Conclusion regarding the peer review of the pesticide risk assessment of the active substance

glufosinate

finalised: 14 March 2005

(revision of 13 April 2005 with minor editorial changes)

SUMMARY

Glufosinate is one of the 52 substances of the second stage of the review programme covered by Commission Regulation (EC) No 451/2000[1], as amended by Commission Regulation (EC) No 1490/2002[2]. This Regulation requires the European Food Safety Authority (EFSA) to organise a peer review of the initial evaluation, i.e. the draft assessment report (DAR), provided by the designated rapporteur Member State and to provide within one year a conclusion on the risk assessment to the EU-Commission.

Sweden being the designated rapporteur Member State submitted the DAR on glufosinate in accordance with the provisions of Article 8(1) of the amended Regulation (EC) No 451/2000, which was received by the EFSA on 3 January 2003. Following a quality check on the DAR, the peer review was initiated on 28 April 2003 by dispatching the DAR for consultation of the Member States and the sole notifier Bayer CropScience. Subsequently, the comments received were examined by the rapporteur Member State and the need for additional data was agreed in an evaluation meeting in January 2004. Remaining issues as well as further data made available by the notifier upon request were evaluated in a series of scientific meetings with Member State experts in April and May 2004.

A final discussion of the outcome of the consultation of experts took place with representatives from Member States on 10 February 2005 leading to a full consensus on all issues and the conclusions as laid down in this report.

The conclusion was reached on the basis of the evaluation of 3 representative uses as proposed by the notifier, representing the 3 main types of use of the compound (apple for non-selective herbicide use in conventional crops, potatoes for use as crop desiccant and transgenic maize for use as selective herbicide) at application rate up 1.5 kg glufosinate-ammonium per hectare. The representative formulated products for the evaluation were “Basta SL 14”, "Basta SL 18" and "Liberty SL 18", soluble concentrates (SL). The latter can be used in genetically modified glufosinate tolerant

[1] OJ No L 53, 29.02.2000, p. 25
[2] OJ No L 224, 21.08.2002, p. 25

organisms (such as maize, oil seed rape and sugar beets). Due to the fact that the ammonium salt, a variant of glufosinate, is used in the formulated product, it should be noted that the evaluated data belong to the variant glufosinate-ammonium, unless otherwise specified.

Adequate methods are available to monitor all compounds given in the respective residue definition except for blood.

Glufosinate-ammonium is poorly absorbed; the average was set to 10% (based on available data). The major metabolites were MPP[3] and NAG[4], minor amounts of MHB[5], MPB[6] and traces of MPA[7]. The oral LD50 was 1510 mg/kg bw in the rat and 416 mg/kg bw in the mouse (leading to a proposed classification with Xn; R22). Dermal LD_{50} was determined > 4000 mg/kg bw for the rat < 2000 mg/kg bw for the female rabbit and > 2000 mg/kg bw for the male rabbit. According to the inhalatory LC_{50} 1.26 mg/l air a classification of Xn; R20 was proposed. Glufosinate-ammonium was mildly irritating to eyes but not to skin and showed no sensitising properties. Relevant oral short term no-observed adverse effect level (NOAEL) is 4.5 mg/kg bw/day, 1-year dog study, based on mortality and decreased glutamine synthetase activity and is an overall value for the studies in dog (proposed classification: Xn; R48/22). Relevant dermal NOAEL is 100 and 300 mg/kg bw/day for male and female rat, respectively. The NOAEL(C) was 0.012 mg/l air leading to a proposed classification of T; R48/23. There was no evidence of genotoxicity or carcinogenicity or direct effects on reproductive performance or fertility observed. The relevant NOAEL for reproduction is 120 ppm (7.5 and 9.6 mg/kg bw/day male and female) in rat based on reduced litter size. However, both pre- and post implantation losses to a high degree were noted and the NOAEL was set to 50 ppm (4.3 mg/kg bw/day). Glufosinate-ammonium induced pre- and post implantation losses, vaginal bleedings, abortions and dead foetuses not induced by maternal toxicity. The relevant developmental NOAEL is 6.3 mg/kg bw/day in the rabbit based on premature deliveries, abortions and dead foetuses (proposed classification: Cat. 2, T; R61/R62). No indications of delayed neurotoxicity. The metabolites (NAG, MPA and MPP) are all less toxic than glufosinate-ammonium.
The acceptable daily intake (ADI) and the acceptable operator exposure level (AOEL) are based on the NOAEL of 6.3 mg/kg bw/day from the rabbit developmental toxicity study. Due to the severe art of effects seen both in the rat and rabbit an additional safety factor of 3 was added. The ADI is 0.021 mg/kg bw/day. The AOEL is 0.0021 mg/kg bw/day since a correction for 10% oral absorption (based on available data) is required. Two acute reference doses (ARfD) values are set; the first is based on the NOAEL from the rabbit developmental study for women of child bearing potential i.e. 0.021 mg/kg bw/day. The second is based on the NOAEL of 4.5 mg/kg bw/day from the 1- year dog study, without additional safety factor, i.e. 0.045 mg/kg bw/day is suggested to be used for the general population.

[3] 3-methyl-phosphinico-propionic acid (MPP)
[4] disodium L-2-acetamido-4-methylphosphinato-butyrate or N-acetyl-glufosinate (NAG)
[5] 2-hydroxy-4-methylphosphinico-butanoic acid (MHB)
[6] 4-methylphosphinico-butanoic acid (MPB)
[7] 2-methylphosphinico-acetic acid (MPA)

Dermal absorption of the formulations Basta SL14 and Basta SL18/Liberty SL18 were 16 % and 7 % for undiluted product and 14 % and 9 % for spraying dilution, respectively.
The estimated operator exposure levels for apple orchards using Basta SL14/SL18 were below the AOEL when personal protective equipment (PPE) was used. The estimated operator exposure both for potato desiccation using Basta SL14/SL18 and for weed control in transgenic maize using Liberty SL18 exceeded the AOEL even when PPE was used.

The metabolism of glufosinate-ammonium has been investigated on the three crops selected as representative uses by the notifier as well as in livestock.
The residue definition proposed for monitoring and risk assessment for apples, potatoes and transgenic maize as well as for products of animal origin is the sum of glufosinate, its salts, MPP and NAG expressed as glufosinate equivalents. This definition protects adequately the consumer.
When the product is used according to the proposed good agricultural practice in apple and maize, no residues above the limit of quantification (LOQ) of 0.1 mg/kg are present at harvest. In potatoes, however, residues can be present up to 0.5 mg/kg and consist essentially of parent glufosinate. These residues are not altered by cooking in boiling water.
In a succeeding crop installed shortly after the use of glufosinate, one unknown metabolite of polar nature can be present but at extremely low levels (around 0.01 mg/kg). Further work should however be done to identify this metabolite.
Cattle liver and kidney can contain measurable levels of residues of MPP (up to 1 and 2 mg /kg respectively) when the animals are fed with potatoes and transgenic maize treated with glufosinate.
Chronic and acute risk assessments for the consumers were carried out according to usual methodologies. Based on the available data, the use on potatoes appeared to lead to an acute risk for toddlers (114 % of the ARfD for general population, including toddlers).

All studies on the fate and behaviour in the environment were performed with the ammonium salt of glufosinate (glufosinate-ammonium). Due to the fact the ammonium ion is ubiquitous in the environment; the fate of the ammonium resulting from the application of glufosinate-ammonium was not followed. Therefore, the results are referred to the fate of the anion glufosinate which is expected to be dissociated in aqueous media at environmentally relevant pH (5-9).
Glufosinate yields the two major metabolites MPP and MPA in soil under dark aerobic conditions. Glufosinate is stable towards photolytical degradation in soil.
Glufosinate is low persistent and metabolites MPP and MPA are low to moderate persistent in soil under aerobic conditions. Plant metabolite in transgenic plants, NAG, is very low persistent in soil. However, Member States may need to further assess this metabolite for uses were a larger portion of the plants is left in the field after cropping. Glufosinate is moderate to high mobile, MPP is high mobile and MPA is high to moderate mobile in soil.
Glufosinate is hydrolytically stable and it is not degraded by photolysis in water. Glufosinate is not readily biodegradable.

In the water phase, at 20 °C under aerobic conditions, the major metabolites were MPP, MPA, P-X,[8] P-Y[9] (= MPF) and NAG. The same metabolites were found under anaerobic conditions. Glufosinate reached levels above 10 % applied radioactivity (AR) in the sediment. An estimated theoretical maximum of 46 % AR was calculated for MPP in the sediment and used for calculation of the predicted environmental concentration in sediment (PEC sed). The dissipation half-lives of glufosinate in the water phase were 1.4 - 13 days at 20°C. The half life for MPP was estimated by extrapolation to be 150 d. Degradation of MPA and P-Y was slower. Further assessement of metabolites NAG and P-X may be needed for MS risk assessement.

Predicted environmental concentrations in surface water (PEC sw) and sediment (PEC sed) presented in the addendum were used for the ecotoxicological risk assessment.

According FOCUS ground water (gw) PELMO 1.1.1. modelling MPP may have some potential to contaminate groundwater in vulnerable areas (trigger of 0.1 µg / L is exceeded in one of the nine scenarios). One field leaching study confirms leaching potential of MPP under vulnerable conditions at levels above 0.1 µg /L. Hence, for this metabolite an assessment with regard to potential relevance in ground water is warranted.

Concentrations of glufosinate-ammonium in the air compartment are expected to be negligible, due to low volatility and short persistence in the atmosphere.

Based on the data available at the EPCO expert meeting on ecotoxicology a high risk to mammals was identified. The acute and long term toxicity exposure ratio (TER) values are 3.5 and 0.13 respectively for the use in apples. The long term TER value is 0.86 in transgenic maize and the long term TER value for insectivorous mammals in potatoes would be 3.25 if the interception factor is disregarded as proposed by EFSA. Further data was submitted by the notifier after the EPCO expert meeting but this was neither evaluated by the RMS nor peer reviewed. The risk assessment can only be concluded when the outstanding data is evaluated.

The resulting TER-values for the acute and long term risk for aquatic organism were all higher than the Annex VI rigger value indicating a low risk to aquatic organisms for all representative uses (pending on a confirmatory data requirement for the long term risk to *Daphnia magna* from the metabolite MPP).

The risk is considered to be low for in-field populations of non-target arthropods (NTA) in potato and transgenic maize. A high risk is identified for off-crop populations of non-target arthropods in potatoes and maize which requires risk mitigation measures such as a 5 m bufferzone at Member State level. The available data at the EPCO expert meeting were not sufficient to demonstrate a safe use for non-target arthropods in orchards, since the tested doses in the field study were lower than those recommended in orchards (1.5 kg as/ha) and the risk assessment can only be concluded when the outstanding data is evaluated.

Based on the available data EFSA considers the risk to non-target plants from the use in orchards and maize as low when a buffer zone of 5 meter is taken into account. The risk from the use in potatoes can be regarded as low without the need for risk mitigation measures.

[8] 3-methylphosphinico-acrylic acid (P-X)
[9] methylphosphinico-formic acid (P-Y)

The risk to birds, bees, earthworms, other soil non-target macro-organisms, soil micro-organisms and biological methods for sewage treatment is considered to be low.

Key words: glufosinate, glufosinate-ammonium peer review, risk assessment, pesticide, herbicide

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BACKGROUND

Commission Regulation (EC) No 451/2000 laying down the detailed rules for the implementation of the second and third stages of the work program referred to in Article 8(2) of Council Directive 91/414/EEC, as amended by Commission Regulation (EC) No 1490/2002, regulates for the European Food Safety Authority (EFSA) the procedure of evaluation of the draft assessment reports provided by the designated rapporteur Member State. Glufosinate is one of the 52 substances of the second stage covered by the amended Regulation (EC) No 451/2000 designating Sweden as rapporteur Member State.

