CLH report

Proposal for Harmonised Classification and Labelling

Based on Regulation (EC) No 1272/2008 (CLP Regulation),
Annex VI, Part 2

International Chemical Identification:

Phosphine

EC Number: 232-260-8

CAS Number: 7803-51-2

Index Number: 015-181-00-1

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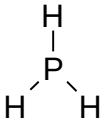
CONTENTS

1 IDENTITY OF THE SUBSTANCE

1.1 Name and other identifiers of the substance

Table 1: Substance identity and information related to molecular and structural formula of the substance

Name(s) in the IUPAC nomenclature or other international chemical name(s)	Phosphine Phosphine gas
Other names (usual name, trade name, abbreviation)	Phosphine, hydrogen phosphide, Phosphorus (tri)hydride Phosphorus(III)hydride Monophosphane Phosphane CYTOP 1
ISO common name (if available and appropriate)	There is no ISO common name.
EC number (if available and appropriate)	232-260-8
EC name (if available and appropriate)	Phosphine
CAS number (if available)	7803-51-2
Other identity code (if available)	127
Molecular formula	H_3P
Structural formula	
SMILES notation (if available)	
Molecular weight or molecular weight range	34 g/mol
Information on optical activity and typical ratio of (stereo) isomers (if applicable and appropriate)	/
Description of the manufacturing process and identity of the source (for UVCB substances only)	/
Degree of purity (%) (if relevant for the entry in Annex VI)	The minimum purity is 994 g/kg.

Note: several names exist for the active substance. The EC name is phosphine and has been used for the redaction of the CLH report.

Composition of the substance

Table 2: Constituents (non-confidential information)

Constituent (Name and numerical identifier)	**Concentration range (% w/w minimum and maximum in multi-constituent substances)**	**Current CLH in Annex VI Table 3.1 (CLP)**	**Current self-classification and labelling (CLP)**
Phosphine	99.4	Press Gas, Flam Gas 1 H220, Skin Corr 1B H314 Acute Tox 2* H330 Aquatic acute 1 H400	Existing harmonized classification

Table 3: Impurities (non-confidential information) if relevant for the classification of the substance

Impurity (Name and numerical identifier)	**Concentration range (% w/w minimum and maximum)**	**Current CLH in Annex VI Table 3.1 (CLP)**	**Current self-classification and labelling (CLP)**	**The impurity contributes to the classification and labelling**
Arsine	0.0023	Press Gas Flam Gas 1 H220 Acute Tox 2* H330 STOT RE 2* H373** Aquatic acute 1 H400 Aquatic Chronic H410	Existing harmonized classification	No

2 PROPOSED HARMONISED CLASSIFICATION AND LABELLING

2.1 Proposed harmonised classification and labelling according to the CLP criteria

Table 4:

	Index No	International Chemical Identification	EC No	CAS No	Classification		Labelling			Specific Conc. Limits, M-factors	Notes
					Hazard Class and Category Code(s)	Hazard statement Code(s)	Pictogram, Signal Word Code(s)	Hazard statement Code(s)	Suppl. Hazard statement Code(s)		
Current Annex VI entry	015-181-00-1	Phosphine	232-260-8	7803-51-2	Press. Gas Flam. Gas 1 Skin Corr. 1B Acute Tox. 2* Aquatic Acute 1	H220 H314 H330 H400	Danger GHS02 GHS09 GHS05 GHS06 GHS04	H220 H314 H330 H400	-	-	U
Dossier submitters proposal	015-181-00-1	Phosphine	232-260-8	7803-51-2	Acute Tox. 1	H330	GHS06	H330	-	-	-
Resulting Annex VI entry if agreed by RAC and COM	015-181-00-1	Phosphine	232-260-8	7803-51-2	Press. Gas Flam. Gas 1 Skin Corr. 1B Acute Tox. 1 Aquatic Acute 1	H220 H314 H330 H400	Danger GHS02 GHS09 GHS05 GHS06 GHS04	H220 H314 H330 H400	-	-	U

