local environment, that results from leaching out of treated wood-in-service. The calculations proposed here do not take into account removal

processes of the substance from the receiving compartment due for example to degradation, volatisation, leaching to ground water. Such removal processes are considered in the calculations proposed in Chapter 7.

186. The general equations proposed in Section 4.1.6 for estimation of emissions from industrially treated wood during storage, apply also for the scenarios of treated wood-in-service. For a certain time period of service-life the local environmental concentration:

- in a water body receiving the substance's emissions from treated wood, can be calculated according to the equation:

$$C_{local\ water, leach, time} = \frac{Q_{leach, time}}{V_{water}} \quad (5.1)$$

- in soil according to the equation:

$$C_{local\ soil, leach, time} = \frac{Q_{leach, time}}{V_{soil} \cdot RHO_{soil}} \quad (5.2)$$

where:

<i>Figure 1</i> $local_{water, leach, time}$	Fi§ local concentration of an active ingredient in a receiving water body resulting from leaching from treated wood, due to rainfall or due to direct contact with the water body, after a certain time period of service life, considered for assessment [kg.m ⁻³]
<i>Figure 3</i> $local_{soil, leach, time}$	Fi§ Figure 5 local concentration of an active ingredient in soil resulting from leaching from treated wood, due to rainfall or due to direct contact with the soil, after a certain time period of service life, considered for assessment [kg.kg ⁻¹]
<i>Figure 6</i> $leach, time$	Fi§ Figure 8 cumulative quantity of an active ingredient, emitted to the relevant environmental compartment due to leaching from treated wood, within a certain time period of service, considered for assessment [kg]
<i>Figure 9</i> $water$	Fi§ Figure 11 volume of the receiving water body [m ³]
<i>Figure 12</i> $soil$	Fi§ Figure 14 (wet) soil volume [m ³]
<i>Figure 15</i> HO_{soil}	Fi§ Figure 17 (wet) soil bulk density [kg.m ⁻³]

187. It should be noted that $C_{local\ water, leach, time}$ and $C_{local\ soil, leach, time}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

188. All concentrations in soil ($C_{local\ soil}$) estimated in this document are expressed in weight of wet soil. If desired, conversion to dry weight can be performed according to the equation 7.12 proposed in Section 7.1.3 of Chapter 7.

189. The estimation of $Q_{leach, time}$ should preferably be based on representative data from well-designed and standardised leaching tests. The general principles for this estimation are described in the following Section, while the specific methodologies and calculations are described in detail in Appendix 2.

190. For the volumes of the receiving compartments (V_{water} and V_{soil}), the relevant scenarios propose default values (see Appendix 3).

5.3.2 Calculation of Local Emissions from Treated Wood-in-Service

191. The local emission of an active ingredient (or any substance of concern in a wood preservative formulation) from treated wood during service as a result of leaching, $Q_{leach,time}$, can be estimated from the results of a leaching test combined with the leachable wood area, considered in the relevant scenarios:

$$Q_{leach,time} = AREA_{wood} \cdot Q_{leach,time}^* \quad (5.3)$$

where:

<i>Figure 18</i> <i>leach,time</i>	Figt	Figure 20	cumulative quantity of an active ingredient, emitted to the relevant environmental compartment due to leaching from treated wood, over a certain time period of service, considered for assessment [kg]
<i>Figure 21</i> <i>*leach,time</i>	Figt		cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a certain time period of service, considered for assessment [kg.m ⁻²]. $Q_{leach,time}^*$ is calculated based on the results of a leaching test.
<i>Figure 23</i> <i>REA_{wood}</i>	Figt		leachable treated wood area [m ²], proposed in the relevant scenarios

192. The values of $Q_{leach,time}^*$ for each of the scenarios, proposed in this document, can be calculated based on the results of well-designed and, if possible, standardised leaching studies. These studies should allow to determine the quantity of an active ingredient (or any substance of concern in a wood preservative formulation) leached out of treated wood per wood surface area and time. The results can then be expressed as a *FLUX*, i.e. quantity of an active ingredient that is leached out of 1 m² of treated wood per day [here expressed in kg.m⁻².d⁻¹], and the $Q_{leach,time}^*$ can subsequently be calculated in principle for any time span of the service life in the respective scenarios. The requirements for the design of appropriate leading tests are given in Appendix 1. Detailed guidance on how the $Q_{leach,time}^*$ can be calculated from the results of such leaching tests is given in Appendix 2.

193. For $AREA_{woods}$, default values are proposed in each scenario (see Appendix 3).

194. Local emissions and concentrations are considered within two different time windows for the service life:

- during the first 30 days of the service life
- during the rest of the service life (> 30 days)

195. The reason for having two time windows is that the releases of the preservative from the treated wood are usually higher in the beginning of service life and level off gradually later on. Furthermore, different chemicals are leached at different rates at different points in time. The 30 day cut-off was recommended by the OECD Belgirate Workshop [OECD 2000c] in order to be coherent with a typical life-cycle period of soil or water organisms. For dynamic scenarios (e.g. release into running water bodies) it is necessary to pay attention to possible acute effects due to peak releases, mainly during the first days of service life.

5.3.2.1 Leaching Tests Required For FLUX Determination

196. In principle, the leaching test should be performed using the contact medium and/or the receiving environmental compartment of the scenario under consideration:

- **‘Wood-in-service’ scenarios that assume contact of treated wood with rain water** (i.e. the scenarios for Use Class 3, and the above soil or fresh/sea water parts of the wood commodities in the scenarios for Use Classes 4a, 4b and 5): In these scenarios the contact medium is rain water whereas the receiving environmental compartment is soil or water.
For these scenarios a leaching test with simulated rainfall should in principle be performed, which would mimic the proposed rainfall pattern, in the storage scenario (see Section 4.1.5) i.e., 3 rain events, lasting ca. 60 min each, every third day with a precipitation of 4 mm.h⁻¹ (i.e. an annual precipitation of 1460 mm.y⁻¹). However, for the reasons explained in Section 4.1.5, the results of a leaching test with wood in direct and continuous contact with water can be used for these scenarios instead.
- **‘Wood-in-service’ scenarios that assume permanent contact of treated wood with fresh or sea water** (i.e. the submerged in fresh or sea water parts of the treated wood commodities in the scenarios for Use Classes 4b and 5 respectively): the contact medium is also the receiving environmental compartment. For these scenarios, a leaching test should be performed with the wood test specimens placed in direct and continuous contact with water. If a product bears claims for use in contact with seawater (Use Class 5), then two sets of a leaching test with wood in direct water contact should be performed: one with de-ionised water and one with simulated seawater. This is due to the fact that review of available literature and experts’ opinions did not allow to conclude whether leaching of a substance from wood in direct contact with saltwater is considerably greater or less than leaching in fresh water. When experience will be gained in the future then the leaching test with simulated seawater can eventually be waived.
- **‘Wood-in-service’ scenarios that assume permanent contact of treated wood with soil** (i.e. the below soil parts of the treated wood commodities in the scenarios of Use Classes 4a). In principle for these scenarios, a leaching test should be performed with the wood test specimens placed in direct and continuous contact with soil. However, the Expert Group agreed that for the initial exposure assessment, the estimation of *FLUX*, can be based on the results of a leaching test with wood in direct contact with water for those substances that are not considered as poorly water soluble substances (PWSS²). If a wood preservative is a PWSS², a leaching study of wood in contact with soil may be required. This should be decided by the regulatory authorities on a case-by-case basis.

The Reasons for the above Conclusion are the Following:

- it is recognised that a test with soil is technically difficult to handle and standardise
- review of available literature data [Peek R, 2001b]:

² Poorly Water Soluble Substances (PWSS) are defined as substances with a limit of water solubility below 100 mg l⁻¹ [ECETOC 2001; OECD 2000f]. (*Annotation: this is consistent with the definition used in the European Technical Guidance Document of Risk Assessment of Existing Substances [EU TGD 1997]*).

PWSS are defined as single component or simple multi-component mixtures (where physical chemical properties are within a narrow range), or complex multi-component mixtures (where there is a wide range in physicochemical properties).

Simple multi-component mixtures (where the components are structurally similar) are considered to be like pure substances and therefore they are considered as PWSS if the solubility of one component is below 100mg l⁻¹.

Complex multi-component mixtures (where components are not structurally related) these are considered poorly water soluble if the solubility of one component is below 1 mg l⁻¹. The differences between these two figures are due to differences in aqueous partitioning behaviour between complex and simple or pure multi-component mixtures. It is noted however that from a risk assessment perspective practical difficulties are typically encountered for substances with a water solubility below 1 mg l⁻¹

- did not allow to generalise that leaching of a substance from wood in direct contact with water is a worst case in comparison to soil contact;
- supported the conclusion that generally leaching of inorganic substances from the below soil part of the treated wood sample is greater than leaching from the above soil part which is exposed to rainfall. Inorganic substances enter soil as dissolved material in the soil pore water which is essentially the same mechanism as for wood in permanent contact with freshwater. It is noted however their dissolution in the pore soil water is influenced by the soil acidity and the moisture and humic acid content of the soil;
- showed that creosote and pentachlorophenol in oil have a different behaviour: gravitational migration from the above soil (or water) parts of the wooden commodities to below soil (or water) parts and then **mass transfer** to soil (or water).
- in light of the above literature review, it is considered that the water solubility of the wood preservative component(s) can be a meaningful trigger to decide whether results from a leaching study using wood in contact with water rather than wood in contact with soil could be used to determine $FLUX_{soil}$.

197. Table 5-3 provides an overview of the type of leaching tests that should be performed for the scenarios of each Use Class.

198. The requirements for the design of appropriate leaching tests, for estimation of $FLUX$ and subsequently of $Q^*_{leach,time}$ for treated wood in direct contact with water, are given in Appendix 1

TABLE 5.3
Overview of the leaching tests required for estimation of *FLUX* in the wood ‘in-service’ scenarios

Use Class	Service conditions	Scenarios for ‘in service’ life stage of treated wood		Contact medium/Receiving env. compartment	Leaching test required for calculation of <i>FLUX</i> for an initial assessment
3	Exterior wood out of ground	House		rain/soil	direct contact with water
		Fence		rain/soil	direct contact with water
		Noise barrier		rain/soil & STP	direct contact with water
4a	In-ground	Transmission pole	above soil part of pole	rain/soil	direct contact with water
			below soil part of pole	soil/soil	<ul style="list-style-type: none"> • direct contact with water if preservatives is not a PWSS² • if preservative is a PWSS, a test with direct contact with soil may be required on a case by case basis
		Fence post	above soil part of post	rain/soil	direct contact with water
			below soil part of post	soil/soil	<ul style="list-style-type: none"> • direct contact with water if preservatives is not a PWSS² • if preservative is a PWSS, a test with direct contact with soil may be required on a case by case basis
4b	Direct contact with fresh water	Jetty	planks of jetty	rain/fresh water	direct contact with water
			poles of jetty	fresh water/fresh water	direct contact with water
		Sheet piling		fresh water/fresh water	direct contact with water
5	Direct contact with sea water	Wharf	planks of wharf	rain/sea water	direct contact with water
			poles of wharf	sea water/sea water	direct contact with: <ul style="list-style-type: none"> - water (de-ionised) - simulated seawater

5.4 Scenario Descriptions and Calculations

199. The emission scenarios, described in the following Sections, were recommended at the OECD Belgirate workshop with respect to:

- representative treated commodities used to build scenarios for each Use (Hazard) Class
- wood dimensions and size of the receiving environmental compartments

The Expert Group has further refined some scenarios, where appropriate.