In accordance with the provisions of Article 8(1) of the amended Regulation (EC) No 451/2000, Sweden submitted the report of its initial evaluation of the dossier on glufosinate, hereafter referred to as the draft assessment report, to the EFSA on 3 January 2003. Following an administrative evaluation, the EFSA communicated to the rapporteur Member State some comments regarding the format and/or recommendations for editorial revisions and the rapporteur Member State submitted a revised version of the draft assessment report. In accordance with Article 8(5) of the amended Regulation (EC) No 451/2000 the revised version of the draft assessment report was distributed for consultation on 28 April 2004 to the Member States and the main notifier Bayer CropScience as identified by the rapporteur Member State.

The comments received on the draft assessment report were evaluated and addressed by the rapporteur Member State. Based on this evaluation, representatives from Member States identified and agreed in an evaluation meeting on 15 January 2004 on data requirements to be addressed by the notifier as well as issues for further detailed discussion at expert level. A representative of the notifier was attending this meeting.

Taking into account the information received from the notifier addressing the request for further data, a scientific discussion of the identified data requirements and/or issues took place in expert meetings organised on behalf of the EFSA by the Pesticide Safety Directorate in York, United Kingdom in April and May 2004. The reports of these meetings have been made available to the Member States electronically.

A final discussion of the outcome of the consultation of experts took place with representatives from Member States on 10 February 2005 leading to the conclusions as laid down in this report.

During the peer review of the draft assessment report and the consultation of technical experts no critical issues were identified for consultation of the Scientific Panel on Plant Health, Plant Protection Products and their Residues (PPR).

In accordance with Article 8(7) of the amended Regulation (EC) No 451/2000, this conclusion summarises the results of the peer review on the active substance and the representative formulation

evaluated as finalised at the end of the examination period provided for by the same Article. A list of the relevant end points for the active substance as well as the formulation is provided in appendix 1.

The documentation developed during the peer review was compiled as a **peer review report** comprising of the documents summarising and addressing the comments received on the initial evaluation provided in the rapporteur Member State's draft assessment report:

- the comments received
- the resulting reporting table (rev. 1.1 of 4 February 2004)
- the consultation report

as well as the documents summarising the follow-up of the issues identified as finalised at the end of the commenting period:

- the reports of the scientific expert consultation
- the evaluation table (rev. 1-1 of 14 March 2005)

Given the importance of the draft assessment report including its addendum (compiled version of February 2005 containing all individually submitted addenda) and the peer review report with respect to the examination of the active substance, both documents are considered respectively as background documents A and B to this conclusion.

By the time of the presentation of this conclusion to the EU-Commission, the rapporteur Member State has made available amended parts of the draft assessment report (B.6, B.8 [rev 2]and B.9 [rev. 2]) which take into account mostly editorial changes. Since these revised documents still contain confidential information, the documents cannot be made publicly available. However, the information given can basically be found in the original draft assessment report together with the peer review report which both is publicly available.

THE ACTIVE SUBSTANCE AND THE FORMULATED PRODUCT

Glufosinate is the ISO common name for 4-[hydroxy(methyl)phosphinoyl]-DL-homoalanine or DL-homoalanin-4-yl(methyl)phosphinic acid (IUPAC, both). Due to the fact that the ammonium salt, a variant of glufosinate, is used in the formulated product, it should be noted that the evaluated data belongs to the variant glufosinate-ammonium, unless otherwise specified.

Glufosinate and glufosinate-ammonium, respectively, belong to the class of organophosphorus herbicides. Glufosinate-ammonium can be used only as herbicide and it is used for the control weed or undesired plant growth. Glufosinate-ammonium is taken up via leaves with the ability to induce leaf chlorosis and necrosis by inhibating the enzyme glutamine synthetase.

The representative formulated products for the evaluation were "Basta SL 14", "Basta SL 18" and "Liberty SL 18", soluble concentrates (SL). The latter can be used in genetically modified glufosinate tolerant organisms (such as maize, oil seed rape and sugar beets).

The representative uses evaluated comprise strip application or application via groundboom sprayer spraying to control weed or undesired plant growth in apple (non-selective herbicide use in conventional crops), potatoes (use as crop desiccant) and transgenic maize (use as selective herbicide) at application rate up 1.5 kg glufosinate-ammonium per hectare.

SPECIFIC CONCLUSIONS OF THE EVALUATION

1. Identity, physical/chemical/technical properties and methods of analysis

The minimum purity of glufosinate-ammonium as manufactured should not be less than 950 g/kg. At the moment no FAO specification exists. The technical material contains no relevant impurity.
The content of glufosinate-ammonium in the representative formulations is 150 g/L (pure) in “Basta SL 14”, 200 g/L (pure) in "Basta SL 18" and 200 g/L (pure) in "Liberty SL 18".

The assessment of the data package revealed no particular area of concern.
The main data regarding the identity of glufosinate-ammonium and its physical and chemical properties are given in appendix 1.

Adequate analytical methods are available for the determination of glufosinate-ammonium in the technical material and in the representative formulation as well as for the determination of the respective impurities in the technical material.
In the amended Volume 4 (January 2005) the composition of all three representative formulations are given. In addition the composition for a fourth formulation is given, which has been used for some studies in the section residues and ecotoxicology.

Analytical methods for the determination of residues of glufosinate and it salts are available Adequate methods are available to monitor all compounds given in the respective residue definition. As the proposed classification is T (toxic) an analytical method for the determination of residues in blood has to be provided, but no method is available at the moment.

2. MAMMALIAN TOXICOLOGY

2.1 ABSORPTION, DISTRIBUTION, EXCRETION AND METABOLISM (TOXICOKINETICS)

Glufosinate-ammonium is rapidly but poorly absorbed, 5-13% within 1 hour in rats. Similar pattern was observed in the dog, where inadequate (9.2-17% of the administered dose) but rapid absorption (within 4 hours) was observed. The average absorption was set to 10%, based on the available data. The excretion is rapid, > 95% 96 hours following administration mainly *via* faeces. It is widely distributed and highest concentration were found in liver, kidneys and testes. There was no evidence

of accumulation. Glufosinate-ammonium is excreted without intensive metabolism. The major metabolites evident in the excreta were 3-methylphosphinico-propionic acid (MPP) and disodium L-2-acetamido-4-methylphosphinato-butyrate (NAG), with minor amounts of 2-hydroxy-4-methylphosphinico-butanoic acid (MHB), 4-methylphosphinico-butanoic acid (MPB) and traces of 2-methylphosphinico-acetic acid (MPA). Glufosinate-ammonium was the predominant in both urine (4-5%) and faeces (66-83%). The major metabolites were MPP (0.5-2% in urine and 1% in faeces) and NAG (appr. 0.1% in urine and 1-8% in faeces)

2.2 ACUTE TOXICITY

The main clinical symptoms observed in the rat, mouse and dog were indicative of effects on the nervous system such as tremor, ataxia, convulsions as well as diarrhoea. The oral LD_{50} was 1510 mg/kg bw in the rat and 416 mg/kg bw in the mouse. Thus, the compound is proposed to be labelled with **Xn; R22 "Harmful if swallowed"**.

The dermal toxicity in rats is low LD_{50} > 4000 mg/kg bw. In the rabbits it was moderate LD_{50}> 2000 mg/kg bw in males but < 2000 mg/kg bw in females. The conclusion by the rapporteur Member State is that based on both the combined results from rat and rabbit studies a classification is not warranted. Some Member States are of the opinion that glufosinate-ammonium should be classified for dermal toxicity. However, the final decision on the classification will be made by ECB.

The toxicity during inhalation in rats was medium to moderate with LC50 1.26 mg/l air. Based upon this fact, it is proposed glufosinate-ammonium to be labelled with **Xn; R20 "Harmful by inhalation"**. However, low risk concerning inhalation exposure is expected to occur due to the specific formulation of glufosinate-ammonium (it is an aqueous solution).

Glufosinate-ammonium was mildly irritating to the eyes but not to the skin and not found to have sensitising properties (Buehler and maximisation test).

2.3 SHORT TERM TOXICITY

The short term effects of glufosinate-ammonium were studied in a 28-day in rat and dog studies, three 90-day studies in rat, two 90-day studies in mouse, one 90-day study in dog, and a 1-year dog study. One 21-day inhalation study in rat and one 28-day dermal study in the rabbit were also performed.

Oral exposure to the rat

In rats clinical effects such as sedation, hunched posture, and spasms were observed at high dose levels. Mortality was observed in female animals at 1443 mg/kg bw/day. At lower dose levels effects on the glutamine synthetase were observed that is indeed the mode of action of glufosinate-ammonium. The NOAEL in the 90-day study was 4000 ppm i.e. 263 and 311 mg/kg bw/day in males and females, respectively.

Oral exposure to the mouse

In mice clinical symptoms (i.e. signs of neurotoxicity) were also seen at the dose of 1750 ppm (274 and 356 mg/kg bw/day in males and females, respectively) and up. Mortality was also observed at

1750 ppm and up. The NOAEL was 1280 ppm i.e. 278 and 288 mg/kg bw/day in males and females, respectively.

Oral exposure to the dog

A significant decrease in brain glutamine synthetase activity (30-53%) at the dose 8 mg/kg bw/day which is defined as an adverse effect, according to the JMPR 1999, was evident the 28-day dog study (Sachsse 1986b). The NOAEL is therefore set to 1 mg/kg bw/day.

In the 90-day dog study (Lina et al., 1982a) with doses up to 256 ppm (approx. 8 mg/kg bw/day), no mortalities occurred. The NOAEL was set to ≥ 8 mg/kg bw/day, glutamine synthetase activity was not measured.

In the 1-year dog study (nominal/achieved dose levels 0, 2/1.8, 5/4.5, 8.5/8.4 mg/kg bw/day, respectively) mortality occurred at the top dose level, one female and one male (Bathe 1984a). They died of hart and circulatory failure due to myocardial necrosis and examples of clinical signs (tremor, ataxia, urinating) noted immediately after test article consumption for these animals as well as for another high dose female that survived. No other animal exhibited any unusual behaviour attributed to the treatment. There is a difficulty in the interpretation of the results of the study since the dogs in the high dose had increased test article consumption during the first 10-17 days of the study. The high dose males received between 10.6-13.6 mg/kg bw/day and females 15.4-16.0 mg/kg bw/day instead of 8.5 respectively 8.4 mg/kg bw/day. Adjustments in dietary concentration were progressively made from day 11 and onwards. Initially the rapporteur Member State proposed a NOAEL of 8.5/8.4 mg/kg bw/day with the explanation that the level at which the animals died was at a theoretically higher dose level, also clarified in the Addendum. This issue was discussed at the Expert Meeting in May 2004.
The meeting come to the conclusion, by also taking the results in the 28-day study into account, that the dose level of 8.5/8.4 mg/kg bw/day was the effect level. Inhibition of glutamine synthetase leads to neurotoxicological effects. The meeting agreed to set an overall NOAEL for the dog to 5 mg/kg bw/day and 4.5 mg/kg bw/day for males and females, respectively.
The relevant oral NOAEL is 4.5 mg/kg bw/day, based on mortality and decreased glutamine synthetase activity and is considered as an overall value for the studies in dog. This value is used for the setting of the ARfD for the general population, see section 2.10 below.
It is proposed that glufosinate-ammonium should be classified with **Xn; R48/22 "Harmful: danger of serious damage to health by prolonged exposure if swallowed.**

Dermal exposure

The relevant dermal NOAEL in the rat is 100 mg/kg bw/day and 300 mg/kg bw/day for males and females, respectively based on clinical signs of toxicity (neurotoxicity symptoms).