Table 5: Reason for not proposing harmonised classification and status under public consultation

Hazard class	Reason for no classification	Within the scope of public consultation
Explosives	Hazard class not applicable	No
Flammable gases (including chemically unstable gases)	Hazard class not assessed in this dossier Current harmonized classification: Flam Gas 1 H220	No
Oxidising gases	Hazard class not assessed in this dossier	No
Gases under pressure	Current harmonized classification: Press Gas	No
Flammable liquids	Hazard class not applicable	No
Flammable solids	Hazard class not applicable	No
Self-reactive substances	Hazard class not assessed in this dossier	No
Pyrophoric liquids	Hazard class not applicable	No
Pyrophoric solids	Hazard class not applicable	No
Self-heating substances	Hazard class not applicable	No
Substances which in contact with water emit flammable gases	Hazard class not applicable	No
Oxidising liquids	Hazard class not applicable	No
Oxidising solids	Hazard class not applicable	No
Organic peroxides	Hazard class not applicable	No
Corrosive to metals	Hazard class not assessed in this dossier	No
Acute toxicity via oral route	Hazard class not assessed in this dossier	No
Acute toxicity via dermal route	Hazard class not assessed in this dossier	No
Acute toxicity via inhalation route	Proposed harmonised classification : Acute Tox. 1 – H330	Yes
Skin corrosion/irritation	Current harmonized classification: Skin Corr. 1B – H314	No
Serious eye damage/eye irritation	Hazard class not assessed in this dossier	No
Respiratory sensitisation	Hazard class not assessed in this dossier	No
Skin sensitisation	Hazard class not assessed in this dossier	No
Germ cell mutagenicity	Hazard class not assessed in this dossier	No
Carcinogenicity	Hazard class not assessed in this dossier	No
Reproductive toxicity	Hazard class not assessed in this dossier	No
Specific target organ toxicity-single exposure	Hazard class not assessed in this dossier	No
Specific target organ toxicity-repeated exposure	Hazard class not assessed in this dossier	No
Aspiration hazard	Hazard class not assessed in this dossier	No
Hazardous to the aquatic environment	Hazard class not assessed in this dossier Current harmonized classification: Aquatic acute 1 – H400	No
Hazardous to the ozone layer	Hazard class not assessed in this dossier	No

3 HISTORY OF THE PREVIOUS CLASSIFICATION AND LABELLING

Phosphine has an harmonized classified according to the Directive 67/548/EEC: F+; R12, R17, T+; R26, C; R34, N; R50.

This classification was translated into CLP regulation (CLP00): Press. Gas; Flam. Gas 1 – H220; Skin Corr. 1B - H314; Acute Tox. 2* - H330; Aquatic Acute 1 – H400.

4 JUSTIFICATION THAT ACTION IS NEEDED AT COMMUNITY LEVEL

Because the classification according to the criteria in Directive 67/548/EEC does not correspond directly to the classification in a hazard class and category under CLP regulation, a minimal classification is currently available for acute toxicity by inhalation for phosphine.

France would like to progressively suppress all the minimal classifications in order to improve the risk management of these substances. The need to update the classification of phosphine regarding its acute toxicity by inhalation is justified considering the wide use of this substance in fumigation activities, with the occurrence of cases of (sub)fatal accidents. In addition, concerning fumigated products, there is a national and European plan for a better occupational risk control for workers manipulating those products.

5 IDENTIFIED USES

This substance is used as an insecticide under PPP (phytopharmaceutical products) Regulation.

Other following uses are reported in ECHA website:

- This substance is used in the following products: semiconductors.
- This substance is used for the manufacture of: electrical, electronic and optical equipment.

6 DATA SOURCES

This CLH dossier is based on the available data on the REACH registration dossier of phosphine, but also on the RAC opinions on aluminium phosphide and trimagnesium disphosphide (2011a, b) and on the DAR on phosphine (2010).

7 PHYSICOCHEMICAL PROPERTIES

Data reported below comes from the DAR on phosphine (2010).