5.4.1 Class 3: Wood not covered, not in contact with ground, exposed to the weather or subject to frequent wetting

200. For this type of wood, three scenarios are considered: a garden fence, a noise barrier in an urbanised area and a cladded house. Because of the wood to soil ratio, the house scenario represents a *worst case* compared to the fence. It was recommended to use the house scenario preferentially but to keep the fence scenario to gather experience with the procedure. The noise barrier scenario resembles the fence with respect to the wood structure, but includes a possible emission route to a public sewage treatment plant (STP).

5.4.1.1 Fence

Description

201. The scenario describes a fence made of poles with planks in between (see Figure 5-1). The planks are considered as the leachable area from which the active ingredient(s) are leached to soil as a result of rainfall. The structure is considered to be 2 m high and 1 m long.

202. The primary receiving environmental compartment is considered to be soil via rain run-off. Emissions to the air are considered negligible from environmental point of view.

203. It is assumed that:

- the receiving compartment is a rectangular soil box 10 cm deep and at a horizontal distance of 10 cm from one side of the fence. Because the length of the soil compartments is equal to the length of the fence, taking a greater fence length does not influence the result.
- leaching occurs only from one side of the planks. Assuming leaching from both sides does not change the results as the soil volume would be doubled.

A full description of the dimensions of wood and soil volume can be found in Appendix 3.

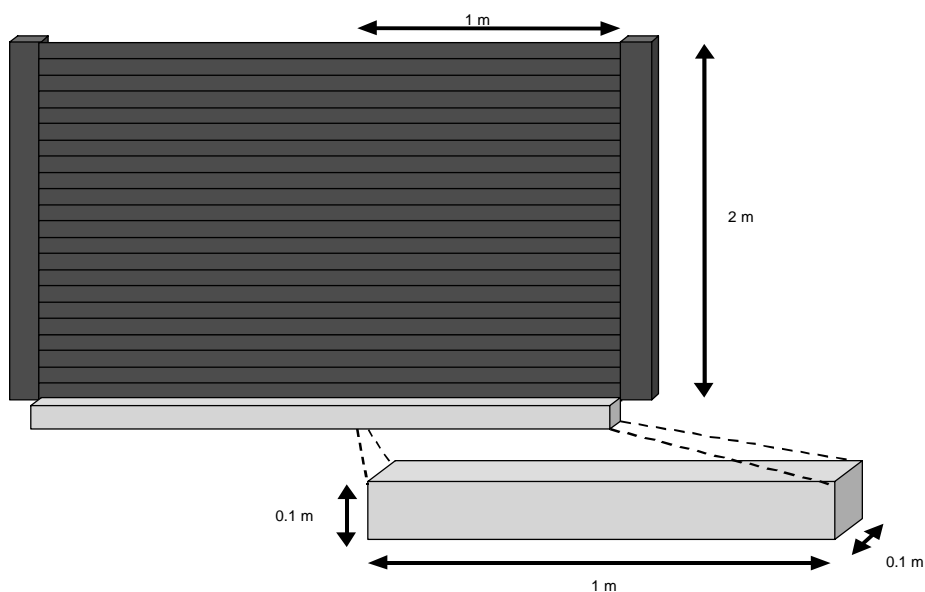


Figure 5-1: Schematic drawing of the fence with receiving soil compartment

Emissions From Treated Wood

Parameters

Scenario: Fence (Use Class 3)	Nomenclature	Value	Unit	Origin
Inputs				
Leachable wood area per m length	$AREA_{fence}$	2	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
(wet) Soil volume per m length	V_{soil}	0,01	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$Clocal_{soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$Clocal_{soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

$$Q_{leach,time1} = AREA_{fence} \cdot Q_{leach,time1}^* \quad (5.4)$$

$$Q_{leach,time2} = AREA_{fence} \cdot Q_{leach,time2}^* \quad (5.5)$$

$$Clocal_{soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (5.6)$$

$$Clocal_{soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (5.7)$$

204. $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching test, are given in Appendix 1. Detailed guidance on how $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ can be calculated from the results of such a leaching test is given in Appendix 2.

205. Based on $Q_{leach,time1}$ and $Q_{leach,time2}$ inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the substance in soil. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

206. It should be noted that $Clocal_{soil,leach,time1}$ and $Clocal_{soil,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

5.4.1.2 Noise barrier

Description

207. The scenario describes a noise barrier that is made of poles with planks in between (see Figure 5-2). The medium size noise barrier in an urbanised area is assumed to be 1000 m long and 3 m high.

208. It is assumed that the leachate resulting from rainfall either ends up directly in the adjacent soil or is collected in the gutter and sewer, and finally enters a municipal sewage treatment plant (STP). Emissions to the air are considered negligible from environmental point of view.

209. Based on information provided by the German UBA and confirmed by the Berlin Senate administration who deals with noise barriers at motorways [Burkhard Wagner, pers. commun. 2001], it is assumed that 70% enters the STP and 30% seeps into the adjacent soil. It is also assumed that leaching occurs only from one side of the planks. A full description of the dimensions of wood and soil volume can be found in Appendix 3.

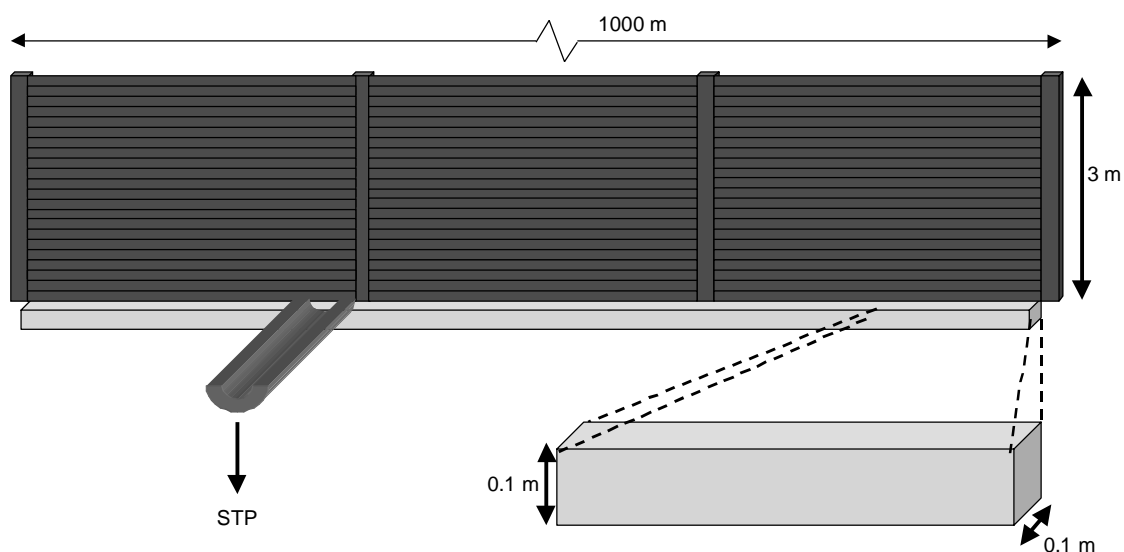


Figure 5-2: Schematic drawing of the noise barrier with receiving compartments

Emissions from Treated Wood

Parameters

Scenario: Noise barrier (Use Class 3)	Nomenclature	Value	Unit	Origin
Inputs				
Leachable area of noise barrier	$AREA_{noise-barrier}$	3000	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
(wet) Soil volume	V_{soil}	10	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Fraction released to soil	F_{soil}	0,3	[-]	D
Fraction released to the STP	F_{STP}	0,7	[-]	D

Parameters, continued

Scenario: Noise barrier (Use Class 3)	Nomenclature	Value	Unit	Origin
Outputs				
Average emission rate of active ingredient to STP over the initial assessment period	$E_{STP,time1}$		[kg.d ⁻¹]	O
Average emission rate of active ingredient to STP over a longer assessment period	$E_{STP,time2}$		[kg.d ⁻¹]	O
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$C_{local,soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$C_{local,soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

STP

Many sewage treatment plant models (e.g. SimpleTreat, EU TGD 1997] require emission rates (E) as an input, i.e. the quantity of the substance entering the STP daily. Therefore, the following formulas suggest calculation of average emission rates over a certain period of assessment.

$$E_{STP,time1} = AREA_{noise-barrier} \cdot F_{STP} \cdot \frac{Q_{leach,time1}^*}{TIME1} \quad (5.8)$$

$$E_{STP,time2} = AREA_{noise-barrier} \cdot F_{STP} \cdot \frac{Q_{leach,time2}^*}{TIME2} \quad (5.9)$$

Soil

$$Q_{leach,time1} = AREA_{noise-barrier} \cdot F_{soil} \cdot Q_{leach,time1}^* \quad (5.10)$$

$$Q_{leach,time2} = AREA_{noise-barrier} \cdot F_{soil} \cdot Q_{leach,time2}^* \quad (5.11)$$

$$C_{local,soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (5.12)$$

$$C_{local,soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (5.13)$$

210. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching tests are given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

211. Based on $Q_{leach,time1}$ and $Q_{leach,time2}$, inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the substance in soil. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

212. It should be noted that $Clocal_{soil,leach,time1}$ and $Clocal_{soil,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

5.4.1.3 House

Description

213. The third scenario describes a timber or timber cladded house. For the calculations, the default value for the height of the claddings is 2.5 m and the circumference of the house is 50 m.

214. The primary receiving environmental compartment is considered to be soil via rain run-off. The default values for the size of the receiving soil are: 10 cm distance from the house and 10 cm deep (see Figure (5-3)). It is considered that leaching of the active ingredient(s) as a result of rainfall occurs only from the outer side of the wood. A full description of the dimensions of wood and soil volume can be found in Appendix 3.

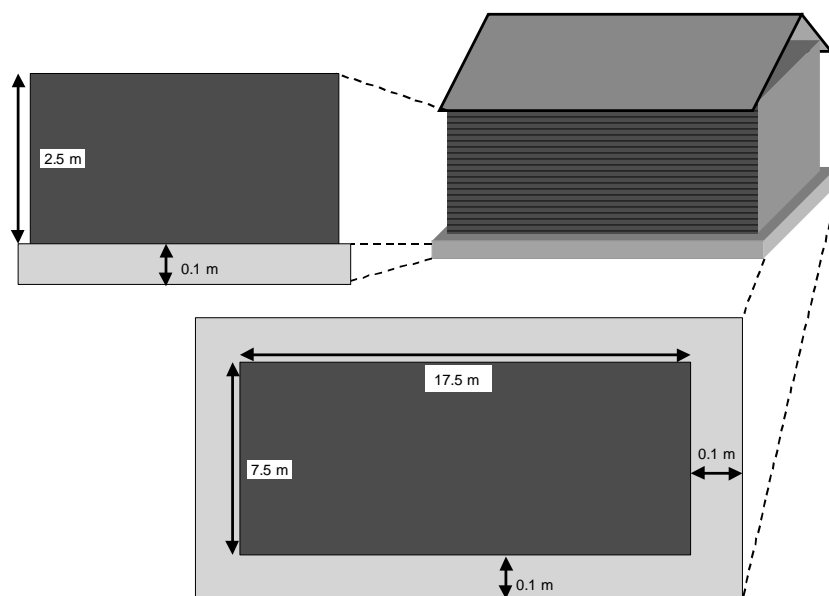


Figure 5-3: Schematic drawing of the timber cladded house with receiving soil compartment.