Inhalatory exposure

In the rat studies performed by inhalation signs of toxicity i.e. neurotoxic effects were seen such as hyperactivity, aggressiveness, squatting, piloerection and clonic convulsions. Mortality was observed

at 0.050 mg/L air. The NOAEL(C) was set to 0.012 mg/L air. Based upon this fact it is proposed that glufosinate-ammonium is proposed to be classified with **T; R48/23 "Toxic: danger of serious damage to health by prolonged exposure through inhalation.** However, low risk concerning inhalation exposure is expected to occur due to the specific type of glufosinate-ammonium (it is an aqueous solution). The final decision will be made by ECB.

2.4 GENOTOXICITY

In the DAR, 7 *in vitro* studies and one *in vivo* study have been evaluated and presented. There was no evidence of genotoxicity of glufosinate-ammonium.

2.5 LONG TERM TOXICITY

Two long term toxicity studies were performed in the rat and one in the mouse. The main effects observed were changes in the haematological and biochemical parameters and increased kidney weight, the NOEL for the rat was 40 ppm (approximately 2 mg/kg bw/day) and for the mouse it was 80 ppm (11 mg/kg bw/day for males). The NOEL for female mice was established at 80 ppm corresponding to 16 mg/kg bw/day.

There was no evidence of carcinogenic potential of glufosinate-ammonium in either the rat or mouse.

2.6 REPRODUCTIVE TOXICITY

Two multigeneration studies were submitted in the dossier on rat order to determine the reproductive effects of glufosinate-ammonium.

In the main study, there were no direct effects on reproductive performance or fertility observed at the highest tested dose (Becker 1986b).

However, in the preliminary study both pre- and post implantation losses to a high degree were noted and the NOAEL was set to 50 ppm i.e. 4.3 mg/kg bw/day based on the increased post implantation losses at 500 ppm i.e. 43 mg/kg bw/day (Becker 1986a).

The highest relevant NOAEL for reproduction was set at 120 ppm i.e. 7.5 and 9.6 mg/kg bw/day for the male and female rat, respectively, based on reduced litter size (Becker 1986a).

In order to examine teratogenic or developmental effects of glufosinate-ammonium three studies in rat and one in the rabbit were submitted in the dossier and evaluated in the DAR.

In rats, clinical signs (neurotoxic effects) mortality were noted at the dose 250 mg/kg bw/day. At 50 mg/kg bw/day vaginal haemorrhage and reduced body weight and body weight gain was evident. The NOAEL for both maternal and developmental effects was 10 mg/kg bw/day (Baeder *et al*., 1985b).

In the rabbit the NOAEL was 6.3 mg/kg bw/day based on premature deliveries, abortions and dead foetuses at 20 mg/kg bw/day. The maternal NOAEL was at the same dose level however, no causal connection could be identified (Baeder *et al*., 1984a).

The severity of the reproductive toxicity was discussed at the Expert Meeting in May 2004. The meeting concluded that there are severe developmental toxicity induced by glufosinate-ammonium seen as pre- and post implantation losses, vaginal bleedings, abortions and dead foetuses not induced

by maternal toxicity. However, the meeting also concluded that the underlying mechanism for this could not be identified but that the reduced glutamine synthetase activity might be involved. The meeting agreed that the data was sufficient to conclude on and that no further studies were needed.
Furthermore, the meeting agreed with the rapporteur Member State of the proposed classification of glufosinate-ammonium as a Category 2 substance **T; R61 "Toxic: may cause harm to the unborn child".**
The relevant developmental NOAEL is 6.3 mg/kg bw/day in the rabbit based on premature deliveries, abortions and dead foetuses (Baeder *et al*., 1984a). This study is used for the setting of the values AOEL, ADI as well as for the ARfD for women of child bearing potential (section 2.10 below).
In addition, the fact that the pre-implantation losses observed in the rat occurred in absence of maternal toxicity led to the rapporteur Member State's proposed classification of **Category 3, R62 "Possible risk of impaired fertility".**

Comment on the classification proposals regarding reproduction toxicity:
The classification of glufosinate-ammonium was discussed at Ispra by the Commission Working Group of Specialised Experts at ECB, Ispra, in the field of reprotoxicity in 1-2 February, 2005. The outcome of the meeting was to propose **Category 2, R61** with respect to developmental toxicity and **Category 2, R60** with respect of developmental toxicity.

2.7 NEUROTOXICITY

There were no indications of delayed neurotoxicity.

Other studies on neurotoxicity are reported in the DAR under the section B.6.8 "Further studies". The NOAEL for acute neurotoxicity in the rat was 100 mg/kg bw based on clinical signs as hunched posture and emaciation at 500 mg/kg bw. No effects were seen on the functional observational battery.

Repeated exposure with glufosinate-ammonium in the rat resulted in clinical effects as well as reduced glutamine synthetase activity at 2000 ppm and the relevant NOAEL is 200 ppm i.e. 14.9 mg/kg bw/day and 17.1 mg/kg bw/day for males and females, respectively.

2.8 FURTHER STUDIES

Mode of action
Several supplemental studies were conducted on the mode of action of glufosinate-ammonium on the glutamine synthetase have been evaluated in the DAR as well as a literature review.

The herbicidal activity of glufosinate-ammonium is mediated by inhibition of the enzyme glutamine synthetase which catalyses the following reaction:

$$\text{L-glutamate} + NH_3 + \text{ATP} \rightarrow \text{L-glutamine} + \text{ADP} + \text{Pi}$$

Plants die as a consequence of the increased level of ammonia. Higher organisms including mammals have other metabolizing systems that can cope with the effect on the glutamine synthetase activity to a certain limit.

Several studies on different species were evaluated in the DAR and the results show that glufosinate-ammonium affects the activity of glutamine synthetase in the brain, liver and kidney tissues which however proved to be reversible to a large extent since other pathways exists for the homeostatic control of ammonia. According to the JMPR (Joint meeting of the FAO panel of experts on pesticide residue sin food and the environment and the WHO core assessment group, Rome 1999) it was concluded that an inhibition of liver glutamine synthetase up to 50% is not considered adverse in isolation. That inhibition of glutamine synthetase in the kidney in absence of pathological finding is not considered adverse. Due to the high vulnerability of the brain and the central nervous system on the other hand a decrease in glutamine synthetase activity > 10% is a marker of potentially adverse effects on brain biochemistry and behavior. The JMPR document is summarized in the Addendum and the studies in the DAR have been assessed based on these criteria.

Relating to the issue of underlying mode of action of the observed reproduction toxicity, three new studies submitted after DAR dispatch regarding glutamine levels in the female rat (both pregnant and non-pregnant) were evaluated as well and is presented in the Addendum. It was evident that glufosinate-ammonium (dose 200 mg/kg bw/day) provokes a statistically significant decrease (around 20-30%) in serum levels of glutamine (a marker for glutamine synthetase activity).

Metabolites

NAG is the major plant metabolite in glufosinate-ammonium tolerant crops. Studies on toxicokinetics, acute toxicity, short term toxicity, genotoxicity, long tem and carcinogenicity, reproductive toxicity as well as neurotoxicity studies were evaluated in the DAR (in total 31 studies). NAG is rapidly absorbed and excreted in the rat. *In vitro* studies show that NAG does not affect glutamine synthetase. However, it has been proven that in mammals, glufosinate-ammonium and NAG interconvert; therefore, in *in vivo* studies, animals administered NAG do show a level of GS inhibition caused by de-acetylation to glufosinate-ammonium. NAG is of low acute toxicity in both the rat and mouse, LD50 > 2895 mg/kg bw. NAG is not a sensitizer, not genotoxic, carcinogenic or teratogenic, nor does it adversely impact reproductive performance. The short term and long term NOAELs are >> than those of glufosinate-ammonium. No adverse effects were seen either in acute or repeated neurotoxicity studies.

MPP is the major plant metabolite in susceptible plants. Studies on toxicokinetics, acute toxicity, short term toxicity, genotoxicity and reproductive toxicity were evaluated in the DAR (in total 19 studies).

It is rapidly excreted in the rat. MPP is of low acute toxicity in both rat (LD50 >1900 mg/kg bw) and the mouse (LD50 >3000 mg/kg bw). MPP is not an irritant or a sensitizer and has no effect on

glutamine synthetase in animals or presumably plants. It is not genotoxic or teratogenic. The short term NOAELs are >> than those of glufosinate-ammonium.

MPA is an environmental metabolite. It results from further degradation of MPP. It has been observed at low levels in rat metabolism studies, presumably *via* MPP. Studies on acute toxicity, short term toxicity and genotoxicity were evaluated in the DAR (in total 6 studies).
It is not acutely toxic (LD50 > 2000 mg/kg bw) or genotoxic. The short term toxicity profile is similar to its precursor MPP.

In conclusion, metabolites (NAG, MPP, and MPA) of glufosinate-ammonium are all less toxic than parent compound glufosinate-ammonium. Thus, proposal of ADI, AOEL and ARfD is referred to glufosinate-ammonium.

2.9 MEDICAL DATA

Reports from suicidal cases (mostly Japan) and accidental misuse of glufosinate-ammonium containing products describes initial effects such as nausea, vomiting, diarrhoea and abdominal pain. Symptoms developing later are impaired respiration, neurological disturbances such as mental status change, tremor, fever, convulsions, hyperthermia and bradychardia/tachycardia.

2.10 ACCEPTABLE DAILY INTAKE (ADI), ACCEPTABLE OPERATOR EXPOSURE LEVEL (AOEL) AND ACUTE REFERENCE DOSE (ARFD)

ADI

Initially in the DAR the rapporteur Member State proposed an ADI of 0.024 mg/kg bw/day based on increased kidney weight and the NOAEL of 2.4 mg/kg bw/day in the 2-generation study in rats. However, the ADI value was discussed at the Expert meeting (May 2004) and it was agreed that it should be based upon the same value as the AOEL the NOAEL in the rabbit developmental toxicity study of 6.3 mg/kg bw/day (Baeder *et al*., 1984a). Since the effects are of severe art and seen both in the rat and rabbit an additional safety factor was, as suggested by the rapporteur Member State for the AOEL, of 3 was agreed on by the Meeting.
The resulting ADI is thus 6.3 mg/kg bw/day/300 i.e. 0.021 mg/kg bw/day.

AOEL

The AOEL is based on the NOAEL of 6.3 mg/kg bw/day in the in the rabbit developmental toxicity study (Baeder *et al*., 1984a). The effects are of severe art and seen both in the rat and rabbit an additional safety factor of 3 was suggested to be used by the rapporteur Member State. This was agreed on by the Meeting. A correction for 10% oral absorption is required (based on the available data), see section 2.1.
The AOEL is thus 6.3 mg/kg bw/day/300*0.1 i.e. 0.0021 mg/kg bw/day.

ARfD

Initially in the DAR the rapporteur Member State proposed **two ARfD** values. Since the critical effect of glufosinate-ammonium is severe effects on reproduction toxicity and this is used for the setting of the AOEL, this was also used for deriving the ARfD. The AOEL is based on the NOAEL of 6.3 mg/kg bw/day in the in the rabbit developmental toxicity study (Baeder *et al*., 1984a). However, in a scientific point of view it is unlikely that these effects would occur in toddlers. Thus, the additional safety factor should not be applied. Therefore, the rapporteur Member State proposed:

1. ARfD of 6.3 mg/kg bw/day/300 i.e. 0.021 mg/kg bw/day
2. ARfD for the toddlers, where no additional safety factor is used; 6.3 mg/kg bw/day/100 i.e. 0.063 mg/kg bw/day.

The setting of ARfD(s) was discussed at the Expert meeting (May 2004) and it was agreed that, from a scientific point of view, it would be possible to set two ARfDs indeed and that it is a risk management decision whether this is feasible or not. The Expert Meeting agreed that the NOAEL (6.3 mg/kg bw/day) from the rabbit developmental study should be used and assigned for the consumer group **"women of child bearing potential"** and since the effects are of a severe character the Meeting agreed with the additional safety factor of 3, see revised DAR.