Table 6: Summary of physicochemical properties

Property	**Value**	**Reference**	**Comment (e.g. measured or estimated)**
Physical state at 20°C and 101,3 kPa	Gas Colourless Pure phosphine is odourless. Phosphine technical has a fishy or garlicky odour.	Lewis, 2000 (report BVL no 1693122) Anonymous, 1989 (report BVL no 1693123)	Method and material tested not reported
Melting/freezing point	-133.8 °C	Lide, 2004 (report BVL no 1693118)	Chemical textbook
Boiling point	-87.75 °C	Lide, 2004 (report BVL no	Chemical textbook

Property	Value	Reference	Comment (e.g. measured or estimated)
		1693119)	
Relative density	1.390 g/L (~ 10^5 Pa)	Lide, 2004 (report BVL no 1693120)	Chemical textbook
Vapour pressure	At -144.48 °C the vapour pressure was found to be 1063.91 Pa.	Gmelin, 1965 (report BVL no 1693121)	Chemical textbook
Surface tension	Not applicable. Based of its chemical nature no influence of the surface tension is expected.		
Water solubility	371 mg/L (260 cm³ in 1000 cm³ water at 17 °C).	Gmelin [original founder], 1965 (report BVL no 1693133)	Chemical textbook
Partition coefficient n-octanol/water	log P_{OW}: -0.27 Investigations concerning the possible pH dependency are not applicable.	Tiemann, 2006 (report BVL no 1693136)	Calculation KOWWIN (Version 1.66)
Flash point	Not applicable		
Flammability	Phosphine is extremely flammable. Classified as F^+ under Directive 67/548/EEC. Harmonised classification under CLP regulation: Flam Gas 1 H220 (worst case).	Anonymous, 1989 (WHO report) (report BVL no 1693138)	Method not reported Material tested not reported Not GLP
Explosive properties	Not applicable in the sense of EEC A14. Phosphine forms explosive mixtures with air at concentrations greater than 1.8 %.	Anonymous, 1989 (WHO report) (report BVL no 1693140)	Method not reported Material tested not reported Not GLP
Self-ignition temperature	The auto-ignition temperature of pure phosphine is 38 °C. Technical phosphine technical ignites spontaneously in air at ambient temperatures at concentrations above 1.8 %. Classified as R17 under	Anonymous, 1989 (WHO report) (report BVL no 1693139)	Method not reported Material tested not reported Not GLP

Property	Value	Reference	Comment (e.g. measured or estimated)
	Directive 67/548/EEC (spontaneously flammable in air). Harmonised classification under CLP regulation : Flam Gas 1 H220 covers this point.		
Oxidising properties	Not applicable in the sense of EEC A17. No EC or OECD test guideline for the oxidative properties of gas is available, but phosphine must be stated to be corrosive to metals, particularly to copper and copper alloys. Due to the low redox potential of phosphane in acidic solutions (-0.063 V) and in alkaline solutions (-0.891 V) phosphine is a reducing agent without any oxidising properties. At 150 °C phosphine will be oxidised to phosphoric acid only in the presence of oxygen acting as a reducing agent.	Document M-II (report BVL no 1693222) and Anonymous, 1989 (WHO report) (report BVL no 1693141)	Method not reported Material tested not reported Not GLP Not acceptable. This information does not address the issue of the Annex point.
Granulometry	Not applicable		
Stability in organic solvents and identity of relevant degradation products	The solubility of phosphine in organic solvents was found to be: Ethanol: 695 mg/L Ether: 2.78 g/L Spirits of turpentine: 4.52 g/L (all at 18 °C) Cyclohexanol: 3.97 g/L (all at 26 °C)	Gmelin [original founder], 1965 (report BVL no 1693135)	Method not reported Material tested not reported Not GLP
Dissociation constant	Not applicable. It is known from chemical textbooks that the pK_b of phosphine is in the order of 26. Also its acid properties	No reference	Chemical textbook

Property	Value	Reference	Comment (e.g. measured or estimated)
	can only be revealed with extreme bases.		
Viscosity	Not applicable		

8 EVALUATION OF PHYSICAL HAZARDS

Current harmonised classification: Press Gas, Flam Gas 1 - H220. Hazard physical classes were not re-assessed.