Emissions from treated wood

Parameters

Scenario: House (Use Class 3)	Nomenclature	Value	Unit	Origin
Inputs				
Leachable wood area	$AREA_{house}$	125	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
(wet) Soil volume	V_{soil}	0,50	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$Clocal_{soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$Clocal_{soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

$$Q_{leach,time1} = AREA_{house} \cdot Q^*_{leach,time1} \quad (5.14)$$

$$Q_{leach,time2} = AREA_{house} \cdot Q^*_{leach,time2} \quad (5.15)$$

$$Clocal_{soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (5.16)$$

$$Clocal_{soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (5.17)$$

215. $Q^*_{leach,time1}$, and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching test are given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

216. Based on $Q_{leach,time1}$ and $Q_{leach,time2}$, inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the

substance in soil. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

216. It should be noted that $C_{local,soil,leach,time1}$ and $C_{local,soil,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

5.4.2 Class 4: Wood in contact with ground or fresh water and permanently exposed to wetting

Class 4a: Wood in contact with ground

217. For Use Class 4a, two scenarios are considered: a transmission pole and a fence post. The fence post was chosen as an additional scenario next to the transmission pole because different types of wood preservatives are used for the respective commodities and because in some countries wooden transmission poles are not used.

5.4.2.1 Transmission Pole

Description

218. The scenario describes a transmission pole with a default diameter of 25 cm and a default length of 9 m, which is buried to a depth of 2 m. It is considered that the receiving environmental compartment in this scenario is a soil cylinder, at 10cm distance from and under the pole (see Figure 5.4). A full description of the dimensions of wood and soil volume can be found in Appendix 3.

219. It is assumed that the emissions from the treated wood to soil is a result of:

- 1) rainfall for the above soil part of the pole, and;
- 2) permanent contact with the soil water phase for the below ground part.

220. On the basis of the test results, the emissions from the above and below soil parts are calculated and summed up to a total emission.

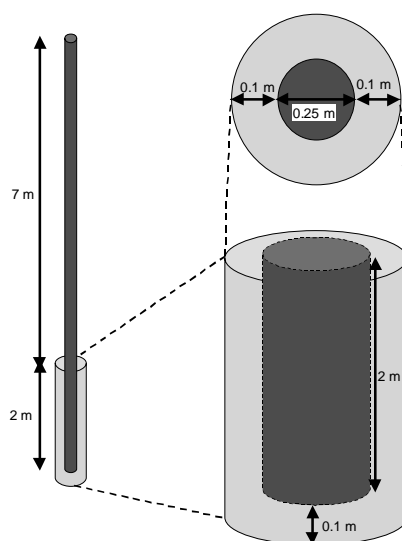


Figure 5-4: Schematic drawing of the transmission pole with receiving soil compartment

Emissions from Treated Wood

Parameters

Scenario: Transmission pole (Use Class 4a)	Nomenclature	Value	Unit	Origin
Inputs				
Wood area above soil	$AREA_{pole,above}$	5,5	[m ²]	D
Wood area below soil	$AREA_{pole,below}$	1,6	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
(wet) Soil volume	V_{soil}	0,2	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$Clocal_{soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$Clocal_{soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

221. As explained in Section 5.3.2.1, if a wood preservative is not a PWSS, it is acceptable that the calculations of the emissions from the above and below soil part of the pole be based on the results of a single test with wood in direct water contact. Therefore, as the $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ will be the same for both parts of the pole, these parts are considered together in the calculations proposed below. However, if a preservative is a PWSS, a test with direct contact with soil may be required for the below soil part of the pole. In this case the emissions from the above and below soil parts should be calculated separately and then summed up to a total emission.

$$Q_{leach,time1} = (AREA_{pole,above} + AREA_{pole,below}) \cdot Q_{leach,time1}^* \quad (5.18)$$

$$Q_{leach,time2} = (AREA_{pole,above} + AREA_{pole,below}) \cdot Q_{leach,time2}^* \quad (5.19)$$

$$Clocal_{soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (5.20)$$

$$Clocal_{soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (5.21)$$

222. $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching test are given in Appendix 1. Detailed guidance on how $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ can be calculated from the results of such a leaching test is given in Appendix 2.

223. Based on $Q_{leach,time1}$ and $Q_{leach,time2}$, inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the substance in soil. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

224. It should be noted that $Clocal_{soil,leach,time1}$ and $Clocal_{soil,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

5.4.2.2 Fence post

225. The second scenario for Use Class 4a describes a rectangular fence post of 10 by 10 cm and a length of 2 m, which is buried to a depth of 0,5 m. It is assumed that the receiving compartment is a rectangular soil box, at 10 cm distance from and under the post (Figure 5.5). A full description of the dimensions of wood and soil volume can be found in Appendix 3.

226. As for the transmission pole, it is assumed that the emissions from the treated wood to soil is a result of:

- 1) rainfall for the above soil part of the pole
- 2) permanent contact with the soil water phase for the below ground part

227. On the basis of these test result, the emissions from the above and below soil part are calculated and summed up to a total emission.

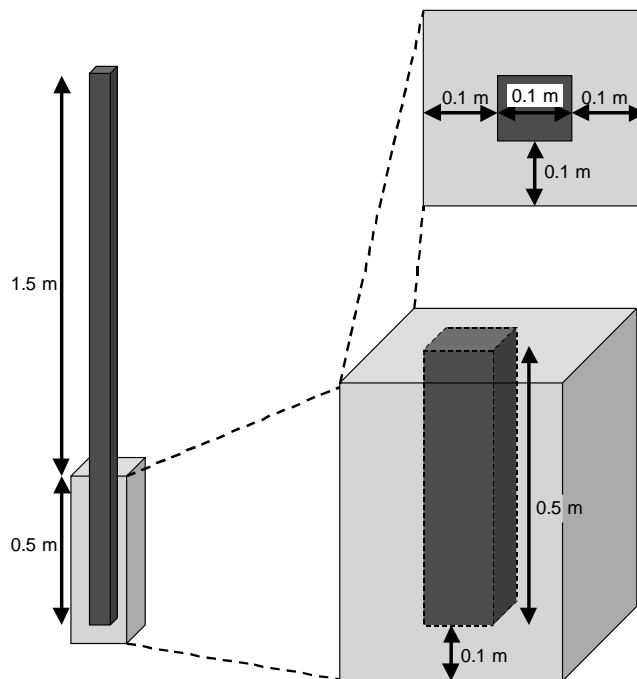


Figure 5-5: Schematic drawing of the fence post with receiving soil compartment

Emissions from Treated Wood

Parameters

Scenario: Fence post (Use Class 4a)	Nomenclature	Value	Unit	Origin
Inputs				
Wood area above soil	$AREA_{post,above}$	0,8	[m ²]	D
Wood area below soil	$AREA_{post,below}$	0,2	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
(wet) Soil volume	V_{soil}	0,05	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D

Parameters, continued

Scenario: Fence post (Use Class 4a)	Nomenclature	Value	Unit	Origin
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$Clocal_{soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$Clocal_{soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

228. As explained in Section 5.3.2.1, if a wood preservative is not a PWSS, it is acceptable that the calculations of the emissions from the above and below soil part of the post be based on the results of a single test with wood in direct water contact. Therefore, as $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ will be the same for both parts of the pole, these parts are considered together in the calculations proposed below. However, if a preservative is a PWSS, a test with direct contact with soil may be required for the below soil part of the post. In this case the emissions from the above and below soil parts should be calculated separately and then summed up to a total emission.

$$Q_{leach,time1} = (AREA_{post,above} + AREA_{post,below}) \cdot Q^*_{leach,time1} \quad (5.22)$$

$$Q_{leach,time2} = (AREA_{post,above} + AREA_{post,below}) \cdot Q^*_{leach,time2} \quad (5.23)$$

$$Clocal_{soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (5.24)$$

$$Clocal_{soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (5.25)$$

229. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching test are given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

230. Based on $Q_{leach,time1}$ and $Q_{leach,time2}$, inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the substance in soil. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

231. It should be noted that $Clocal_{soil,leach,time1}$ and $Clocal_{soil,leach,time2}$ represent the concentration at the end of the assessment time period without to take into account removal processes.

Class 4b: Wood In Contact With Water

232. For Use Class 4b, two scenarios are considered: a jetty in a lake and a sheet piling in a small stream or waterway. The jetty scenario is a *worst case* with respect to the wood surface area, whereas the sheet pilings scenario represents a *worst case* because of the wood being exposed mainly under water.

5.4.2.3 Jetty in Lake

Description

233. The jetty scenario describes a 8 m long walkway of transversal planks, supported by two longitudinal planks of 8 m long and 2 cm wide, placed on 8 poles of 2 m length and 20 cm diameter (see Figure 5.6).

234. The receiving compartment in the jetty scenario is a circular pond with a default diameter of 100 m and a default depth of 2 m. It is considered that the:

- planks are exposed to rain (therefore they are usually treated according to Use Class 3). Leaching of a substance is considered to potentially occur from the outer side of the planks only, therefore half of the total plank area is used in the calculations.
- poles are in permanent contact with the water (therefore they are usually treated according to Use Class 4b). For calculations, the poles are considered to be completely submerged in water, because, compared to the dimensions of the receiving compartment, distinction between the above and below water parts of the pole would have only a marginal influence on the calculated concentrations.

235. A full description of the dimensions of wood and water volume can be found in Appendix 3.

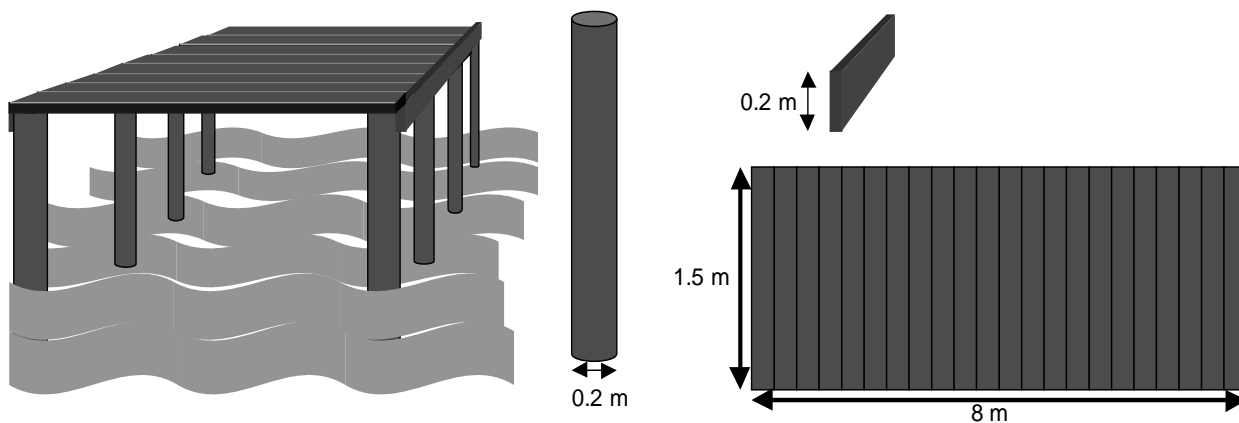


Figure 5-6: Schematic drawing of the jetty scenario

Emissions from Treated Wood

Parameters

Scenario: Jetty (Use Class 4b)	Nomenclature	Value	Unit	Origin
Inputs				
Leachable wood area planks	$AREA_{planks}$	16,2	[m ²]	D
Wood area poles	$AREA_{poles}$	10,0	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
Water volume	V_{water}	1,6E4	[m ³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local water at the end of the initial assessment period	$Clocal_{water,leach,time1}$		[kg.m ⁻³]	O
Concentration in local water at the end of a longer assessment period	$Clocal_{water,leach,time2}$		[kg.m ⁻³]	O