In line with the idea of the rapporteur Member State developmental toxicity effects or effects on reproductive parameters from a scientific point of view could not be said to be applicable for the "**general population"** as well. Thus, the Expert Meeting agreed to use the NOAEL of 4.5 mg/kg bw/day from the 1-year dog study (also the overall NOAEL for dog) for the second ARfD. The effects observed in the 1-year dog study (Bathe 1984a) at the dose 8.4/8.5 mg/kg bw/day were mortality during the initial phase of exposure and neurotoxic signs and in the 28-day dog study a significant decrease in brain glutamine synthetase activity at the dose 8 mg/kg bw/day was noted. These are common representative acute effects induced by glufosinate-ammonium. No additional safety factor was appointed. The relevant information has been included in the revised DAR.

Conclusion

Two ARfD values are proposed to be set for glufosinate-ammonium

1. **ARfD for women of child bearing potential; 6.3 mg/kg bw/day/300 i.e. 0.021 mg/kg bw/day**
2. **ARfD for the general population; 4.5 mg/kg bw/day/100 i.e. 0.045 mg/kg bw/day**

2.11 DERMAL ABSORPTION

Three studies for each formulation Basta SL14 and Basta SL18/Liberty SL18, one *in vivo* study in rat and two *in vitro* studies, one in human skin and one in rat skin are evaluated in the DAR. The quality of the *in vitro* studies in human skin was discussed at the Expert Meeting in May 2004 and it was concluded that the number of samples and standard deviations were such that the data could not be relied on. Thus, the Meeting concluded no correction for rat skin to human skin could be applied on the basis of these data.

The dermal absorption of the formulations Basta SL14 and Basta SL18/Liberty SL18 were decided to be 16 % and 7 % for undiluted product and 14 % and 9 % for spraying dilution, respectively.

2.12 EXPOSURE TO OPERATORS, WORKERS AND BYSTANDERS

There are three representative plant protection products, all water soluble formulations, and three representative uses, respectively. Basta SL14 and Basta SL18 contain 150 g glufosinate-ammonium/L and 200 g glufosinate-ammonium/L, respectively. The third formulation is Liberty SL18 which contains 200 g glufosinate-ammonium/L.

Two representative exposure scenarios were included in the dossier for the Basta formulations and are evaluated in the DAR.

1. Fruit crops; weed control in apple orchards. Two different techniques of spraying are evaluated. The product is either sprayed with tractor mounted small boom sprayer with single nozzles or with tractor mounted hand held pressure sprayers with hose and spray lance. The application rate is 1.125 kg a.s./ha for Basta SL14 and 1.5 kg a.s./ha for Basta SL18 and the lowest spray volume is 150 L/ha and 200 L/ha, respectively.
2. Field crops; potato desiccation. The application is with tractor mounted boom sprayer with hydraulic boom and nozzles. The application rate is 0.45 kg a.s./ha for Basta SL14 and 0.6 kg a.s./ha for Basta SL18 and the lowest spray volume is 150 L/ha and 200 L/ha, respectively.

The third representative exposure scenario included in the dossier and evaluated in the DAR is for Liberty SL18.

3. Transgenic maize, selective weed control (broad spectrum foliar herbicide). The application is performed using tractor mounted sprayers with hydraulic boom and nozzles. The application rate is 0.8 kg a.s./ha and the lowest spray volume is 200 L/ha.

Operator

Apple orchards

In apple orchards, glufosinate-ammonium is sprayed via boom spraying, the tractor is typically equipped with a small spray boom with appropriate width that allows passing close to trees on the rows without damaging the trunks. A band is sprayed between the trunks to control weeds, whereas the row between the trees is left untreated in order to avoid erosion and to allow re-entering. Therefore, the small boom only carries one or two boom end nozzles, which enable to spray a proper herbicide band. In addition, the wings of the boom are typically protected in order to ensure that no spray drift occurs. This is an important device which avoids that apples and leaves are hit by herbicide spray droplets. Contamination via drift would damage both the fruit and the tree. A typical tractor boom application scenario in the UK POEM and the German model consider field crop sprayers with up to 36 m booms width and 70 nozzles which allow to treat 20-50 ha/day in a field crop.

Therefore, the risk assessment for operators using Basta SL14 and Basta SL18 in apple orchards was based on a field study with the relevant application technique in a young almond orchard (Baugher, 1987a). The outcome of the risk assessment has shown that the AOEL was exceeded when no PPE was used but when PPE was used the estimated operator exposure levels were below the AOEL.

Operator exposure to Basta SL14/SL18 when applied with hose sprayers and spray gun in apple orchards calculated from the highest sample of the field study (Baugher, 1987a) and comparison to % of AOEL (0.0021 mg/kg bw/dy).

Formulation	No PPE	With PPE: During M/Land A
Basta SL14 (1.125 kg a.s./ha)	400%	93%
Basta SL18 (1.5 kg a.s./ha)	310%	65%

M/L= mixing and loading, A=application, PPE = With a hat, chemical resistant gloves, no hygiene of the hands and face, long pants and long sleeve shirt during mixing/loader/application (Scenario no. 3, Baugher 1987a)

Field crop; potato desiccation

The risk assessment for operators using Basta SL14/SL18 for potato desiccation was based on calculation according to the UK POEM and German model. The outcome of the risk assessment show that the AOEL was exceeded even when PPE was used. Below estimated exposure levels according to the German model are presented, generally the estimated exposure levels in the UK model were higher.

Lowest predicted operator exposure levels using the German model for Basta SL14 and SL18 when applied in potatoes expressed as % of AOEL (0.0021 mg/kg bw/day).

Formulation	No PPE	With PPE: M/L (gloves) and A (coverall)
Basta SL14 (0.45 kg a.s./ha)	4800%	150%
Basta SL18 (0.6 kg a.s./ha)	3400%	130%

M/L= mixing and loading, A=application

After the DAR was submitted the notifier has presented a model (BCS model) based on three field studies. The EPCO Expert Meeting (May 2004) discussed the appropriateness of the three studies to support revision of UK POEM/German operator exposure models and the meeting agreed that the model is not appropriate for the risk assessment of glufosinate-ammonium. The Expert Meeting concluded that the notifier should present a clear and detailed explanation of how the submitted studies relate to the proposed use (e.g. equipment used, work patterns, treated area, application rates and dilutions, container sizes, crop height etc.) and discussion on the impact of any differences. However, this information was already evident in the Addendum.

The EPCO meeting agreed that the study that could be used is based on fentin hydroxide in potatoes (Wicke, 1999a). However, the total exposure, using the 75th percentile, was 0.077 mg/kg bw/day which exceeds the AOEL (3666%). When PPE is used and the exposure is calculated using the 75th percentile the exposure is 0.0029 mg/kg bw/day and the AOEL is still exceeded (138%).

Transgenic maize

The risk assessment for operators using Liberty SL18 for weed control in transgenic maize was based on calculation according to the UK POEM and German model. The outcome of the risk assessment has shown that the AOEL was exceeded even when PPE was used. Below, estimated exposure levels according to the German model are presented, generally the estimations in the UK model was higher.

Lowest predicted operator exposure levels using the German model for Liberty SL18 when applied in transgenic maize expressed as % of AOEL (0.0021 mg/kg bw/day).

Formulation	No PPE	With PPE: M/L (gloves) and A (coverall)
Liberty SL18 (0.8 kg a.s./ha)	7600%	150%

M/L= mixing and loading, A=application

Workers

The exposure for workers was below the AOEL in all cases.

Bystander

The estimated bystander exposure showed that exposure levels to Basta SL14 and Basta SL18 and for Liberty SL18 were below the AOEL for all scenarios except for the scenario of Basta SL14 application in apple orchards where the estimated levels were 125% of the systemic AOEL.

3 Residues

3.1 NATURE AND MAGNITUDE OF RESIDUES IN PLANT

3.1.1 Primary crops

The metabolism of 14C-glufosinate-ammonium has been studied on three crops, representing its 3 main types of use: apple for non-selective herbicide use in conventional crops, potatoes for use as crop dessicant and transgenic maize for use as selective herbicide.

In apple, after application of glufosinate-ammonium during the vegetation period, residues resulting from root uptake were found in leaves, shoots and apples. In apple fruits no intact parent glufosinate was found. The only major metabolite present was identified as 3-methyl-phosphinico-propionic acid (MPP).

In potatoes, the use of glufosinate-ammonium shortly before harvest does not allow time for extensive metabolism since the application quickly kills the crop and stops metabolic activity. Therefore the only relevant compound identified in dried leaves and tubers was the parent glufosinate (> 90%). Minor amounts of MPP were also found.

In transgenic maize, the metabolism is determined by the insertion of a gene coding for the enzyme phosphinothricin acetyltransferase which gives the plant the ability to metabolize the biologically active L-isomer of glufosinate to N-acetyl-L-glufosinate (NAG). After post-emergence application of glufosinate-ammonium, the major part of the extractable residues consisted in parent glufosinate, NAG and MPP, with MPP being the main residue in grains and NAG being the main residue in feed fractions.

The main residue of concern identified in the metabolism studies is glufosinate. Toxicity studies carried out on NAG and MPP indicate that they are of lower toxicity. The residue definition proposed by the RMS for monitoring and risk assessment in order to cover the 3 representative uses (Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate equivalents) protects therefore adequately the consumer.

This residue definition is valid for the 3 representative uses supported by the manufacturer, because for each type of use only one metabolism study was evaluated. Any use of glufosinate on any other crop should be supported by metabolism data to verify the adequacy of the residue definition established for these 3 representative uses.

Supervised residue trials were carried out in apple, potatoes and maize, in accordance with the representative uses. Data concerning the storage stability of the residues demonstrated their stability under the storage conditions of the trials. The information is sufficient to predict the exposure of the consumer and to propose MRLs. In apple and maize, no residues were found at harvest. In potatoes, residues were present up to 0.5 mg/kg and were consisting essentially of parent glufosinate.

No data has been submitted concerning the effects of industrial and/or household preparation on the nature of residues. The effect of processing on the residue level was however investigated on several commodities.

In citrus and grapes, after a non selective use of glufosinate in conditions similar to the use in apples, residues of MPP, when present in the raw commodity, are mainly transferred into molasses and pomace.

In potatoes, the level of glufosinate residues was not altered by cooking in boiling water. Baking and microwave cooking were not examined. Processing of potatoes into chips and flakes resulted in a concentration of glufosinate residues by a 2- and 3-fold factor, respectively. However, taking into

account the weight loss during processing, it can be stated that the processed commodities contained less than 50% of the residues initially present on the raw commodity.

In transgenic maize, trials carried out with an exaggerated rate of application indicated the presence of NAG at the level of the limit of determination in flour. No residue was transferred into oil.

In other trials carried out on oilseeds (rape seed and soybean), no transfer of the residue to the oil was observed. This was expected from the polar nature of the residues.

A processing study was also carried out on sugar beets. Residues present in the root were transferred to the dried pulp and molasses. No residue was present in refined sugar.

3.1.2 Succeeding and rotational crops

Rotational crops studies were carried out with radish, lettuce and wheat. These crops were planted after ageing periods representative of a crop failure replanting (28 days), immediate re-cropping (119 days) and later re-cropping (300 and 364 days). Parent glufosinate was not identified in any of the samples. The metabolite MPP was present in lettuce, radish and wheat grains planted 28 days after soil treatment and only in wheat grains planted after 119 days. The levels were however very low and do not lead to any safety concern. One unknown metabolite (metabolite A) of polar nature was also present in the 28 days samples but at extremely low levels (around 0.01 mg/kg). It was the view of the expert meeting organised on behalf of the EFSA by the Pesticide Safety Directorate in York, United Kingdom in May 2004 that further work should be done to identify metabolite A.

It can be concluded that the potential for glufosinate and its metabolites to accumulate in soil and rotational or succeeding crops is low and that field trials are not necessary, unless metabolite A would be of toxicological significance.