9 TOXICOKINETICS (ABSORPTION, METABOLISM, DISTRIBUTION AND ELIMINATION)

Table 7: Summary table of toxicokinetic studies

Method	Results	Remarks	Reference
Inhalation	Inhaled phosphine (PH_3) is considered to be readily absorbed through the lungs and Excreted with urine as hypophosphite and phosphite and via lungs as PH_3		WHO (1988) (TOX2005-1201)

9.1 Short summary and overall relevance of the provided toxicokinetic information on the proposed classification(s)

Few data are available on the toxicokinetics of phosphine. The information below are based on the WHO/IPCS report (1988).

Phosphine is generally considered to be readily absorbed through the lungs. Inhaled phosphine produces neurological and hepatic symptoms suggesting that it reaches the nervous system and liver. Ingested phosphides have been shown to reach the liver and blood in rats and human beings. In rats, phosphine that is not excreted in the expired air is oxidized and appears in the urine, mainly as hypophosphite and phosphite. An unidentified metabolite is also reported, detectable by paper chromatography and distinct from pyrophosphate and metaphosphate. The fact that phosphine is incompletely oxidized and the proportion of an administered dose that is eliminated as expired phosphine increases with the dose suggests that the oxidative pathway is slow.

10 EVALUATION OF HEALTH HAZARDS

Acute toxicity

10.1 Acute toxicity - oral route

Hazard class not evaluated in this dossier

10.2 Acute toxicity - dermal route

Hazard class not evaluated in this dossier

10.3 Acute toxicity - inhalation route

Table 8: Summary table of animal studies on acute inhalation toxicity

Method, guideline, deviations if any	**Species, strain, sex, no/group**	**Test substance, form and particle size (MMAD)**	**Dose levels, duration of exposure**	**Value** LC_{50}	**Reference**
Acute inhalation toxicity study, US EPA, whole body. GLP Acceptable	Rat SD, 5M + 5F/group	PH_3	9-19-22-35-55-64-109 ppm 4 h	LC_{50}: 57 ppm (M/F) (0.08 mg/L)	Nachreiner, D.J. and Dodd, D.E. (1986)
Acute inhalation toxicity study, US EPA, head only. GLP. Acceptable	Rat SD Part 1: 5M+5F/group Part 2: 10M/group	1% PH_3 in nitrogen	Part 1: 0-1.3-6-28 ppm Part 2: 3.1-10-18 6 h	No LC_{50} was calculated, 50% mortality at 28 ppm	Newton, P.E. (1991)
Acute inhalation toxicity study. No guideline, non GLP Acceptable	Rat Wistar, 5M + 5F/group	PH_3, developed from magnesium phosphide	0 - 15.4 – 26 - 47 ppm 4h	LC_{50}: 34.6 ppm (0.048 mg/L)	Roy, B.C. (1998)
Acute inhalation toxicity study whole body, US EPA. GLP. Acceptable	Rat Fisher 344 15/sex/group	PH_3	2.4 - 4.9 - 11 ppm 6 h	LC_{50}: > 11 ppm (M/F) (> 0.016 mg/L or > 0.675 mg/kg bw)	Newton, P.E. (1993)
Acute inhalation toxicity study, whole body, exposure Similar to OECD 403, Non-GLP Not reliable	Rat, Slc:SD 10M + 10F/group	PH_3, developed from magnesium phosphide	150 – 165 – 182 – 200 – 220 – 242 ppm 1 h	LC_{50}: 204/179 ppm (M/F) (0.29/0.25 mg/L air (M/F) or 12.9/11.4 mg/kg bw (M/F))	Shimizu, Y. *et al.* (1982)
Acute inhalation toxicity study, whole body, Similar to OECD 403, Non-GLP Acceptable	Rat ChR-CD 6M/group	PH_3 (gaseous phosphine)	Dose levels not reported 4 hours	LC_{50} M: 11 ppm equivalent to: 0.015 mg PH_3 /L air	Waritz, R.S. and Brown R.M. (1975); Amer. Ind. Hyg. Assoc. J., p 452
Acute inhalation toxicity study Equivalent or similar to Guideline: OECD Guideline 403, GLP not specified Acceptable	Mouse ICR 10M/group	99.995% pure PH_3	First experiment: 17.2 ppm ; 25.1 ppm ; 31.7 ppm ; 41.6 ppm ; 59.2 ppm for 1 hour Second experiment: 22.5 ppm ; 26.5 ppm ; 33.4 ppm ; 45.5 ppm ; 66.9 for 4 hours	LC_{50} for 1 hour exposure was greater than 59.2 ppm and that for 4-hour exposure was between 26.5 ppm and 33.4 ppm.	Omae K., Ishizuka C. and Nakashima H 1996
Acute inhalation	Rat Wistar female	PH_3, developed	Sample A :	The LC_{50} values	Muthu M.,