D=default, A=based on information of applicant, O=output

Calculations

236. As explained in Section 5.3.2.1, it is acceptable that the calculations of the emissions from the above (planks) and below water (poles) part of the jetty be based on the results of a single test with wood in direct water contact. Therefore, as $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ will be the same for both planks and poles, these parts are considered together in the calculations proposed below.

$$Q_{leach,time1} = (AREA_{planks} + AREA_{poles}) \cdot Q^*_{leach,time1} \quad (5.26)$$

$$Q_{leach,time2} = (AREA_{planks} + AREA_{poles}) \cdot Q^*_{leach,time2} \quad (5.27)$$

$$Clocal_{water,leach,time1} = \frac{Q_{leach,time1}}{V_{water}} \quad (5.28)$$

$$Clocal_{water,leach,time2} = \frac{Q_{leach,time2}}{V_{water}} \quad (5.29)$$

The summation only applies when the same active substance is used on the poles and the planks.

237. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1). The requirements for the design of such a leaching test are given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

238. It should be noted that $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ represent the concentration at the end of the assessment time period without to take removal processes into account.

Sheet piling in a waterway

239. The second scenario for Use Class 4b describes a sheet piling of poles in a small streaming waterway. The poles have a length of 1,5 m and a diameter of 10 cm. There are 5 poles on both sides per meter waterway length (see Figure 5.7). The waterway is 1 km long, 1.5 deep and 5 m wide, the residence time in the waterway is 20 days. A full description of the dimensions of wood and water volume can be found in Appendix 3.

240. For calculations, it is assumed that the total surface of the poles is in contact with water. This may be a slight overestimation of the emission, however, in reality impregnated planks may also be used in this type of sheet pilings.

241. The highest concentration is reached when the water has passed the sheet piling, in other words, the contact time of the wood with the water is determined by the residence time. This means that with a given flux, the local concentration is equal for all time points considered.

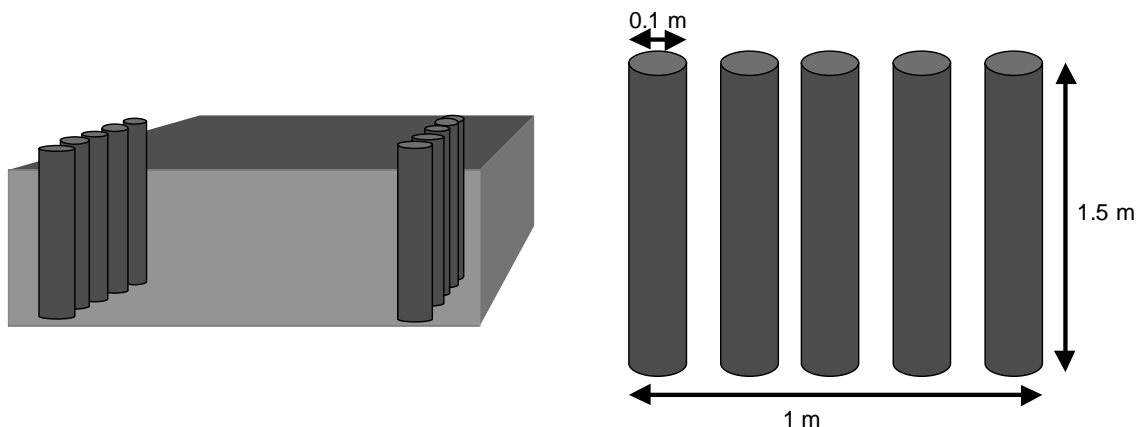


Figure 5-7: Schematic drawing of sheet pilings in a small streaming waterway

Emissions from Treated Wood

Parameters

Scenario: Sheet piling in a waterway (Use Class 4b)	Nomenclature	Value	Unit	Origin
Inputs				
Wood area per m waterway length	$AREA_{poles}$	4,71	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
Water volume per m waterway length	V_{water}	7,5	[m ³]	
Residence time of water in waterway	TAU_{wway}	20	[d]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local water at the end of the initial assessment period	$Clocal_{water,leach,time1}$		[kg.m ⁻³]	O
Concentration in local water at the end of a longer assessment period	$Clocal_{water,leach,time2}$		[kg.m ⁻³]	O

D=default, A=based on information of applicant, O=output

Calculations

$$Q_{leach,time1} = AREA_{poles} \cdot \frac{Q^*_{leach,time1}}{TIME1} \cdot TAU_{wway} \quad (5.30)$$

$$Q_{leach,time2} = AREA_{poles} \cdot \frac{Q^*_{leach,time2}}{TIME2} \cdot TAU_{wway} \quad (5.31)$$

$$Clocal_{water,leach,time1} = \frac{Q_{leach,time1}}{V_{water}} \quad (5.32)$$

$$Clocal_{water,leach,time2} = \frac{Q_{leach,time2}}{V_{water}} \quad (5.33)$$

242. The requirements for the design of an appropriate leaching test with treated wood in direct contact with water is given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

243. It should be noted that $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

5.4.3 Class 5: Wood permanently exposed to salt water

5.4.3.1 Wharf

244. The scenario for Use Class 5 considers the wharfs commonly used for intermediate-sized shipping. Wharfs for large ocean-going shipping are usually constructed with steel and concrete. Small boat jetties resemble the sort of construction depicted in the fresh water scenario (Use Class 4b). It is assumed that the wharf is 100 m long with walling and kerbing extending the full length. The walling is doubled at the front and back of the fender piling. Piles with associated rubbing strips are spaced at 5 m intervals.

245. The receiving environmental compartment is the seawater at up to 5m distance from the wharf. Emissions potentially occur from the submerged part due to permanent contact with seawater and from the upper part due to rain. Part of the fender piles are submerged at high tide only. In principle, all these parts must be considered separately in the design of the leaching tests. However, distinction between the above water and (partly) submerged parts of the pole would have only a marginal influence on the calculated concentrations in view of the dimensions of the receiving compartment. For calculations:

- poles are considered to be completely submerged in water
- planks and poles are considered separately as for the reasons explained in Section 5.3.2.1, two different leaching tests are required: one with wood in direct contact with de-ionised water for planks and one with wood in direct contact with simulated seawater for poles.

246. A full description of the dimensions of wood and sea water volume can be found in Appendix 3.

247. As for the sheet piling scenario, the contact time of the wood with the water and therefore the concentration is determined by the residence time. This means that for a given flux, the local water concentration is equal for all time points considered. This summation only applies if the same active substance is used on the poles and the planks.

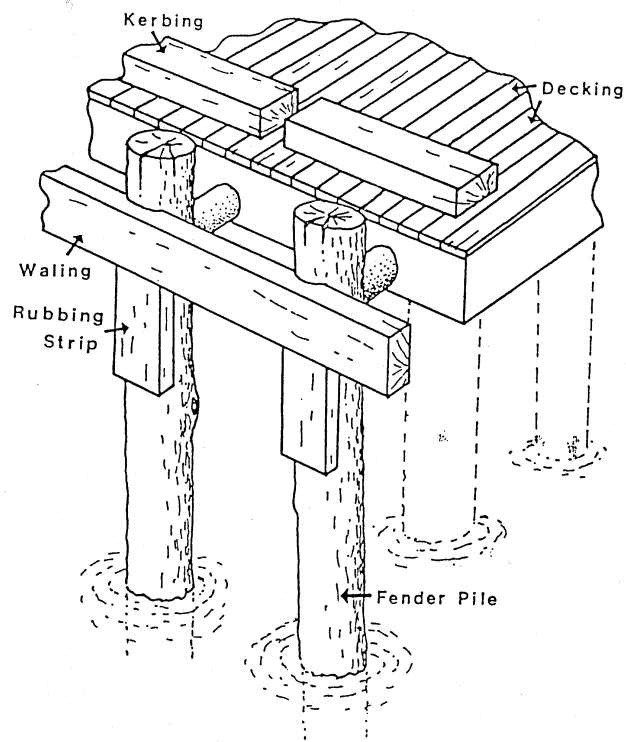


Figure 5-8: Schematic drawing of a part of the harbour wharf

Emissions from treated wood

Parameters

	Nomenclature	Value	Unit	Origin
Inputs				
Leachable wood area planks	$AREA_{planks}$	296	[m ²]	D
Leachable wood area poles	$AREA_{poles}$	911	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
For Planks				
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period (calculated on the basis of a leaching experiment with de-ionised water)	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period (calculated on the basis of a leaching experiment with de-ionised water)	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
For Poles				
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period (calculated on the basis of a leaching experiment with simulated seawater)	$Q^{**}_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period (calculated on the basis of a leaching experiment with simulated seawater)	$Q^{**}_{leach,time2}$		[kg.m ⁻²]	A
Water volume along wharf	V_{water}	1000	[m ³]	D
Residence time of the seawater	$TAU_{seawater}$	0,5	[d]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local (sea) water at the end of the initial assessment period	$Clocal_{seawater,leach,time1}$		[kg.m ⁻³]	O
Concentration in local (sea) water at the end of a longer assessment period	$Clocal_{seawater,leach,time2}$		[kg.m ⁻³]	O

D=default, A=based on information of applicant, O=output

Calculations

- When poles and planks are considered separately:

$$Q_{leach,time1} = \left[\left(AREA_{planks} \cdot \frac{Q_{leach,time1}^*}{TIME1} \right) + \left(AREA_{poles} \cdot \frac{Q_{leach,time1}^{**}}{TIME1} \right) \right] \cdot TAU_{seawater} \quad (5.34)$$

$$Q_{leach,time2} = \left[\left(AREA_{planks} \cdot \frac{Q_{leach,time2}^*}{TIME2} \right) + \left(AREA_{poles} \cdot \frac{Q_{leach,time2}^{**}}{TIME2} \right) \right] \cdot TAU_{seawater} \quad (5.35)$$

- When poles and planks are considered together and the calculation are based on the results of a single leading test with wood in contact with de-ionised water:

$$Q_{leach,time1} = \left[(AREA_{planks} + AREA_{poles}) \cdot \frac{Q_{leach,time1}^*}{TIME1} \right] \cdot TAU_{seawater} \quad (5.36)$$

$$Q_{leach,time2} = \left[(AREA_{planks} + AREA_{poles}) \cdot \frac{Q_{leach,time2}^*}{TIME2} \right] \cdot TAU_{seawater} \quad (5.37)$$

$$Clocal_{seawater,leach,time1} = \frac{Q_{leach,time1}}{V_{water}} \quad (5.38)$$

$$Clocal_{seawater,leach,time2} = \frac{Q_{leach,time2}}{V_{water}} \quad (5.39)$$

248. The requirements for the design of appropriate leaching tests with treated wood in direct contact with water (de-ionised or simulated seawater) are given in Appendix 1. Detailed guidance on how $Q_{leach,time1}^*$ and $Q_{leach,time2}^*$ resp. $Q_{leach,time1}^{**}$ and $Q_{leach,time2}^{**}$ can be calculated from the results of such a leaching test is given in Appendix 2.251. It should be noted that $Clocal_{seawater,leach,time1}$ and $Clocal_{seawater,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

6. EMISSION ESTIMATION FOR PROFESSIONAL AND AMATEUR *IN-SITU* TREATMENTS (CURATIVE AND PREVENTIVE)

6.1 Introduction

249. This Chapter proposes an approach for estimation of the emissions to the environment, that may result from preventive or curative treatments on wooden structures that are already in place. These treatments are performed *in-situ*, indoors or outdoors, by professionals or amateurs. The following six main treatments of this type were identified by the Belgirate workshop [OECD 2000c]:

- Spraying (indoors)
- Brushing (indoors and outdoors)
- Fumigation (indoors)
- Injection (indoors/outdoors)
- Wrapping (outdoors), and
- Preventive treatment of building foundations against termites.