3.2 NATURE AND MAGNITUDE OF RESIDUES IN LIVESTOCK

Metabolism studies were conducted with orally administered glufosinate-ammonium and N-acetyl-L-glufosinate, representing the main compounds the animals are exposed to by consumption of conventional and transgenic crop respectively .The doses administered to animals were considerably in excess of the potential dietary exposure. Orally administered ^{14}C-glufosinate-ammonium and ^{14}C-N-acetyl-L-glufosinate fed to lactating goats and egg-laying hens are both rapidly and efficiently excreted. Most of the test substances were excreted unchanged due to the polar nature of the dosed materials. Less than 0.2% of the administered dose for each study was found in edible tissues and commodities. No accumulation was observed in any tissue.

As observed in the rat metabolism NAG underwent a descetylation to glufosinate. Glufosinate, NAG and MPP were the major constituents of the residues in edible organs and tissues with relative amount depending on the tissue.

The metabolic pattern in animal commodities is about the same as in plant commodities. The proposed residue definition is therefore the same (Sum of glufosinate, its salts, 3-methyl-phosphinico-

propionic acid, and N-acetyl-glufosinate expressed as glufosinate equivalents) and protects also adequately the consumer.

Animal feeding studies were conducted for poultry (laying hens) and cattle (dairy cows). The animals were fed either with a mixture of glufosinate and the main metabolite in conventional crops (MPP), or with a mixture of glufosinate and the main metabolite in glufosinate-tolerant crops (NAG). In each study, the dose levels fed to animals were comparable to those expected from the consumption by livestock of crops belonging to the representative uses. These studies were sufficient for estimating the residue levels in food of animal origin.

The poultry feeding studies showed that glufosinate-derived residues are not likely to occur at measurable levels in eggs or poultry tissues.

The cow feeding studies indicate that no measurable glufosinate-derived residue is likely to occur in meat, milk and fat. In liver and kidney however, residues of the metabolite MPP can be present up to 1 and 2 mg/kg respectively. These residues rapidly decrease after at the end of the exposure period.

3.3 CONSUMER RISK ASSESSMENT

The chronic dietary risk assessment has been based on the Theoretical Maximum Daily Intake (TMDI) model calculations using the WHO European diet model, the Swedish 90 percentile model diet and the German model diet (4-6 year old girl). For these calculations the LOQ of 0.1 mg/kg has been used for commodities for which MRLs is proposed to be fixed at the limit of quantification. The three models indicated low TMDI values (between 10 and 20 % of the ADI), indicating no risk resulting from the chronic exposure to residues.

A short term exposure risk assessment using the WHO methodology and the UK model diet for adults and toddlers was carried out, using the appropriate ARfD for the relevant population (0.021 mg/kg bw/d for women of child bearing potential or 0.045 mg/kg bw/d for the general population). The National Estimated Short Term Intakes were calculated to be below the ARfD in all cases but one. Consumption of treated potatoes by toddlers may lead to an exceedence of the ARfD (0.045 mg/kg bw/d). The exceedence is slight (114 %), but account should be taken at risk management level of the narrow margin of safety (about 200) existing between the ARfD for the general population and the level where very severe effects, such as myocardial necrosis leading to death were observed in dogs.

3.4 PROPOSED MRLS

Based on the available data base, the following MRLs are needed to cover the representative uses supported by the notifier:

apples and maize: 0.1* mg/kg (* indicates the limit of quantification)
potatoes: 0.5 mg/kg
liver of ruminants: 2 mg/kg
kidneys of ruminants: 1 mg/kg

other products of animal origin: 0.1* mg/kg (* indicates the limit of quantification)

From these proposals, as mentioned here above, the use on potatoes and the related MRL proposal appear to lead to a risk issue.

4 Environmental fate and behaviour

All studies on the fate and behaviour in the environment were performed with the ammonium salt of glufosinate (glufosinate ammonium). Due to the fact the ammonium ion is ubiquitous in the environment; the fate of the ammonium resulting from the application of glufosinate-ammonium was not followed. Therefore, the results are referred to the fate of the anion glufosinate which is expected to be dissociated in aqueous media at environmentally relevant pH (5-9).

4.1 FATE AND BEHAVIOUR IN SOIL

4.1.1. Route of degradation in soil

Metabolism of glufosinate in soil under dark aerobic conditions at 20 – 22 ºC is studied in three separated studies where up to nine different soils are used. Most of the soils were in the acidic pH range (pH = 5.0 – 6.5) with only one soil being neutral or slightly alkaline (pH = 7.3). For two studies (four soils) the position of the labelled carbon (1st carbon) did not allow to characterize the metabolic pattern and to reach any conclusion on the mineralization. In the third study (four soils) two major metabolites were identified **MPP** (3-methylphosphonico-propionic acid, maximum 47 % AR after 7 days) and **MPA** (2-methylphosphonico-acetic acid, maximum 26 % AR after 14 days). Mineralization at the end of the study (120 d) was between 20 – 60 % AR) and bound residues between 21 – 38 % AR.

A study where degradation is examined under anaerobic conditions is available but not found acceptable. Therefore, in the DAR a new study on the degradation of glufosinate in soil under anaerobic conditions was required. This study was submitted by the notifier (February 2004) and assessed by RMS in and Addendum (April 2004). The study shows a slower degradation of glufosinate than in aerobic conditions but no new metabolites were found. The expert meeting on environmental fate and behaviour (EPCO 2, April 2004) agreed with the RMS conclusions. Results from this study may need to be considered by MS in their national authorization for those situations where anaerobic conditions are to be expected.

The soil photolysis study available shows that glufosinate is stable towards photolytical degradation in soil.

4.1.2. Persistence of the active substance and their metabolites, degradation or reaction products

Laboratory soil aerobic degradation studies indicate that glufosinate is low persistent ($DT_{50lab.corr.20°C}$ = 6 to 11 days). There are studies where the aerobic degradation of metabolites MPP (two studies, four soils) and MPA (one study, two soils) is investigated. Both metabolites show to be low to moderate

persistent under these conditions (MPP $DT_{50lab.corr.20°C}$ = 6.1 - 14 days; MPA $DT_{50lab.corr.20°C}$ = 8.1 - 23 days). Degradation of plant metabolite in transgenic plant **NAG** (disodium L-2-acetamido-4-methylphosphinato-butyrate) in soil under aerobic conditions at 20 °C has also been investigated in two separated studies (four soils). In these studies, it has been demonstrated that NAG is very low persistent in soil ($DT_{50lab.20°C}$ = 0.5 to 1 day). Need for further assessment of this metabolite in soil (PEC soil calculations for GMO crops other than maize) was discussed in the expert meeting on environmental fate and behaviour. The meeting agreed that for the representative uses the contamination of soil with this metabolite from the portion of the plant left in the field after cropping is adequately addressed. MS may need to further assess this metabolite for uses were a larger portion of the plants is left in the field after cropping.

4.1.3. Mobility in soil of the active substance and their metabolites, degradation or reaction products

Batch adsorption and desorption studies are available for glufosinate and metabolites MPP and MPA in different soils. Data indicate that glufosinate is moderate to high mobile (K_f = 0.2 – 3.4), MPP is high mobile (K_f = 0.16 – 1.1) and MPA is high to moderate mobile (K_f = 0.22 – 22) in soil. Correlation with organic matter content is not applicable to these compounds, but correlation with clay content has been demonstrated for glufosinate. Indications that this correlation is also applicable to the metabolites are less certain due to the lower number of data. There are also evidences of a week correlation between MPA mobility and soil pH. The potential mobility of glufosinate and their metabolites is confirmed by the column leaching studies available.

4.2 FATE AND BEHAVIOUR IN WATER

4.2.1. Surface water and sediment

Glufosinate is hydrolytically stable in the range of environmental relevant pH (5 – 9) and it is not degraded by photolysis in water.

Glufosinate is not readily biodegradable according the available information.

For the parent glufosinate-ammonium there are four water sediment studies available with a total of five aerobic systems being studied, two of them specifically designed to characterize unidentified compounds P-X and P-Y. Additionally, a study in an anaerobic water sediment system is available. In another study the fate and behaviour of metabolite MPP in two water sediment systems is investigated. Two rice paddy field studies are available in the dossier. These field studies are not applicable to the representative uses assessed at EU level.

At 20 °C the major metabolites found in the water phase under aerobic conditions were MPP (maximum 80 % AR after 7 d), MPA (maximum 17 % AR after 50 d), **P-X** (3-methylphosphinico-acrylic acid, maximum 12 % after 50 d), **P-Y** (=**MPF**, methylphosphinico-formic acid, maximum 22 % AR after 60 d) and **NAG** (disodium-L-2-acetamido-4-methylphosphinato-butyrate, maximum 12 % AR after 1d). The same metabolites were found under anaerobic conditions but only MPP, and P-Y exceed the 10 % AR. Glufosinate reached levels above 10 % AR in the sediment (maximum 13 % after 1 and 7d). Metabolite MPP reached levels of 9.8 % AR in the sediment and was still increasing

at the end of one of the water sediment studies (130 d). No other metabolite reaches levels above 10 % AR in the sediment.

The dissipation half-lives of glufosinate in the water phase were 1.4 - 13 days at 20°C (a higher value of 42 d was regarded as an outlier due to the ceased microbial activity). The half life for MPP was estimated by extrapolation to be 150 d. Degradation of MPA and P-Y was slower, since no clear declination patterns were reached within study periods up to one year.

Evaluation meeting (January 2004) questioned whether the metabolites NAG and P-X deserved futher consideration at EU level. General consensus of the expert meeting on environmental fate and behaviour was that no further data on these metabolites was necessary to conclude the EU risk assessment. One expert considered that further assessement of these metabolites at MS level will be necessary.

PEC sw (glufosinate and MPP, MPA, P-Y, P-X and NAG) and PEC sed (glufosinate only) for the representative uses were initially estimated using a draft version of FOCUS sw (Step 1 for all compounds and Step 2 for the parent only). Worst case DT_{50} (for parent and MPP) and maximum amount of metabolite found in the whole system were used in the calculation. For MPP in sediement, since the maximum was not reached at the end of the study, the total remaining radioactivity in the system was assumed to become MPP and partition into the sedimet. This resulted in an estimated theoretical maximum of 46 % AR as MPP in sediment.

Only maximum PEC sw were calculated for metabolites MPA, P-Y, P-X and NAG due to the lack of information on the degradation rate of these metabolites. These values were used in the ecotoxicological risk assessment.

The evaluation meeting (January 2004) had some concerns on the worst case DT_{50} selected for glufosinate, the assumptions made for metabolite MPP and on the use of a pre-released version of FOCUS sw. RMS presented a clarification and new PEC sw calculations based only drift loadings and 0.5 % run off (field:water ratio 10:1)in an Addendum (April 2004). This addendum was discussed in the expert meeting on environmental fate and behaviour that agreed with the RMS on that the DT_{50} = 42 days should be regarded as an outlier not relevant for the representative uses proposed in EU due to insufficient microbial activity. It was also decided to use PEC sw and PEC sed presented in the addendum for the ecotoxicological risk assessment. The expert meeting also agreed that the assumptions made for MPP in the sediment were a worst case and that MS could need further data to refine the risk assessment.

4.2.2. Potential for ground water contamination of the active substance their metabolites, degradation or reaction products

The potential for leaching of glufosinate and its metabolites to groundwater was simulated with FOCUS gw PELMO 1.1.1 for the nine FOCUS gw scenarios, modified to take into account the clay dependence of sorption. For glufosinate and MPP sorption was described as a function of clay content and for MPA as a function of clay content and pH. According this modelling MPP may have some potential to contaminate groundwater in vulnerable areas (trigger of 0.1 µg / L is exceeded in one of the nine scenarios). Evaluation meeting (January 2004) had some concerns on the non-standard

adsorption assumptions made in this modelling exercise. RMS presented an addendum (April 2004) were the correlation with clay content was clarified. This addendum was discussed in the expert meeting on environmental fate and behaviour and the approach followed by the RMS was found acceptable.