Method, guideline, deviations if any	Species, strain, sex, no/group	Test substance, form and particle size (MMAD)	Dose levels, duration of exposure	Value LC_{50}	Reference
toxicity study Non-guideline, Non-GLP Not reliable	6/dose	from aluminium phosphide	20 ppm for 6 h ; 40 ppm for 4 h ; 27 ppm for 8 h ; 40 ppm for 6 h. Sample B : 33 ppm for 6 h ; 60 ppm for 4 h ; 33 ppm for 8 h.	ranged from 28 ppm (27°C) to 33.3 ppm (26.1°C) with related exposure period of 5.2 to 7.4 hours respectively for the products A and B.	Krishnakumari M.K., Muralidhara V. and Majumder S.K. 1980

M: male
F: female

10.3.1 Short summary and overall relevance of the provided information on acute inhalation toxicity

Phosphine is currently classified as T+; R26 "Very toxic by inhalation" according to Directive 67/548/EC and translated into a minimum classification as Acute Tox. 2* (inhalation) H330: "Fatal if inhaled" according to the CLP Regulation.

It has to be noted that RAC opinions on the harmonised classification and labelling for acute inhalation toxicity of aluminium phosphide and trimagnesium diphosphide are available (ECHA, 2011a, b) with three studies in common with the current dossier : Waritz, R.S. and Brown R.M. (1975), Roy, B.C.(1998), and Shimizu, Y. *et al.* (1982). Aluminium phosphide and trimagnesium disphosphide readily release phosphine by hydrolysis, which is responsible for most of the toxic activity of metal phosphides. The committee concluded that the highest values **204/179 ppm** (male/female) were obtained from the study (Shimizu, 1982) where exposure lasted only for 1 hour and concentration was not measured but calculated based on amount of Mg_3P_2 added to a chamber with water. The LC_{50} value of **34.6 ppm** was obtained based on the study of Roy (1998), where the method of measurement is not very well documented. Due to deficiencies reported in Roy, (1998), it was proposed to take the LC_{50} value obtained from the Waritz and Brown study (1975): **11 ppm**.

Among other studies identified, 3 were published.

In the study of Newton *et al.* (1993), 15 Fischer rats/sex were exposed for 6 hours to 0, 2.4, 4.9 and 11 ppm (analytical exposure). All animals survived these exposures, consequently **no LC_{50}** can be derived. This study was assessed in the DAR and considered supplementary. Beyond the fact that the exposures last 6 hours (instead of 4 hours as stated in guidelines), the authors have maybe selected too low concentrations.

The study by Muthu *et al.* (1980) has an unusual protocol. Six Wistar rats per dose were exposed to different samples of the substance (A or B, without any details on these samples), and at different exposure times (4 to 8 hours). From these exposures, the authors derived concentration-time products. For the sample A, the LC_{50} derived was **28 ppm for 5.2 hours** of exposure, and for the sample B, **33.3 ppm for 7.4 hours** of exposure. With regard to the protocol and the missing information, the results of this study seem difficult to interpret.