250. The main differences between these treatments and the industrial ones discussed in Chapter 4 are:

- Operators of the “curative/preventive” treatments are professionals and amateurs applying wood preservatives everywhere on mobile works of various sizes. Operators of industrial preventive treatments are workers of the industry, operating at fixed facilities.
- Remedial (curative and late preventive) treatments are applied to wood products and commodities already in service, and subject or potentially exposed to bio-deterioration. This activity includes maintenance of public and private works. The aim is to prevent failures and the restoration of the preventive protection, whenever possible.
- The industry delivers treated wood materials and products, while professional and amateur provide service to existing materials and products.

6.2 Selection of representative scenarios

251. The Expert Group found it more appropriate that selection of scenarios for estimation of the emissions from these treatments be based on the use site (indoors or outdoors) and on the wooden commodities treated by these techniques, rather than on the basis of the application techniques as done for industrial applications.

252. For **indoor treatments by spraying, brushing and injection**, no scenario is proposed in this document because the emissions to the environment, during these treatments and from treated wood after the treatments, are considered to be negligible. However, these emissions to the indoor air are relevant for human exposure assessment. Indoor treatments are also relevant for the exposure assessment of bats in countries where bats are protected animals (e.g. in most European countries) [Chadwick J *et al.*, 1992; Mitchell-Jones AJ *et al.*, 1989]. Bats are exposed to treated wood via contact.

253. For **fumigation indoors** a specific scenario is proposed because the gas used indoors is released to the atmosphere few days after the treatment.

254. Typical **outdoor treatments** are brushing of fences and houses, and injection and wrapping of utility poles. Therefore, the respective scenarios introduced in Table 5.2 of Section 5.2 are used for estimation of emissions from these treatments. An additional ‘bridge’ scenario is proposed for brushing

outdoors as in some countries such commodities are treated by brushing. Preventive foundation treatment against termites is a special case and therefore a specific emission scenario has been developed for this treatment.

255. With respect to the environmental compartments potentially exposed, it is considered that:

- for **fumigation indoors**, the compartment exposed is the atmosphere which receives the gas used a few days after the treatment.
- for **all outdoor treatments**, the major environmental compartment, potentially exposed, is soil. Emissions to soil can occur during the application itself and from treated wood after application (except for wrapping where it is considered that emissions can occur only after application). As a consequence, emissions from these two stages have to be summed up.
- During preventive treatment of building foundations, the product is deliberately sprayed on soil and concrete substrates. During application emissions occur also to the atmosphere. After application, the product applied to soil may reach the ground water.
- in some countries **outdoor brushing** are used for treating commodities such as bridges over water bodies. In such cases, the water body is potentially exposed.

256. **Table 6.1** provides an overview of the potentially exposed environmental compartments from professional and amateur *in-situ* treatments.

TABLE 6-1									
Potential exposure of environmental compartments from professional and amateur <i>in-situ</i> treatments									
Treatments (Curative or Preventive)	Operators (Users)	Potential Exposure of Environmental Compartments							Emission Scenario
		During treatment				After treatment			
		Air indoors	Air outdoors	Soil	Surface water	Soil	Ground water	Surface water	
<i>Indoor treatments (Use Classes 1 & 2)</i>									
Fumigation	Professionals only	+	+						Fumigation scenario
<i>Outdoor treatments (Use Classes 3, 4a & 4b)</i>									
Brushing	Amateurs mainly + Professionals		+	+	+(a)	+	+	+(a)	<ul style="list-style-type: none"> • Fence • House • Bridge
Injection	Professionals only			+		+	+		Transmission Pole
Wrapping	Professionals only					+	+		Transmission Pole
Termite prevention (foundation treatment)	Professionals only		+	+		+	+		House foundation

(a) for the ' Bridge scenario' only.

6.3 General considerations on the calculation of the local environmental concentrations

257. Depending on the type of treatment, emissions may occur during application, from treated wood after the application or from both. This section provides the general principles applied in all scenarios for the estimation of the local emissions and subsequently of the local environmental concentrations from both stages (i.e. during and after application).

6.3.1 Emissions resulting from application

258. The emission rate (E) of an active ingredient (or any other substance of concern in a wood preservative formulation) to the receiving compartment as a result of the application itself can be calculated according to the following general equation:

$$E_{applic} = AREA_{wood} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{applic} \cdot N_{applic} \cdot 10^3$$

[NOTE: 10^3 is not needed if $RHO_{product}$ is expressed in kg/L]

where:

Figure 25 <i>applic</i>	Figt quantity of the active ingredient emitted to soil or surface water <u>per day</u> [kg.d ⁻¹] or [l. d ⁻¹]
Figure 27 <i>REA_{wood}</i>	Figt wood area treated per day [m ² . d ⁻¹]
Figure 29 <i>applic,product</i>	Figt application rate of the product, i.e. quantity of the product applied per m ² of wood [kg.m ⁻² or l.m ⁻²]
Figure 31 <i>a.i.</i>	Figt fraction of active ingredient in product [-]
Figure 33 <i>HO_{product}</i>	Figt density of the product [kg/L]
Figure 35 <i>applic.</i>	Figt fraction of product lost to soil or surface water [-]

N_{applic} = numberofapplications

(the default value of N_{applic} is 2)

In general, it can be considered that the treatment is performed over 1 day. In the descriptive sections for the relevant scenarios (Section 0), this general calculation is further specified.

259. The concentration in the receiving compartment on the day of application, $Clocal_{soil,applic}$ and $Clocal_{surfacewater,applic}$, can then be obtained by dividing E_{applic} by the dimensions of the soil compartment or the surface water body, respectively.

6.3.2 Emissions and local concentration due to leaching from treated wood

260. Emissions from treated wood after application are considered relevant only for outdoor treatments. In the relevant scenarios (i.e., fence, house, bridge and transmission pole), the emissions and local concentrations in soil or surface water due to leaching of the active ingredient from treated wood ($Q_{leach,time}$ and $Clocal_{soil,leach,time}$ or $Clocal_{water,leach,time}$), can be calculated according to the methods given in Sections 5.3.1 and 5.3.2. It must be noted that the fluxes, used to estimate the emissions ($Q_{leach,time}$), must be

determined in standardized leaching tests that are representative for the scenario and treatment under consideration. This means that the wood used in the leaching test must be treated according to the relevant method, i.e. brushing, injection or wrapping.

6.3.3 Total local concentrations due to application and leaching

261. For those cases where both the emissions during application and the emissions resulting from the leaching of the active ingredient from treated wood determine the local concentration in soil or surface water, the following general formula can be used:

$$C_{local, total, time} = C_{local, applic} + C_{local, leach, time} \quad (6.2)$$

where:

Figure 37 $local_{total, time}$	Figt	local concentration of active ingredient in soil or surface water resulting from application and subsequent leaching from treated wood at the end of the assessment period [$kg.kg^{-1}$] resp. [$kg.m^{-3}$]
Figure 39 $local_{applic}$	Figt	local concentration of active ingredient in soil or surface water at the end of the day of application [$kg.kg^{-1}$] resp. [$kg.m^{-3}$]
Figure 41 $local_{leach, time}$	Figt	local concentration of active ingredient in soil or surface water, resulting from leaching from treated wood, at the end of the assessment time period considered (0-30 days or >30 days), calculated according to the equations in Section 5.3.1 and 5.3.2., [$kg.kg^{-1}$] resp. [$kg.m^{-3}$]

6.4 Scenario descriptions and calculations

- Each of the following scenario descriptions for both indoor fumigation and outdoor treatments includes:
- a description of the use pattern. This description includes information on: the technology used in mixing, application and transfer of preservatives; products used; use site; pests controlled; rate and frequency of use; generation and disposal of waste.
- a description of the: 1) pathways that emissions to the environment may occur and 2) environmental compartments potentially exposed;
- proposes calculations of the local emissions and local concentrations in these compartments.

6.4.1 Fumigation indoors

6.4.1.1 Use Pattern

262. Fumigation is performed strictly by professionals and represents a very small percentage of the total wood preservation activity. Fumigation is the method used to treat wooden interiors of churches, chapels, libraries, museums, monuments or mills. It is applied in small chambers of some cubic metres volume. The gas is forced into the interior of wood in a pressure vessel or under plastic sheets. Fumigation is the method of choice for treatment of precious artwork, e.g. altars, madonnas, furniture. Shipping containers and their loads are also fumigated for preservation purposes. This is done for shipping wood and furniture.

Products

263. Products are basically insecticides in the form of gases. For decades, methyl bromide was widely used in room fumigation, but is now abandoned because of its ozone depletion potential. Sulfuryl fluoride is

its substitute. Hydrocyanic acid and phosphine are only used in fumigation chambers. They are no longer used in room fumigation. Inert gases such as nitrogen, carbon dioxide and argon are also used, but with lower efficiency need much longer contact periods up to several weeks. Table 6-2 provides examples of substances mostly used for fumigation nowadays.

TABLE 6.2
Examples of gaseous products and active ingredients used for wood preservation by fumigation

Product	Active ingredient
S-Gas	Methyl bromide
Cyanosil	Hydrocyanic acid
Phostoxin	Phosphine
Sulfurylfluoride	Sulfurylfluoride
	Nitrogen
	Carbon dioxide
	Mixture of nitrogen and carbon dioxide
	Argon

Operation

264. For room fumigation in buildings all windows and openings are sealed gas-tight with an adhesive tape. Smaller wooden structures can be fumigated under sealed plastic sheets. Objects in big rooms may be sealed under plastic sheets. If the building is not gas tight enough, insects may survive. The eradication of insects depends upon the product type, the concentration and duration of the fumigation. The gas is pumped in from a reservoir and a concentration of 10 to 50 g.m⁻³ is maintained throughout 48 to 72 hours. After treatment the gas is ventilated off the roof or a window into the atmosphere. The recollection of ventilated sulfurylfluoride gas by mobile gas absorbers and washers is currently being developed.