In a three year lysimeter study with two soils with application pattern comparable to the representative use in pome fruit neither the parent compound nor any of the analysed metabolites were detected in the leachate.

Two field leaching studies are available. In one of them, performed in UK, glufosinate was found at maximum levels of 5.5 µg / L at 75 cm depth after 14 d and at a maximum slightly above 0.1 µg / L at 120 cm eight months after application. MPP showed a higher leaching potential than the parent compound in this study with a maximum of 26 µg / L at 120 cm depth. Time series of concentrations in soil water collected at 150 cm depth indicates that the mean concentration over the two years study exceed 0.1 µg / L for one of five replicate samplers. MPA was found less mobile that the parent compound with maximum levels of 0.76 µg / L at 75 cm depth after the autumn application and levels slightly above LOQ (0.05 µg / L) after the spring application. This study was considered to represent an extreme worst case by the RMS and the results not fully reliable. The reliability of this study was discussed in the expert meeting in the context of the residue definition in ground water. The meeting agreed that the study was reliable and it confirms leaching potential of MPP under vulnerable conditions at levels above 0.1 µg /L. Hence, for this metabolite an assessment with regard to potential relevance in ground water is warranted.

4.3 FATE AND BEHAVIOUR IN AIR

Concentrations of glufosinate-ammonium in the air compartment are expected to be negligible, due to low volatility and short persistence in the atmosphere. Volatility of other salts of glufosinate has not been investigated but is expected to be low.

5 Ecotoxicology

5.1 RISK TO TERRESTRIAL VERTEBRATES

A revised risk assessment is available in the addenda of April and June 2004. In the last addendum recommendations from the EPCO expert meetings on fate, ecotoxicology and toxicology are taken into account. The risk to birds and mammals is calculated according to the new Guidance Document on Birds and Mammals (SANCO/4145/2000). The risk was calculated for a small herbivorous mammal in orchards, a medium herbivorous bird, a small insectivorous bird, and a medium herbivorous mammal in maize and potato as foreseen in the above mentioned guidance document. In addition, for the use in orchards, the risk was calculated for an omnivorous bird with mixed diet feeding on 50% short grass and 50% large insects and a large herbivorous bird, and for the use in potato an insectivorous mammal was included since the relevance of the herbivore was questioned by one MS at the EPCO expert meeting on ecotoxicology in April 2004.

In the first tier risk assessment triggers were breached on acute time scale for mammals in orchards and on a long term time scale for birds and mammals for all the representative uses. In the addendum of June 2004 a refined assessment was presented for all time scales. The refined assessment was based on:

1. A new study with higher test concentrations on avian reproduction resulting in a NOEC of 122 mg glufosinate-ammonium/kg bw/day which was accepted by the EPCO expert meeting.
2. Measured residues in grass in orchards. The upper value of 85 mg/kg was used, due to the limited number of data.
3. Plant DT_{50} of 7 days, based on residue data in glufosinate-tolerant GMO maize.
4. Band treatment in orchards, where 50% of the area is treated the PT factor was set to 0.5. However, this approach was not accepted by the EPCO expert meeting as it was considered that proportion of field treated does not necessarily equate to the time spent in the crop and therefore the PT of 1.0 was maintained.
5. Data on “wilting rate”, indicating that treated weeds are completely wilted after one week. Based on this the ftwa values were recalculated. During the EPCO expert meeting concern was expressed about this approach as it could underestimate exposure, but it was agreed to use the approach proposed by the RMS.
6. For herbivores in the potato scenario, a deposition factor of 0.5 was used, since the crop itself is considered to be inedible. It is noted by EFSA that this factor was also used for insectivorous mammals, mainly feeding on large insects beneath the crop canopy. EFSA does not consider it appropriate to use an interception factor for insects as this is already taken into account in the default RUD factors from the guidance document SANCO/4145/2000 as these values were derived from field studies with crops which already intercepted product.

Based on the refined risk assessment for birds, the risk is considered to be low for all representative uses of glufosinate. This was supported by the EPCO expert meeting.

For wild mammals, the long term TER trigger of Annex VI was clearly breached for the representative uses in orchards and GMO maize, while for herbivores in potato the TER was only slightly below the trigger (TER = 4.5). It was agreed at the EPCO expert meeting that there was enough supporting information from a field study to assume that the PT factor in potato was over-estimated and therefore the risk for wild mammals was considered to be addressed for this representative use. Nevertheless EFSA proposes to address the long term risk to insectivorous mammals in potatoes as EFSA does not think it is appropriate to use an interception factor.
Also the Annex VI trigger value for the acute risk to herbivorous mammals in orchards is breached indicating a high risk. The relevance of this scenario was questioned during the EPCO expert meeting. This needs to be addressed by the notifier. Further data was submitted by the notifier after the EPCO expert meeting but this was not evaluated by the RMS nor peer reviewed. The risk assessment can only be concluded when the outstanding data is evaluated.

5.2 RISK TO AQUATIC ORGANISMS

Mysidopsis sp. and *Lemna sp.* were the most sensitive species from all aquatic species tested with glufosinate-ammonium and the lead formulations. Both the acute and long term risk to aquatic organisms was calculated using initial PECsw values resulting from spray drift figures according to Rautmann *et al.* 2001 at 1 m and run-off/drainage 0.5% of the hectare dose, with a field:water ratio of 10:1. This risk calculation is available in the Addendum of April 2004 which was discussed at the EPCO expert meeting on ecotoxicology in April 2004.

Acute toxicity data on fish, daphnia and algae are available for the metabolites MPP, MPA, MPF and NAG. Additionally the effects of metabolites MPP and MPA on *Lemna gibba* were tested. The metabolites tested were less toxic than glufosinate-ammonium in the acute toxicity studies. One of the metabolites, MPP, was slowly degraded, and therefore long term studies with fish and *Daphnia magna* were provided. In the daphnia reproduction study with MPP significant effects were observed at the lowest test concentration. The notifier proposed an extrapolated EC_{10} value to replace the NOEC in the risk assessment. This proposal was rejected by in as the OECD guidance document states that extrapolations below the lowest test concentration should not be trusted and 20% effects was observed at the lowest test concentration. Therefore a new study on the effects of MPP on Daphnia reproduction is required. However, due to the significant margin to expected effects, the data requirement is considered confirmatory by the EPCO expert meeting and should be assessed at Member State level.

The resulting TER-values for the acute and long term risk were all higher than the Annex VI trigger values for all representative use scenarios indicating a low risk to aquatic organisms.

As in the water sediment study the content of glufosinate-ammonium and the metabolite MPP was higher than 10%, a risk assessment for sediment dwelling organisms was required. For glufosinate-ammonium, the assessment was based on the no effect level of *Mysidopsis*, and for MPP the present assessment is based on the extrapolated EC_{10} values for daphnia reproduction, indicating a low risk for sediment dwelling organisms. However, due to the uncertainty of the extrapolated effect data on MPP, this should be confirmed when the new study is available.

5.3 RISK TO BEES

Acute contact and oral toxicity studies both with glufosinate-ammonium and the lead formulations are available. In the DAR the HQ-values for the highest dose rate and the lowest LD_{50} are given as this will result in the worst-case HQ value. In the list of endpoints the other HQ-values are mentioned as well. The resulting HQ values do not breach the appropriate Annex VI trigger value indicating a low risk to bees.

5.4 RISK TO OTHER ARTHROPOD SPECIES

Toxicity to non-target arthropods was high in laboratory studies on the two indicator species *Aphidius rhopalosiphi* and *Typhlodromus pyri* and on 4 additional species tested at doses corresponding to the field rates of the lead formulations: *Pardosa* ssp., *Chrysoperla carnea*, *Poecilus cupreus* and *Aleochara bilineata*. Severe effects were also noted among several species in extended laboratory and semi-field tests. Hence, for refinement of the effect assessment for non-target arthropods in the treated area and the potential for recovery, field studies were submitted by the notifier. The available field data demonstrated a recovery of affected populations within one season at doses up to and including 2 x 0.8 kg as/ha. Hence, the risk is considered to be low for in-field populations of NTA in GMO maize and potato.

The most sensitive species, *T. pyri* was not present in the field studies but were tested in a dose-response test on natural substrate in the laboratory. The resulting LR_{50} value was used in the off-crop assessment according to ESCORT 2. It was agreed at the EPCO expert meeting on ecotoxicology in April 2004 that a correction factor of 2 would be required to sufficiently protect the off-crop populations of NTA. A high risk is identified for off-crop populations of non-target arthropods in potatoes and maize which requires risk mitigation measures such as a 5 m bufferzone at MS level. The expert meeting also agreed that the effects on *T. pyri* do not need to be taken into account in the risk assessment for the in-crop populations of NTA since this species would not be present in field crops.

The presently available data are not sufficient to demonstrate safe use for non-target arthropods in orchards, since the tested doses in the field study were lower than those recommended in orchards (1.5 kg as/ha). Besides, in orchards a different NTA community compared to that in field crops is anticipated. A field study in apple orchards is now available, and was submitted by the notifier in November 2004 after the EPCO Expert meeting, but has so far not been evaluated by the RMS.

5.5 RISK TO EARTHWORMS

Studies on the acute toxicity to earthworms from glufosinate-ammonium, the lead formulations Basta SL 14 and Basta SL 18 and the soil metabolites MPP, MPA and NAG are available. No long term studies are available and not required since the persistence triggers are not met. The TER-values resulting from the endpoints derived from these studies do not breach the Annex VI trigger value indicating a low risk to earthworms for the representative uses.

5.6 RISK TO OTHER SOIL NON-TARGET ORGANISMS

Studies on *Folsomia candida* were submitted for the formulations Basta SL14 and SL18. No other soil macro-organism species were tested. From the results of the available studies, it seems that the formulation Basta SL18 is more toxic than the SL14 formulation. As a worst case, the risk assessment of glufosinate is based on the SL18 formulation. Possible toxicity of the major metabolites in soil is considered to be covered by the available studies, since the maxima would have occurred within the

28 days duration of the tests. The TER-values resulting from the endpoints derived from these studies do not breach the Annex VI trigger value indicating a low risk to collembola for the representative uses.

5.7 RISK TO SOIL NON-TARGET MICRO-ORGANISMS

The results from available laboratory studies performed at relevant test concentrations of glufosinate-ammonium, MPP, MPA and one SL19 formulation indicate that the effects on nitrogen conversion and soil respiration is acceptable at the recommended application rates. Also a concentration equal to up to 10 times the recommended application rate was tested, effects above 25% were seen on soil respiration and nitrogen turnover. However at the maximum application rate effects were below the Annex VI trigger value of 25% indicating a low risk to soil micro-organisms from the representative uses of glufosinate.

5.8 RISK TO OTHER NON-TARGET-ORGANISMS (FLORA AND FAUNA)

The results from herbicidal screening studies show that glufosinate-ammonium as a broad-spectrum herbicide has significant effects on most of the tested plant species. The effects are more pronounced on dicotyledonous species. It is noted by EFSA that no TER values are presented in the DAR. Therefore these values are presented here by EFSA. No ER_{50}-values for the active substance are presented in the DAR. But based on the results reported in the study summary this ER50 is below 0.08 kg as/ha, the lowest concentration tested, for 4 out of 18 tested dicotyledonous species when the product is applied post-emergence. All tested dicotyledonous species show effects far above 50% at 0.3 kg as/ha. Hence it is not possible to calculate a worst-case TER-value for the a.s. But an EC50 value is available for the formulation. The lowest value is 101 g as/ha based on dry weight for *Veronica persica* which is also one of the 4 most sensitive species in the study with the a.s.