In the study by Omae *et al.* (1996), ICR male mice (10/group) were exposed for 4 hours to 22.5, 26.5, 33.4, 45.5 and 66.9 ppm. No mortality was noted at the two lowest concentrations (22.5 and 26.5 ppm), and all animals died at the three others concentrations (33.4, 45.5 and 66.9 ppm). The authors concluded that the LC_{50} was **between 26.5 and 33.4 ppm**. It has to be noted that, in the other experiment lasting 1 hour, the authors did not observed mortality up to 59.2 ppm.

Finally, two other studies identified were not published, but summarised in the DAR (2010).

The study from Nachreiner *et al.* (1986) has been assessed in the draft assessment report (DAR) (2010) of phosphine and was considered acceptable. Sprague Dawley rats (5/sex/group) were exposed by inhalation

route for 4 hours at actual concentrations of 9, 19, 22, 35, 55, 64 and 109 ppm. The study was conducted according the OPPTS guideline and GLP. No mortality was noted at the four lowest concentrations (9, 19, 22 and 35 ppm), 3/10 animals died at 55 ppm, 9/10 at 64 ppm, and all animals died at 109 ppm. The authors concluded that the four-hour inhalation LC_{50} in rats of phosphine was approximately **57 (49-66) ppm** for the combined sexes.

The study from Newton *et al.* (1991) has also been assessed in the DAR. Sprague Dawley rats (5/sex) were exposed for 6 hours to 0, 1.3, 6, and 28 ppm. **No LC_{50}** was calculated, but a 50 % mortality of animals was observed at an actual concentration of 28 ppm phosphine. It was considered as supplementary data: unless it was conducted according to OPPTS guidelines and under GLP, there were some deviations (exposure period was 6 hours, no necropsy data submitted, and no LC_{50} calculated...).

10.3.2 Comparison with the CLP criteria

Overall, on the eight studies available :

- 5 derived LC_{50} that fall into category 1 (< 100 ppm);
- 2 were not able to derive LC_{50};
- 1 derived LC_{50} that fall into category 2 (100-500 ppm)

Based on a weight of evidence, except the study of Shimizu *et al.* (1982), all studies allowing the derivation of a LC_{50} fall into category 1 criteria for acute inhalation toxicity (< 100 ppm). The study from Shimizu *et al.* (1982) suffer from serious deficiencies : exposure lasted only for 1 hour and concentration was not measured but calculated based on amount Mg_3P_2 added to a chamber with water. For information, LC_{50} from this study for 4 hours calculated with the Haber's law would have been 51/45 (male/female) ppm, which is consistent with results of other studies and therefore with criteria for a classification as Acute Tox.1. Concerning the studies that were not able to derive a LC_{50}, for one of them, concentrations selected may be too low (Newton *et al.*, 1993). For the other one, the LC_{50}, even if not derived by the authors, could be 28 ppm as half of the animals died at this concentration (Newton *et al.*, 1991). Results are therefore relatively consistent between studies.

It has to be noted that, neither the toxicokinetics data (showing a systemic activity) nor the physical and chemical properties available suggest a corrosive action of phosphine.

According to CLP guidance document (2015), in general, classification is based on the lowest LC_{50} value available. Consequently, classification in category 1 (gases) – H330 is warranted as the majority of studies derives an LC_{50} clearly under 100 ppm, the upper limit of the category.

It can be noted that in the report for aluminium phosphide, RAC provided additional recommendations for phosphine classification : "*According to RAC, phosphine should be reclassified into acute inhalation toxicity category 1, having in mind that the LC_{50} values for phosphine from three studies are in a range between 11 – 51 ppm, well below the guidance values of 100 ppm for acute inhalation toxicity hazard category 1 for toxic gases. While the classification according to the DSD Directive, T+; R26, is appropriate since all LC_{50} values are in a range of 0.015 – 0.072mg/l which is well below the DSD guidance value ≤0.5mg/l/4h for this category*", which are therefore in line with our conclusions.