265. In fumigation chambers the products are delivered to wood from outside, by fume generators, or *in-situ*, by braking cartridges. The vapour pressure of the substance itself provides pressure for impregnation or diffusion. The effectiveness of the operation depends on the time allowed for the toxic gas to diffuse through the exposed product. Application periods are usually 3 to 5 days. The gas concentration is analysed after 24 and 48 hours and dosing is repeated, if necessary. Temperature is above 15 °C. Air humidity is low. After treatment the fumigation gas is released slowly to the atmosphere. This may also take several days.

Cleaning and maintenance

266. The need for cleaning is limited. Practically no solid, or liquid waste is generated. Maintenance includes surveillance, so that operations are carried out in restricted areas or buildings, with a permanent necessity to avoid any gas entrapping which could injure operators.

6.4.1.2 Environmental Emission Pathways

267. As batch operation, there is no known recovery of the excess of chemical, which, as default, is considered released to the atmosphere. After treatment degassing to outdoor air extends over 1-2 days (in the case of hydrocyanic acids up to 3–5 days) depending on the size of the object and the weather conditions.

TABLE 6.3
Environmental Emission Pathways of Fumigation Indoors

Primary medium	Pathway	Result
Treatment: Fumigation indoors		
<i>Use Classes 1, 2</i>	Scenario: room and chamber fumigation	
Outdoor air	<ul style="list-style-type: none"> Release of substance after fumigation 	$E_{atm,fumi}$

6.4.1.3 Calculation of emissions from application

268. The scenario for room and chamber fumigation considers:

- the retention of the fumigant in goods (i.e. fraction of fumigant retained in the material treated)
- the disintegration (i.e. the fraction of fumigant decomposed or converted into other substances).

Parameters

Application: 'Room and chamber fumigation' scenario	Nomenclature	Value	Unit	Origin
Inputs				
Total room fumigation volume	$V_{fumigated}$	100	[m ³]	D
<ul style="list-style-type: none"> chamber/container small room (e.g. museum) big volume (e.g. church) 		300		
		10000		
Application rate of the product	$Q_{applic,product}$		[kg.m ⁻³]	A
Fraction of retention in goods	F_{ret}	0,02	[-]	D
Fraction of disintegration	F_{disin}	0,001	[-]	D
Period during release to outdoor air after treatment	$T_{release}$		[d]	A
Outputs				
Emission rate of active substance to atmosphere after fumigation	$E_{atm,fumi}$		[kg.d ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

269. Assuming that all gas is released to outdoor air after fumigation within x days:

$$E_{atm,fumi} = \frac{V_{fumigated} \cdot Q_{applic,product} \cdot (1 - F_{ret}) \cdot (1 - F_{disin})}{T_{release}} \quad (6.3)$$

270. The emissions $E_{atm,fumi}$ can be used as input for an atmospheric distribution model for a point source (e.g. the atmospheric plume model) to estimate local concentrations and gaseous deposition rates in the vicinity of the treated object. Descriptions of such models can be found for example in [EU TGD 1997].

6.4.2 Outdoor treatments

271. The scenarios considered relevant for estimation of emissions from the outdoor treatments are:

- **brushing:** fence and house scenarios, described in Sections 5.4.1.1 and (respectively), and bridge scenario;
- **injection and wrapping:** transmission pole scenario;
- **preventive treatment of foundations against termites:** house foundation scenario.

6.4.2.1 Brushing outdoors

Use pattern

272. Outdoor brushing is performed by professionals but mostly by amateurs and by do-it-yourself (DIY) fans. This treatment is paid a special attention because of the wide consumption by the DIY sector particularly in Europe. DIY users are mainly involved in repeated maintenance, where wood protection has to be restored systematically.

273. The major commodities treated are fences, house claddings and bridges or walkways. In principle, treatments have to be applied to sound wood; the preparation of the wood surface is critical and takes most of the time. Good practice imposes at least two layers (average break of 4-5 hours in between) to achieve a minimal impregnation. Decoration using a stain, paint or varnish should follow with intermediate drying periods (1–2 days). However, decoration is not always applied.

Products

274. Products for outdoor applications should be resistant to weathering. In Europe, they should comply at least with the performance requirements of CEN ‘Hazard Class 3’ [CEN 1992]. Labels usually mention the conditions of use as ‘exterior use’; however, do-it-yourself products are often sold for multi-purposes (interior, exterior). Products are usually sold as ready-to-use formulations and their compatibility with stains, varnishes and paints has always to be examined cautiously. The common carrier for oilborne products is white spirit and for waterborne is water.

275. In Europe, typical application rates to achieve the efficacy required by the CEN performance standard EN 599 [CEN 1996] are 200 g.m⁻² of wood resp. 200 ml.m⁻² or less (curative and/or preventive).

Cleaning, maintenance and waste disposal

276. Waste wood, waste wood dust, protection foil, cleaning solvents, used cans and unused product should be disposed of according to national waste disposal regulations.

6.4.2.1.2 *Environmental Emission Pathways*

277. During brushing, product losses are due to spills and drips. These losses will end-up in soil, if soil is not protected with a plastic foil or in surface water. After application, emissions to soil or surface waters from treated wood may occur due to rainfall. Emissions to soil may subsequently reach the ground water.

278 Table 6.4 summarises the emissions pathways and the environmental compartments that can potentially be exposed during outdoor brushing.

TABLE 6.4
Environmental Emission Pathways For Brushing Outdoors

Primary medium	Pathway	Result
Treatment: Brushing Outdoors		
Hazard class 3	Scenarios: Fence, House or Bridge	
Outdoor air	<ul style="list-style-type: none"> • evaporations from surface of timber depending on vapour pressure of active substance • co-distillation with solvent 	Not considered because of instant dilution and turbulence in air
Surface water	<ul style="list-style-type: none"> • dripping to surface water during application 	$E_{water,brush}$ $Clocal_{water,brush}$
Soil	<ul style="list-style-type: none"> • dripping to soil during application 	$E_{soil,brush}$ $Clocal_{soil,brush}$
Waste disposal	<ul style="list-style-type: none"> • waste wood • used cans and unused product cleaning solvent • protection foil 	According to national waste disposal regulations

6.4.2.1.3 *Calculation of emissions*

279. The following calculations for emissions to soil from both, the application itself and the treated wood after application, are based on the fence and house scenarios. These scenarios are described in detail in Sections 5.4.1.1 and 5.4.1.3 respectively, and therefore they are not repeated here. The calculations for the bridge scenario are similar, but the emissions occur into surface water. Both sides of the fence are treated. Only the upper sides and the handrails of the bridge are treated. A description of the wood and water volume in the scenarios can be found in Appendix 3.

280. Regarding product losses to soil during brushing, Erwin Graf, EMPA, Switzerland, [personal commun. 2001] considers that they vary from 3% to a maximum of 20% while industry considers that 2% product lost is acceptable but is probably overestimated [David Aston, Arch Timber Protection Ltd, personal commun. 2001]. Based on this information the Expert Group proposed the following emission factors:

- Professionals: $F_{soil,brush}$ or $F_{water,brush} = 0,03$
- Amateurs: $F_{soil,brush}$ or $F_{water,brush} = 0,05$

Emissions from application

Parameters

Application: Fence and House scenarios	Nomenclature	Value	Unit	Origin
Inputs				
Hence: treated wood area (both sides) per day	$AREA_{fence}$	4	$[m^2 \cdot d^{-1}]$	D
House: treated wood area	$AREA_{house}$	125	$[m^2 \cdot d^{-1}]$	D
Application rate of the product	$Q_{applic,product}$		$[l \cdot m^{-2}]$	A
Content of active substance in product	$f_{a.i.}$		[-]	A
Density of product	$RHO_{product}$		$[kg \cdot m^{-3}]$	A
Fraction of product lost to soil during application	$F_{soil,brush}$	<ul style="list-style-type: none"> • 0,03 prof. • 0,05 amat. 	[-]	D
Fence: (wet) soil volume per m length of fence(both sides)	V_{soil}	0,02	$[m^3]$	D
House: (wet) soil volume	V_{soil}	0,5	$[m^3]$	D
Bulk density of wet soil	RHO_{soil}	1700	$[kg_{wwt} \cdot m^{-3}]$	D
Outputs				
Emission of active ingredient to soil during the day of application	$E_{soil,brush}$		$[kg \cdot d^{-1}]$	O
Concentration in local soil at the end of the day of application	$Clocal_{soil,brush}$		$[kg \cdot kg_{wwt}^{-1}]$	O

D=default, A=based on information of applicant, O=output

Calculations (Fence)

$$E_{soil,brush} = AREA_{fence} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{soil,brush} \cdot 10^3 \quad (6.4)$$

Table 1

$$Clocal_{soil,brush} = \frac{E_{soil,brush}}{V_{soil} \cdot RHO_{soil}} \quad (6.5)$$

Calculations (House)

$$E_{soil,brush} = AREA_{house} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{soil,brush} \cdot 10^3 \quad (6.6)$$

$$Clocal_{soil,brush} = \frac{E_{soil,brush}}{V_{soil} \cdot RHO_{soil}} \quad (6.7)$$

Parameters

Application: 'Bridge' scenario	Nomenclature	Value	Unit	Origin
Inputs				
Bridge: treated wood area per day	$AREA_{bridge}$	10	$[m^2 \cdot d^{-1}]$	D
Application rate of the product	$Q_{applic,product}$		$[kg \cdot m^{-2}]$ or $[l \cdot m^{-2}]$	A
Content of active substance in product	$f_{a.i.}$		[-]	A
Density of product	$RHO_{product}$		$[kg \cdot m^{-3}]$	A
Fraction of product lost to surface water during application	$F_{water,brush}$	0,03 prof. 0,05 amat.	[-]	D
Water volume under bridge	V_{water}	20	$[m^3]$	D
Output				
Emission of active substance to water during the day of application	$E_{water,brush}$		$[kg \cdot d^{-1}]$	O
Concentration in local water at day of application	$Clocal_{water,brush}$		$[kg \cdot m^{-3}]$	O

D=default, A=based on information of applicant, O=output

Calculations (Bridge over pond)

$$E_{water,brush} = AREA_{bridge} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{water,brush} \cdot 10^3 \quad (6.8)$$

Table 2

$$Clocal_{water,brush} = \frac{E_{water,brush}}{V_{wat}} \quad (6.9)$$

Emissions from treated wood after application

281. For the fence and house scenarios, the emissions to soil from treated wood can be calculated according to Sections 5.4.1.1 and 5.4.1.3 respectively.

Parameters

After application: 'Bridge scenario	Nomenclature	Value	Unit	Origin
Inputs				
Treated wood area	$AREA_{bridge}$	10	[m ²]	D
Water volume	V_{water}	20	[m ³]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local water at the end of the initial assessment period	$Clocal_{water,leach,time1}$		[kg.m ⁻³]	O
Concentration in local water at the end of a longer assessment period	$Clocal_{water,leach,time2}$		[kg.m ⁻³]	O

D=default, A=based on information of applicant, O=output

Calculations

$$Q_{leach,time1} = AREA_{bridge} \cdot Q^*_{leach,time1} \quad (6.10)$$

$$Q_{leach,time2} = AREA_{bridge} \cdot Q^*_{leach,time2} \quad (6.11)$$

$$Clocal_{water,leach,time1} = \frac{Q_{leach,time1}}{V_{water}} \quad (6.12)$$

$$Clocal_{water,leach,time2} = \frac{Q_{leach,time2}}{V_{water}} \quad (6.13)$$

282. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water (see Section 5.3.2.1.). The treatment of wood test specimens in this test should be representative for the brushing treatment. The requirements for the design of such a leaching test are given in Appendix 1. Detailed guidance on how $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ can be calculated from the results of such a leaching test is given in Appendix 2.