Representative use	Distance from the field	Drift rate (g as/ha)	EC50 (g as/ha)	TER	Trigger
Orchards (1.5 kg as/ha)	1 m	42	101	**2.4**	5
	5 m	8.6		11.8	
Maize (2 x 0.8 kg as/ha)	1 m	44.32		**2.28**	
	5 m	9.12		11.1	
Potatoes (0.6 kg as/ha)	1 m	16.6		6.1	

Based on the available data EFSA considers the risk to non-target plants from the use in orchards and maize as low when a buffer zone of 5 meter is taken into account. The risk from the use in potatoes can be regarded as low without the need for risk mitigation measures.

Studies on the effects of the major metabolites in soil on non-target terrestrial plants are available. The summary of this study is available in the addendum of June 2004. The soil metabolite MPP showed no herbicidal activity neither at pre-emergence nor at post-emergence application with doses

of 2.5 and 10 kg/ha. The soil metabolite MPA showed no herbicidal activity at pre-emergence application with doses of 2.5 and 10 kg/ha. At post-emergence application, the dose rate 2.5 kg/ha caused herbicidal damage in the range of 30%, at the dose rate 10 kg/ha up to 80%. The risk from the metabolites to non-target plants is considered to be low.

Results from insecticidal screening studies are presented as LC90 and LC100 values, and it is not possible to draw conclusions on the magnitude of effects under more realistic doses.

Only MPP is subject for an assessment of the toxicological relevance of metabolites in groundwater. The results from the study supported the conclusion from the toxicological data that MPP is not a relevant metabolite in groundwater.

5.9 RISK TO BIOLOGICAL METHODS OF SEWAGE TREATMENT

A study was made available with glufosinate-ammonium. The risk for biological methods of sewage treatment is considered to be low.

6 Residue definitions

Soil

Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid and 2-methylphosphonico-acetic acid, L-2-acetamido-4-methylphosphinato-butyric acid and their salts.
Definitions for monitoring: Glufosinate and their salts expressed as glufosinate free acid equivalents.

Water

Ground water

Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid and 2-methylphosphonico-acetic acid and their salts.
Definitions for monitoring: Sum of glufosinate and their salts expressed as glufosinate free acid equivalents.

Surface water

Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid, 2-methylphosphonico-acetic acid and methylphosphinico-formic acid and their salts.
Definitions for monitoring: Sum of glufosinate, 3-methylphosphonico-propionic acid and their salts expressed as glufosinate free acid equivalents (3-methylphosphonico-propionic acid is pending on further data and it is expected to be removed from the residue definition if low risk is confirmed by these data).

Sediment

Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid and their salts.

Air

Definitions for risk assessment: Sum of glufosinate and their salts.

Definitions for monitoring: Sum of glufosinate and their salts expressed as glufosinate free acid equivalents.

Food of plant origin

Definitions for risk assessment: Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate free acid equivalents

Definitions for monitoring: Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate free acid equivalents

Food of animal origin

Definitions for risk assessment: Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate free acid equivalents

Definitions for monitoring: Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate free acid equivalents

Overview of the risk assessment of compounds listed in residue definitions for the environmental compartments

Soil

Compound (name and/or code)	**Persistence**	**Ecotoxicology**
Glufosinate	Low persistent ($DT_{50lab.corr.20°C}$ = 6 to 11 d)	See 5.5, 5.6 and 5.7
MPP	Low to moderate persistent ($DT_{50lab.corr.20°C}$ = 6.1 - 14 d)	Acute risk to earthworms and risk to soil non-target micro-organisms is considered to be low.
MPA	Low to moderate persistent ($DT_{50lab.corr.20°C}$ = 8.1 - 23 d)	Acute risk to earthworms and risk to soil non-target micro-organisms is considered to be low.
NAG (from parts of GMO plants left in the field)	Very low persistent ($DT_{50lab.20°C}$ = 0.5 to 1 d)	Acute risk to earthworms is considered to be low.

Ground water

Compound (name and/or code)	**Mobility in soil**	**> 0.1 µg / L 1m depth for the representative uses**	**Pesticidal activity**	**Toxicological activity**	**Ecotoxicological activity**
Glufosinate	moderate to high mobile (K_f = 0.2 – 3.4)	FOCUS modelling: No	Yes	Yes	Yes

Compound (name and/or code)	Mobility in soil	> 0.1 µg / L 1m depth for the representative uses	Pesticidal activity	Toxicological activity	Ecotoxicological activity
MPP	high mobile (K_f = 0.16 – 1.1)	FOCUS modelling: Yes, one scenario above the trigger. Field leaching study: Yes, annual average above trigger.	No	Lower than glufosinate-ammonium LD 50 > 2000 mg/kg Not irritating Not sensitizing Not genotoxic	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with *Lemna gibba*, algae, invertebrates and fish. The long term risk to *Daphnia magna* is considered to be low pending on confirmatory data.
MPA	high to moderate mobile (K_f = 0.22 – 22)	No	No	Lower than glufosinate-ammonium LD 50 > 2000 mg/kg Not genotoxic	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with *Lemna gibba*, algae, invertebrates and fish.

Surface water and sediment

Compound (name and/or code)	Ecotoxicology
Glufosinate (water and sediment)	See 5.2
MPP (water and sediment)	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with *Lemna gibba*, algae, invertebrates and fish. The long term risk to *Daphnia magna* and the risk to sediment dwelling organisms is considered to be low pending on confirmatory data.

Compound (name and/or code)	Ecotoxicology
MPA (water phase only)	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with *Lemna gibba*, algae, invertebrates and fish.
P-X (water phase only) Considered not to require further consideration at EU level.	
P-Y (= MPF) (water phase only)	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with algae, invertebrates and fish.
NAG (water phase only) Considered not to require further consideration at EU level	The risk to aquatic organisms is considered low (trigger not breached) based on acute toxicity studies with algae, invertebrates and fish.

Air

Compound (name and/or code)	Toxicology
Glufosinate	See section 2.1, 2.2 and 2.3

LIST OF STUDIES TO BE GENERATED OR STILL ONGOING

Analytical methods for residues

- Notifier to submit a validated analytical method for the determination of residues in blood. [For clarification, a method has to be provided due to the fact the substance is classified as T (toxic). The RMS has indicated in the DAR that no method has been submitted, but no data requirement was set. In addition, also during the annotation process no comment regarding the missing method was made. However, it seems that validated methods are available, because the notifier has submitted adequate method to some MS for national authorisation purposes].

Mammalian toxicology

- Toxicokinetic study in the rabbit; absorption and excretion in the rabbit doc MEF-04/335 (Koester, 2004), submitted to the rapporteur Member State 01/12/2004. Not evaluated.
- A revised operator risk calculation based on the new AOEL figure was submitted to the rapporteur Member State 01/12/2004. Not evaluated.

Residues

- Notifier to submit further information concerning the identity of metabolite A occurring in succeeding/rotational crops (relevant for all representative uses, no submission date proposed by the notifier, refer to point 3.1.2)
- Notifier to consider to generate unit to unit variability data on residues in potatoes with the aim of refining the default variability factor used in the acute intake calculations (relevant for the use as desiccant in potatoes; no submission date proposed by the notifier, refer to point 3.3)
- A revised acute consumer risk calculation was submitted to the rapporteur Member State 01/12/2004. (relevant for the representative use on potatoes, not evaluated by the RMS, refer to point 3.3).
- A new processing study was submitted to the rapporteur Member State in December 2004. (relevant for the representative use on potatoes, not evaluated by the RMS, refer to point 3.1.1).

Ecotoxicology

- Notifier to address the risk for herbivorous mammals (relevant for the representative uses in GMO maize and orchards, revised risk assessment submitted in December 2004, not evaluated by the RMS, refer to point 5.1).
- Notifier to address the risk to insectivorous mammals. This is proposed by EFSA after the EPCO Expert meeting. (relevant for the representative uses in potatoes, no submission date proposed by the notifier, refer to point 5.1)
- A field study on NTA in orchards. (relevant for the use in orchards, study report submitted in December 2004, not evaluated by RMS, refer to point 5.4)
- New study on the long term toxicity of MPP to *Daphnia* set as confirmatory data requirement by the EPCO expert meeting (relevant for all representative uses, no submission date proposed by the notifier, refer to point 5.2)

CONCLUSIONS AND RECOMMENDATIONS

Overall conclusions

The conclusion was reached on the basis of the evaluation of 3 representative uses as proposed by the notifier, representing the 3 main types of use of the compound (apple for non-selective herbicide use in conventional crops, potatoes for use as crop desiccant and transgenic maize for use as selective herbicide) at application rate up 1.5 kg glufosinate-ammonium per hectare. The representative formulated products for the evaluation were “Basta SL 14”, "Basta SL 18" and "Liberty SL 18", soluble concentrates (SL). The latter can be used in genetically modified glufosinate tolerant organisms (such as maize, oil seed rape and sugar beets). Due to the fact that the ammonium salt, a variant of glufosinate, is used in the formulated product, it should be noted that the evaluated data belongs to the variant glufosinate-ammonium, unless otherwise specified.

Adequate methods are available to monitor all compounds given in the respective residue definition except for blood.

Glufosinate-ammonium is rapidly but poorly absorbed, the average absorption was set to 10% (based on available data). It is widely distributed and the highest concentration was found in the liver, kidneys and testes, no evidence of accumulation. The major metabolites were MPP and NAG, with minor amounts of MHB, MPB and traces of MPA.

The oral LD_{50} was 1510 mg/kg bw in the rat and 416 mg/kg bw in the mouse, proposed labelling Xn; R22. Dermal toxicity in rats is low LD_{50} > 4000 mg/kg bw and in the rabbits moderate, LD_{50} > 2000 mg/kg bw for males and LD_{50} < 2000mg/kg bw for females. Based on the inhalatory LC_{50} set at 1.26 mg/l air, a labelling Xn; R20 was proposed. Glufosinate-ammonium was mildly irritating to the eyes but not to the skin and not found to have skin sensitising properties.

The relevant oral short term NOAEL is 4.5 mg/kg bw/day in the 1-year dog study, based on mortality and decreased glutamine synthetase activity and an overall value for the studies in dog, proposed labelling Xn; R48/22. The relevant dermal NOAEL is 100 mg/kg bw/day for males and 300 mg/kg bw/day for females based on clinical signs of toxicity (neurotoxicity symptoms) in the rat. The inhalatory NOAEL was set to 0.012 mg/l air, proposed labelling T; R48/23.

There was no evidence of genotoxicity or carcinogenicity of glufosinate-ammonium.

There were no direct effects on reproductive performance or fertility observed. The relevant NOAEL for reproduction was set 120 ppm i.e. 7.5 and 9.6 mg/kg bw/day for male and female the rat based on reduced litter size. However, both pre- and post implantation losses to a high degree were noted and the NOAEL was set to 50 ppm i.e. 4.3 mg/kg bw/day.

Glufosinate-ammonium induced pre- and post implantation losses, vaginal bleedings, abortions and dead foetuses not induced by maternal toxicity and the relevant developmental NOAEL is 6.3 mg/kg bw/day in the rabbit based on premature deliveries, abortions and dead foetuses, proposed

classification as a Category 2 substance T; R61. The fact that the pre-implantation losses observed in the rat occurred in absence of maternal toxicity, R62 is also proposed.
There were no indications of delayed neurotoxicity.
The metabolites of glufosinate-ammonium (NAG, MPA and MPP) are all less toxic than glufosinate-ammonium. Thus, proposal of ADI, AOEL and ARfD is referred to glufosinate-ammonium.
The ADI and AOEL are based on the NOAEL of 6.3 mg/kg bw/day in the rabbit developmental toxicity study. Due to the severe art of effects seen both in the rat and rabbit an additional safety factor of 3 was added. The resulting ADI is 0.021 mg/kg bw/day. A correction for 10% oral absorption (based on available data) is required for setting the AOEL which results in 0.0021 mg/kg bw/day.
Two ARfD values are proposed; the first ARfD is based on the NOAEL in the rabbit developmental study for women of child bearing potential i.e. 0.021 mg/kg bw/day. The second ARfD is based on the NOAEL of 4.5 mg/kg bw/day from the 1-year dog study, without additional safety factor, i.e. 0.045 mg/kg bw/day is suggested to be used for the general population.
The dermal absorption of the formulations Basta SL14 and Basta SL18/Liberty SL18 were 16 % and 7 % for undiluted product and 14 % and 9 % for spraying dilution, respectively.
The estimated operator exposure for apple orchards using Basta SL14/SL18 was below the AOEL when PPE was used. The estimated operator exposure for both potato desiccation using Basta SL14/SL18 and for weed control in transgenic maize using Liberty SL18 was exceeded even when PPE was used.