For the classification of mixtures containing phosphine, FR is of the opinion to retain the acute toxicity estimate (ATE) value of 11 ppm, *i.e.* the LC_{50} from the study of Waritz *et al*. Despite the lack of information in the study (doses used and mortality not given), this is the lowest LC_{50} available. Moreover, considering the uncertainties of the database (general quality of the studies), FR made the choice to select the most conservative value.

10.3.3 Conclusion on classification and labelling for acute inhalation toxicity

Phosphine should be classified in acute hazard category 1 for inhalation, H330, according to the Regulation (EC) 1272/2008/EC.

10.4 Skin corrosion/irritation

Hazard class not evaluated in this dossier

10.5 Serious eye damage/eye irritation

Hazard class not evaluated in this dossier

10.6 Respiratory sensitisation

Hazard class not evaluated in this dossier

10.7 Skin sensitisation

Hazard class not evaluated in this dossier

10.8 Germ cell mutagenicity

Hazard class not evaluated in this dossier

10.9 Carcinogenicity

Hazard class not evaluated in this dossier

10.10 Reproductive toxicity

Hazard class not evaluated in this dossier

10.11 Specific target organ toxicity-single exposure

Hazard class not evaluated in this dossier

10.12 Specific target organ toxicity-repeated exposure

Hazard class not evaluated in this dossier

10.13 Aspiration hazard

Hazard class not evaluated in this dossier

11 EVALUATION OF ENVIRONMENTAL HAZARDS

Hazard class not evaluated in this dossier

12 EVALUATION OF ADDITIONAL HAZARDS

Hazard class not evaluated in this dossier

13 ADDITIONAL LABELLING

14 REFERENCES

Committee for Risk Assessment (RAC). 2 december 2011a. Opinion proposing harmonised classification and labelling at Community level of aluminium phosphide. ECHA/RAC/CLH-O-0000002201-92-01/F

Committee for Risk Assessment (RAC). 2 december 2011b. Opinion proposing harmonised classification and labelling at Community level of trimagnesium diphosphide. ECHA/RAC/DOC CLH-O-0000002194-79-01/F

European Commission. Draft Assessment Report Phosphane, prepared by Germany in January 2010, with updated addendum of 2011.

Muthu M., Krishnakumari M. K., Muralidhara, and Majumder S. K. 1980. A Study on the Acute Inhalation Toxicity of Phosphine to Albino Rats. Bull. Environm. Contam. Toxicol. 24, 404-410.

Nachreiner, D.J. and Dodd, D.E. (1986), (unpublished), cited in the Draft Assessment Report (2011)

Newton, P.E. (1991) (unpublished), cited in the Draft Assessment Report (2011)

Newton P. E., Schroeder R. E., Sullivan J. B., Busey W. M. and Banas D. A. 1993. Inhalation Toxicity of Phosphine in the Rat: Acute, Subchronic, and Developmental. Inhalation Toxicology 5, p. 223-239

Omae K., Ishizuka C., Nakashima H., Sakurai H., Yamazaki K., Mori K., Shibata T., Kanoh H., Kudo M. and Tati M. 1996. Acute and Subacute Inhalation Toxicity of Highly Purified Phosphine (PH3) in Male ICR Mice. J Occup Health; 38 : 36-42.

Roy, B.C. (1998) (unpublished), cited in the Draft Assessment Report (2011)

Shimizu, Y. *et al.* (1982) (unpublished), cited in the Draft Assessment Report (2011)

Waritz R. S. & Brown R. M. 1975. Acute and Subacute Inhalation Toxicities of Phosphine, Phenylphosphine and Triphenylphosphine. American Industrial Hygiene Association Journal, Volume 36, - Issue 6

WHO/IPCS. 1988. Environmental Health Criteria 73; Phosphine And Selected Metal Phosphides

15 ANNEXES

Separate Annex I and confidential annex to the CLH report .