283. It should be pointed out that $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

Calculation of the total local concentration in soil and surface water

284. The total local concentration in soil resp. surface water as a result of application and subsequent leaching of the active ingredient(s) from treated wood is calculated as follows:

$$Clocal_{soil,total,time1} = Clocal_{soil,brush} + Clocal_{soil,leach,time1} \quad (6.14)$$

$$Clocal_{soil,total,time2} = Clocal_{soil,brush} + Clocal_{soil,leach,time2}$$

with $Clocal_{soil,leach,time1}$ and $Clocal_{soil,leach,time2}$ calculated according to Equations 5.6 and 5.7 for the fence scenario and 5.16 and 5.17 for the house scenario.

$$Clocal_{water,total,time1} = Clocal_{water,brush} + Clocal_{water,leach,time1} \quad (6.15)$$

$$Clocal_{water,total,time2} = Clocal_{water,brush} + Clocal_{water,leach,time2} \quad (6.16)$$

with $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ calculated according to Equations 6.12 and 6.13.

6.4.2.2 Injection outdoors

6.4.2.2.1 Use pattern

285. Injection outdoors is applied only by professionals as a preventive or curative treatment. It addresses the same wood pathologies as indoor injection, i.e., rots, at large, with variable severity and, to a lower extent, termites, locally. The difference relies on more severe climatic conditions and the occurrence of additional disorders due to such climates. This type of treatment practice is more common in civil engineering situations of high economic value (e.g. maintenance of wooden transmission poles). Injection outdoors is also often applied to the adjacent soil of buildings as an extension to the building's treatment.

286. A small percentage of pole production show signs of failure after 5 years mostly due to pre-treatment decay (high moisture before impregnation and poor initial penetration). Preventive treatment of poles is mostly done by pressure processes. In some countries such as Switzerland, the retention of the active ingredient in the part of a spruce pole, that would be buried in soil, is increased either by perforation of the base zone (to allow for higher retention during pressure treatment) or by injections, in addition to pressure treatment, and prior to implantation of the poles. Post-treatment of poles is normally performed in the field after 9–12 years in service and twice within the whole life span of an average of 35 years. In US the treatment can be repeated every five years. Poles on concrete and hard ground are not treated.

Products

287. Products have fungicidal and insecticidal action and the active ingredients used are similar to those in pressure (penetrating) processes. Inorganic chemical preservatives are mostly used.

288. In Europe, the products used for building remediation should fulfil the efficacy criteria for hazard classes 3, 4, 5, depending on location of the commodities to be treated: products must be resistant to weathering, show absence of depletion from wood in contact with critical compartments (soil, water) and are normally selected on a risk/benefit basis.

Operation

289. The treatment should be performed in sound wood. Failing parts have to be cleaned. An additional preparation is burning of the damaged surfaces. Excessive reduction of size or sections of the construction, requires replacement. The application techniques are:

1. injection of a liquid preservative
2. pasting, caulking, plugging, implants are also used.

290. The injections are performed as follows: the device is fixed on poles, a lever forces a special needle inside the pole and injects a dose of liquid inside wood. The injections usually have a length of 700 mm, depth 60 mm, outflow of preservative fluid in depth of 45 mm. The number of injections that should be performed per perimeter is empirically calculated by dividing the perimeter of pole by 6. The injections are placed every 20cm in fibre direction and every 2.5cm perpendicular to the fibre direction but displaced by 10 cm. The application rate is ca. 0.5kg product.m⁻² or 0.5 L.m⁻². After injection the treated area is coated with bitumen to prevent leaching. Only the part buried in the soil is treated, usually to a depth of ca. 90 to 100 cm.

Cleaning, maintenance and waste disposal

291. These applications often use water based products. Cleaning of equipment with water is usually done at the end of every work day.. There is also waste generation due to the adjustment of the various products to the size/section of the commodity (cuts, excesses). Waste wood, protection foil, cleaning solvents, used cans and product hold-ups should be disposed off according to national waste disposal regulations.

6.4.2.2.2 Environmental Emission Pathways

292. During injection, product losses occur due to dripping. Losses during treatment are reported to amount to 5%. These drips will end-up in soil, if soil is not protected with a plastic foil. After application, emissions to soil from treated wood may occur due to direct contact; it is considered that only part of the pole, buried in soil, is treated. These emissions may subsequently reach the ground water.

293. Switzerland, for example, does not allow injections in drinking water protection zones because active ingredients could be spilled and leach to ground water. In such zones wrapping treatment is preferred (see following Section 0). Neither application by injection or wrapping is allowed during heavy rain.

294. Table 6-5 summarises the environmental compartments potentially exposed and the emission pathways.

Table 6.5
Environmental Emission Pathways for Injection Outdoors

Primary medium	Pathway	Result
Treatment: Injection outdoors		
Hazard class 4a	Scenario: Transmission pole	
Outdoor air	ventilation by air turbulence	Considered negligible
Surface water	transmission poles do not stand near water; not relevant	not relevant
Soil	adjacent soil may be contaminated	$E_{soil, inj}$ $Clocal_{soil, inj}$
Ground water	Figure 43 Substance may leak to ground water	Use appropriate leaching model
Waste disposal	<ul style="list-style-type: none"> Waste wood, waste wood dust Used cans and product hold-up Cleaning solvent 	According to national waste disposal regulations

6.4.2.2.3 Calculation of emissions

295. The following calculations of emissions to soil from both, the application itself and the treated wood after application, are based on the transmission pole scenario. This scenario is described in detail in Section 0., therefore, it is not repeated here.

Emissions from application

Parameters

Application: Transmission pole scenario	Nomenclature	Value	Unit	Origin
Inputs				
Treated wood area per day	$AREA_{pole, inj}$	0,8	[m ² .d ⁻¹]	D
Application rate of the product	$Q_{applic, product}$		[kg.m ⁻²] or [l.m ⁻²]	A
Content of active substance in product	$f_{a.i.}$		[-]	A
Density of product	$RHO_{product}$		[kg.m ⁻³]	A
Fraction of product lost/emitted during application due to dripping	$F_{soil, inj}$	0,05	[-]	D
(wet) Soil volume	V_{soil}	0,2	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Emission of active ingredient during application	$E_{soil, inj}$		[kg.d ⁻¹]	O
Concentration in local soil at the end of the day of application	$Clocal_{soil, inj}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

$$E_{soil, inj} = AREA_{pole, inj} \cdot Q_{applic, product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{soil, inj} \cdot 10^3 \quad (6.17)$$

$$C_{local,soil,inj} = \frac{E_{soil,inj}}{V_{soil} \cdot RHO_{soil}} \quad (6.18)$$

Emissions from treated wood after application

Parameters

After application: Transmission pole scenario	Nomenclature	Value	Unit	Origin
Inputs				
Treated wood area (below soil)	$AREA_{pole,below}$	0,8	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
Density of product	$RHO_{product}$		[kg.m ⁻³]	A
(wet) Soil volume	V_{soil}	0,2	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$C_{local,soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$C_{local,soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

296. The emissions to soil from treated wood, due to direct contact, can be calculated according to the equations below. Because not the whole part of the pole below soil is treated but ca. 0,1 m, the $AREA_{pole,below}$ to be used in these formulas is set at 0,8 m².

$$Q_{leach,time1} = AREA_{pole,below} \cdot Q^*_{leach,time1} \quad (6.19)$$

$$Q_{soil,leach,time2} = AREA_{pole,below} \cdot Q^*_{leach,time2} \quad (6.20)$$

$$C_{local,soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (6.21)$$

$$C_{local,soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (6.22)$$

297. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water, if the wood preservative is not a poorly water soluble substance (PWSS) (see Section 5.3.2.1). If the wood preservative is a PWSS then a leaching test with wood in soil contact may be required. This should be decided by the regulatory authorities on a case by case basis.

298. It should be noted that $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ must be determined from the results of leaching tests where the treatment of the wood test specimens is representative for the injection treatment. The requirements for the design of a leaching test with wood in direct contact with water are given in Appendix 1.

299. It should be pointed out that $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ represent the concentration at the end of the assessment time period without to take removal processes into account.

Calculation of the total local concentration in soil

300. The total local concentration in soil as a result of application and subsequent leaching from treated wood is calculated as:

$$Clocal_{soil,total,time1} = Clocal_{soil,inj} + Clocal_{soil,leach,time1} \quad (6.23)$$

$$Clocal_{soil,total,time2} = Clocal_{soil,inj} + Clocal_{soil,leach,time2} \quad (6.24)$$

6.4.2.3 Wrapping: transmission pole

301. Wrapping is performed by professionals only. It may be applied for preventive purposes on sound wood before attack or for curative purposes after previously treated wood has been already in service for some time. “Wooden structures” already in service are difficult to treat because of their weight and because they are difficult to remove. Stakes, piling and, at large, all poles are exposed to biodegradation around the ground line. Wrapping appears to be a safe means of containment of the wood preservatives applied. Wrapping is considered to be a wood preservation application method, as long as the film, plastic sheet, bituminous paper or any other physical barriers are a complementary containment of biocides.

Products

302. Most of the products are either salts or oxides. They should be capable of impregnating rapidly media of high moisture content (soft rot): among them diffusable products and products highly soluble in water; hence, the need for containment. The product (biocide and film) is a bandage, which may be sealed, glued or moulded onto wood at the edges. More integrated products are used on the market, such as films with biocides chemically bonded. There are also materials, used only for wrapping, which form physical barriers; these materials are non-chemical or biological products and therefore are out of the scope of this document.

Operation

303. The aim is to seal a bandage around the part of (structural) timber preventively or following damage, in order to increase its service life. The essential requirement is the soundness of the wood surface. The preparation of the wood surface and its clean up to sound wood is crucial. Burning surfaces is recognised as a potentially successful initial stage of curative clean up.

304. The commodity representative for wrapping is the transmission pole that was described in Section 0. Only the part buried in the soil is wrapped, usually to a depth of ca. 90 to 100 cm. The application rate is ca. 1.5kg product.m⁻². A maximum number of three treatments are applied during the service life of the pole. Because the product is applied as a paste on foil or sheet or as a bituminous paper, losses during application are considered negligible and, only the emissions from treated wood after application, are estimated.

Cleaning, maintenance and waste disposal

305. The same procedures as for injection outdoor apply.

6.4.2.3.1 Environmental Emission Pathways

306. It is considered that during wrapping, no emissions can occur. Emissions to soil may occur after application, due to direct contact; it is considered that only part of the pole, buried in soil, is treated. Emissions in soil may subsequently reach the ground water.

307. Table 6-6 summarises the environmental compartments potentially exposed and the emission pathways.

TABLE 6.6
Environmental Emission Pathways for Wrapping Outdoors

Primary medium	Pathway	Result
Treatment: Wrapping outdoors		
Hazard Class 4a		
Scenario: transmission poles		
Outdoor air	ventilation by air turbulence	Considered negligible
Surface water	Figure 44 transmission poles do not stand near water; not relevant	not relevant
Soil	contamination of adjacent soil	Considered negligible

Calculation of the emissions

308. The following calculations of emissions to soil, from treated wood after application, are based on the transmission pole scenario. This scenario is described in detail in Section 0., therefore, it is not repeated here.

Parameters

After application: Transmission pole scenario	Nomenclature	Value	Unit	Origin
Inputs				
Treated wood area (below soil)	$AREA_{pole,below}$	0,8	[m ²]	D
Duration of the initial assessment period	$TIME1$	30	[d]	D
Duration of the long-term assessment period	$TIME2$		[d]	D
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over the initial assessment period	$Q^*_{leach,time1}$		[kg.m ⁻²]	A
Cumulative quantity of an active ingredient leached out of 1 m ² of treated wood over a longer assessment period	$Q^*_{leach,time2}$		[kg.m ⁻²]	A
Density of product	$RHO_{product}$		[kg.m ⁻³]	A
(wet) Soil volume	V_{soil}	0,2	[m ³]	D
Bulk density of wet soil	RHO_{soil}	1700	[kg _{wwt} .m ⁻³]	D
Outputs				
Cumulative quantity of an active ingredient, leached over the initial assessment period	$Q_{leach,time1}$		[kg]	O
Cumulative quantity of an active ingredient, leached over a longer assessment period	$Q_{leach,time2}$		[kg]	O
Concentration in local soil at the end of the initial assessment period	$Clocal_{soil,leach,time1}$		[kg.kg _{wwt} ⁻¹]	O
Concentration in local soil at the end of a longer assessment period	$Clocal_{soil,leach,time2}$		[kg.kg _{wwt} ⁻¹]	O

D=default, A=based on information of applicant, O=output

Calculations

309. The emissions from treated wood and the local concentration in soil can be calculated according to the following equations. Because not the whole part of the pole below soil is treated but ca. 0,1 m, the $AREA_{pole,below}$ to be used in this formulas is set at 0,8 m².

$$Q_{leach,time1} = AREA_{pole,below} \cdot Q^*_{leach,time1} \quad (6.25)$$

$$Q_{leach,time2} = AREA_{pole,below} \cdot Q^*_{leach,time2} \quad (6.26)$$

$$Clocal_{soil,leach,time1} = \frac{Q_{leach,time1}}{V_{soil} \cdot RHO_{soil}} \quad (6.27)$$

$$Clocal_{soil,leach,time2} = \frac{Q_{leach,time2}}{V_{soil} \cdot RHO_{soil}} \quad (6.28)$$

310. $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ are calculated on the basis of a leaching test with wood in direct contact with water, if the wood preservatives is not a poorly water soluble substance (PWSS) (see Section 5.3.2.1). If the wood preservative is a PWSS then a leaching test with wood in soil contact may be required. This should be decided by the regulatory authorities on a case by case basis.

311. It should be noted that $Q^*_{leach,time1}$ and $Q^*_{leach,time2}$ must be determined from the results of tests where the treatment of the wood test specimen is representative for the wrapping treatment. The

requirements for the design of a leaching test with wood in direct contact with water, are given in Appendix 1.

312. It should be pointed out that $Clocal_{water,leach,time1}$ and $Clocal_{water,leach,time2}$ represent the concentration at the end of the assessment time period without taking into account removal processes.

6.4.2.4 Termite Control

313. Two cases can be distinguished where termite control is needed: when termites are inside the building, posing a threat to all wood products and cellulose derivatives, or when they are outside.

314. When termites are inside, curative strategies have to be applied and be completed by preventive actions (i.e. formation of barriers). Curative treatments are mostly performed by injection and aim to create an envelope barrier of building components usually from “from top to bottom”. Environmental emissions from injection indoors are considered negligible and therefore they are not discussed in this document.

315. When termites are outside, preventive treatment of all potentially degradable products should be performed and adequate barriers against incursion should be created. In regions where the presence of termites is known, preventive measures should be taken before and during the erection of the building. To this end, a series of biocide barriers are created by spraying. In this type of treatment the product is applied to soil and concrete substrates and not to wood directly. However, some countries consider this treatment as a wood preservation process because the ultimate goal of the treatment is to protect the wooden structures of the future building. Other countries categorise termiticides used for foundation treatment as insecticides and not as wood preservatives. However, the categorisation of termiticide is a regulatory issue and does not influence the potential environmental exposure from the use of these products. Therefore, the Biocides Steering Group agreed to include a scenario for this specific treatment in this document.

6.4.2.4.1 Use pattern for preventive treatment of building foundations

316. The process aims to create a preventive envelope of biocide barriers for the building to be erected. For each stage of construction, the product should be sprayed in successive phases:

- 1) excavation: crude soil (bottom and vertical parts) is sprayed before the concrete is added.
- 2) after pouring the concrete in the foundation raft, the walls of foundations should be treated and voids filled (tuff fillers and soil)
- 3) filling the voids with tuff or soil : the bare interface and “soil square” should be sprayed
- 4) pouring concrete for the soil slab : the remaining pathways (fluids and wires) should be sprayed
- 5) the base of walls and poles (pre - treated, but cut ends) should be sprayed
- 6) following the erection of the building: vertical walls should be sprayed in order to establish an insurmountable envelope. This type of barrier is used to protect also piping and wiring to be followed by subterranean termites.
- 7) at the end of the work, the earth at the perimeter, in contact with the walls above the ground line should be sprayed.

Products

317. Termiticide products are normally emulsion based, and some are flowable powders. Their mode of action is mostly based on acute and chronic toxicity in insects via neurotoxicity, hormonal effect or growth inhibition. In general, they are selected on the basis of low doses and possible delayed effect for the

purpose of transmission inside the colonies. Products are applied at 100 kg/m³ of soil or 5 L/m² of soil assuming a penetration of 5 cm in the topsoil. Products are designed for low mobility in standard soil.

Basic safety precautions

318. Soil treatments under slabs and foundations shall not exceed the perimeter of the surface covered by the roof.

Environmental Emission Pathways

319. During preventive treatment of foundations by spraying, emissions occur to the atmosphere. After the treatment, the product, deliberately applied to soil and concrete substrates, may leach to the groundwater.

6.4.2.4.3 Calculation of emissions from preventive treatment of foundations against termites

320. The calculations are based upon a standard house foundation scenario of 100 m² (10 m x 10 m) surface on soil. The scenario is provided in Figure 6-1. The treatment is performed by spraying.

Parameters

Application: House foundation scenario	Nomenclature	Value	Unit	Origin
Inputs				
Total area treated per day	$AREA_{ground}$		$[m^2 \cdot d^{-1}]$	D
- bottom of excavation		35		
- walls of excavation		140		
- soil surface interior		68		
- perimeter		44		
- Sum		287		
Application rate of the product	$Q_{applic,product}$		$[kg \cdot m^{-2}$ or $l \cdot m^{-2}]$	A
Content of active substance in product	$f_{a.i.}$		[-]	A
Density of product	$RHO_{product}$		$[kg \cdot m^{-3}]$	A
Fraction of product emitted to air during application: <i>vapour pressure at 20°C [Pa]</i>	F_{applic}		[-]	D
<0,005		0,001		
0,005 - <0,05		0,01		
0,05 - <0,5		0,02		
0,5 - <1,25		0,075		
1,25 - <2,5		0,15		
>2,5	0,25			
Outputs				
Emission rate of an active ingredient to the atmosphere during treatment	$E_{atm,term}$		$[kg \cdot d^{-1}]$	O
Quantity of an active ingredient (or any substance of concern in the product) applied to soil per day	$Q_{soil,term}$		$[kg \cdot d^{-1}]$	O

D=default, A=based on information of applicant, O=output

Calculations

During treatment

321. Assuming that the treatment is performed over one day, and that emissions are released to the atmosphere, the emission rate can be calculated as follows:

$$E_{atm,term} = AREA_{ground} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot F_{applic} \cdot 10^3 \quad (6.29)$$

The emissions $E_{atm,term}$ can be used as input for an atmospheric distribution model for a point source (e.g. the atmospheric plume model) to estimate local concentrations and gaseous deposition rates in the vicinity of the treated object. Descriptions of such models can be found for example in [EU TGD 1997].

After treatment

322. The application to soil is intended as the termite barrier. The components of the product applied to soil may reach the ground water via leaching. According to this scenario the quantity of an active ingredient (or any substance of concern in the product) applied to soil is:

$$Q_{soil,term} = AREA_{ground} \cdot Q_{applic,product} \cdot f_{a.i.} \cdot RHO_{product} \cdot 10^3 \quad (6.30)$$

323. Based on $Q_{soil,term}$, inputs for soil leaching models can be calculated for predictions of the concentration of the active ingredient in ground water via potential leaching of the substance in soil. It should be noted that use of $Q_{soil,term}$ for input into soil leaching models is considered as a worst case because the foundation of a house is protected from rain. Some guidance on how soil leaching models can be used for these purposes is given in Appendix 4.

Figure 6-2: House foundation scenario

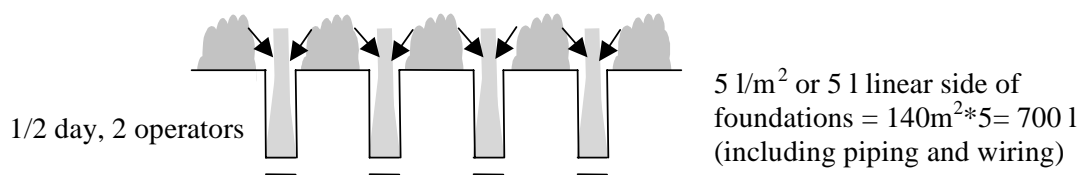
PROFESSIONAL PRE-TREATMENT OF FOUNDATIONS (NON-WOOD SUBSTRATE) TO PROTECT WOOD AGAINST TERMITES

PHASES developed surface of soil
 bottom of excavations = $70\text{m} \times 0,5 = 35\text{m}^2$
 walls of excavations = $70 \times 2 \times 1\text{m} = 140\text{m}^2$
 soil surface (interior) = 68m^2
 perimeter $44\text{m} \times 1\text{m}$ width = 44m^2
 dose 5l/m^2 of ready to use preservation, suitable for soil and wall contact

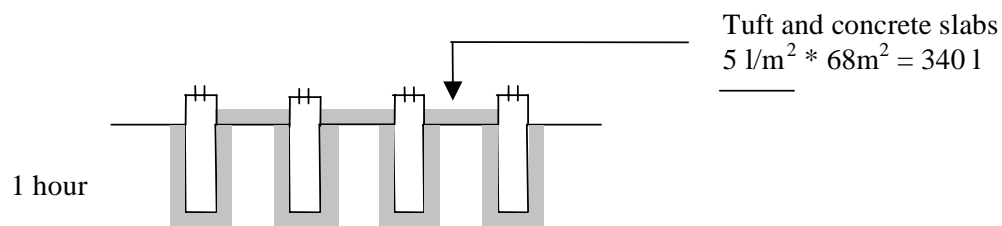
TOTAL NEEDS $35 + 140 + 68 + 44 = 287\text{m}^2$

Wood preservative (emulsion) $287 \times 5 = 1435 \text{ l}$

PHASE 1 Application to bottom of excavations 5l/m^2 , $35\text{m}^2 * 5 = 175 \text{ l}$
PHASE 2 Application to foundation walls and filling with earth treated and mixed -
 spray interior soil



PHASE 3 Treatment of the interior soil



PHASE 4 Treatment of additional soil at perimeter