The metabolism of glufosinate-ammonium has been investigated on three crops, representing its main 3 types of use (apple for non-selective herbicide use in conventional crops, potatoes for use as crop desiccant and transgenic maize for use as selective herbicide) as well as in livestock.
The residue definition proposed for monitoring and risk assessment for apples, potatoes and transgenic maize as well as for products of animal origin is the sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate equivalents. This definition protects adequately the consumer.
Supervised residue trials were carried out in apple, potatoes and maize, in accordance with the representative uses. In apple and maize, no residues above the LOQ (0.1 mg/kg) were found at harvest. In potatoes, residues were present up to 0.5 mg/kg and were consisting essentially of parent glufosinate. These residues were not altered by cooking in boiling water.
Rotational crops studies were carried out with radish, lettuce and wheat. Parent glufosinate was not identified in any of the samples. One unknown metabolite (metabolite A) of polar nature was present in the 28 days samples but at extremely low levels (around 0.01 mg/kg). Further work should however be done to identify this metabolite.
Animal feeding studies were conducted for poultry (laying hens) and cattle (dairy cows). Cattle liver and kidney were the only tissues with measurable levels of residues (up to 1 and 2 mg MPP/kg respectively).
Chronic and acute risk assessments for the consumers were carried out according to usual methodologies. The use on potatoes appeared to lead to an acute risk for toddlers.

All studies on the fate and behaviour in the environment were performed with the ammonium salt of glufosinate (glufosinate-ammonium). Due to the fact the ammonium ion is ubiquitous in the environment; the fate of the ammonium resulting from the application of glufosinate-ammonium was not followed. Therefore, the results are referred to the fate of the anion glufosinate which is expected to be dissociated in aqueous media at environmentally relevant pH (5-9).

Glufosinate yields the two major metabolites MPP and MPA in soil under dark aerobic conditions. Under anaerobic conditions glufosinate shows slower degradation than but no new metabolites are formed. Glufosinate is stable towards photolytical degradation in soil. Glufosinate is low persistent in soil under aerobic conditions. Metabolites MPP and MPA show to be low to moderate persistent. Plant metabolite in transgenic plants, NAG, is very low persistent in soil. However, MS may need to further assess this metabolite for uses were a larger portion of the plants is left in the field after cropping. Glufosinate is moderate to high mobile (K_f = 0.2 – 3.4), MPP is high mobile (K_f = 0.16 – 1.1) and MPA is high to moderate mobile (K_f = 0.22 – 22) in soil. Correlation with organic matter content is not applicable to these compounds, but correlation with clay content has been demonstrated for glufosinate. There are also evidences of a week correlation between MPA mobility and soil pH.

Glufosinate is hydrolytically stable in the range of environmental relevant pH (5 – 9) and it is not degraded by photolysis in water. Glufosinate is not readily biodegradable according the available information. The major metabolites in the water phase at 20 °C under aerobic conditions were MPP, MPA, P-X, P-Y and NAG. The same metabolites were found under anaerobic conditions but only MPP, and P-Y exceed the 10 % AR. Glufosinate reached levels above 10 % AR in the sediment. Metabolite MPP reached levels of 9.8 % AR in the sediment and an estimated theoretical maximum of 46 % AR may be calculated and was used for PEC sed calculation. No other metabolite reaches levels above 10 % AR in the sediment. The dissipation half-lives of glufosinate in the water phase were 1.4 - 13 days at 20°C. The half life for MPP was estimated by extrapolation to be 150 d. Degradation of MPA and P-Y was slower. Further assessement of metabolites NAG and PX may be needed for MS risk assessement. Worst case DT_{50} (for parent and MPP) and maximum amount of metabolite found in the whole system were used in the PEC sw calculation. Only maximum PEC sw were calculated for metabolites MPA, P-Y, P-X and NAG. PEC sw and PEC sed presented in the addendum were used for the ecotoxicological risk assessment. The expert meeting on environmental fate and behaviour (April 2004) also agreed that the assumptions made for MPP in the sediment were a worst case and that MS could need further data to refine the risk assessment.

According FOCUS gw PELMO 1.1.1. modelling MPP may have some potential to contaminate groundwater in vulnerable areas (trigger of 0.1 µg / L is exceeded in one of the nine scenarios).

In a three year lysimeter study with application in pome fruit neither the parent compound nor any of the analysed metabolites were detected in the leachate.

Two field leaching studies are available. In one of them, MPP showed a higher leaching potential than the parent compound with a maximum of 26 µg / L at 120 cm depth. The expert meeting agreed that the study was reliable and that it confirms leaching potential of MPP under vulnerable conditions at levels above 0.1 µg /L. Hence, for this metabolite an assessment with regard to potential relevance in ground water is warranted.

Concentrations of glufosinate-ammonium in the air compartment are expected to be negligible, due to low volatility and short persistence in the atmosphere.

Based on the data available at the EPCO expert meeting on ecotoxicology a high risk to mammals was identified. The acute and long term TER values are 3.5 and 0.13 respectively for the use in apples. The long term TER value is 0.86 in GMO maize and the long term TER value for insectivorous mammals in potatoes would be 3.25 if the interception factor is disregarded as proposed by EFSA. Further data were submitted by the notifier after the EPCO expert meeting but this was neither evaluated by the RMS nor peer reviewed. The risk assessment can only be concluded when the outstanding data is evaluated.
Based on the refined risk assessment for birds, the risk is considered to be low for all representative uses of glufosinate. This was supported by the EPCO expert meeting.
The resulting TER-values for the acute and long term risk for aquatic organism were all higher than the Annex VI rigger value indicating a low risk to aquatic organisms for all representative uses (pending on a confirmatory data requirement for the long term risk to *Daphnia magna* from the metabolite MPP).
The risk to bees is considered low.
The risk is considered to be low for in-field populations of non-target arthropods in GMO maize and potato. A high risk is identified for off-crop populations of non-target arthropods in potatoes and maize which requires risk mitigation measures such as a 5 m bufferzone at MS level. The available data at the EPCO expert meeting were not sufficient to demonstrate a safe use for non-target arthropods in orchards, since the tested doses in the field study were lower than those recommended in orchards (1.5 kg as/ha). The risk assessment can only be concluded when the outstanding data is evaluated.
The risk to earthworms, other soil non-target macro-organisms and soil micro-organisms is considered to be low for all the representative uses.
Based on the available data EFSA considers the risk to non-target plants from the use in orchards and maize as low when a buffer zone of 5 meter is taken into account. The risk from the use in potatoes can be regarded as low without the need for risk mitigation measures.
The risk to biological methods for sewage treatment is considered to be low.

Particular conditions proposed to be taken into account to manage the risk(s) identified

- Two ARfD values are proposed;
  The first ARfD, based on the NOAEL of 6.3 mg/kg bw/day from the rabbit developmental study, with an additional safety factor of 3, for women of child bearing potential i.e. 0.021 mg/kg bw/day.
  The NOAEL of 4.5 mg/kg bw/day from the 1- year dog study is used for the second ARfD i.e. 0.045 mg/kg bw/day is suggested to be used for the general population.

- A high risk is identified for off-crop populations of non-target arthropods in potatoes and maize which requires risk mitigation measures such as a 5 m bufferzone.
- A high risk is identified for non-target plants in orchards and maize which requires risk mitigation measures such as a 5 m bufferzone.

Critical areas of concern

- The estimated operator exposure exceeded the AOEL (based on available data) for the representative uses transgenic maize (Liberty SL18) as well as potatoes (Basta SL14 and SL18) even when PPE was worn.
- An acute dietary risk has been identified for toddlers for the representative use as crop desiccant in potatoes. The exceedence of the ARfD relevant for children (0.045 mg/kg bw/d) although slight (refer to point 3.3) is a major area of concern due to the narrowness of the margin existing between the ARfD and the level causing mortality in dogs.
- A high risk to mammals was identified for all the representative uses. The acute and long term TER values are 3.5 and 0.13 respectively for the use in apples and thus below the relevant Annex VI trigger of 10 and 5, respectively. The long term TER value is 0.86 in GMO maize and the long term TER value for insectivorous mammals in potatoes would be 3.25 if the interception factor is disregarded. These values are also below the relevant Annex VI trigger of 5.
- A high risk is identified for off-crop populations of non-target arthropods in potatoes and maize which requires risk mitigation measures such as a 5 m bufferzone. The available data at the EPCO expert meeting on ecotoxicology were not sufficient to conclude on the risk assessment for non-target arthropods in orchards, since the tested doses in the field study were lower than those recommended in orchards (1.5 kg as/ha).
- A high risk is identified for non-target plants in orchards and maize which requires risk mitigation measures such as a 5 m bufferzone.

APPENDIX 1 – LIST OF ENDPOINTS FOR THE ACTIVE SUBSTANCE AND THE REPRESENTATIVE FORMULATION

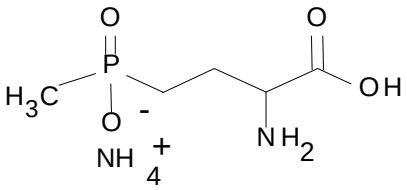
(Abbreviations used in this list are explained in appendix 2)

Appendix 1.1: Identity, Physical and Chemical Properties, Details of Uses, Further Information

Active substance (ISO Common Name) ‡	Glufosinate (unless otherwise stated the following data relate to the variant glufosinate-ammonium)
Function (e.g. fungicide)	Herbicide

Rapporteur Member State	Sweden
Co-rapporteur Member State	Germany

Identity (Annex IIA, point 1)

Chemical name (IUPAC) ‡	ammonium(DL)-homoalanin-4-yl(methyl)phosphinate
Chemical name (CA) ‡	2-amino-4-(hydroxymethylphosphinyl)butanoic acid, monoammonium salt
CIPAC No ‡	437.007
CAS No ‡	77182-82-2
EEC No (EINECS or ELINCS) ‡	278-636-6
FAO Specification (including year of publication) ‡	None
Minimum purity of the active substance as manufactured (g/kg) ‡	950
Identity of relevant impurities (of toxicological, environmental and/or other significance) in the active substance as manufactured (g/kg)	None
Molecular formula ‡	$C_5H_{12}NO_4P.H_3N$
Molecular mass ‡	198.19
Structural formula ‡	

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Physical-chemical properties (Annex IIA, point 2)

Melting point (state purity) ‡	215-218 °C d (99.5 % pure)
Boiling point (state purity) ‡	n.a.
Temperature of decomposition	245-305 °C (99.5%)
Appearance (state purity) ‡	Crystalline powder (99.2%)
Relative density (state purity) ‡	Density: 1.32 g/cm³ (23 °C)
Surface tension	72.1 mN/m (1 g/L)
Vapour pressure (in Pa, state temperature) ‡	$<3.1x10^{-5}$ at 50 °C (99.5%)
Henry's law constant (Pa m^3 mol^{-1}) ‡	4.48×10^{-9}
Solubility in water (g/l or mg/l, state temperature) ‡	pH 5.4: >500 g/l at 20 °C pH 7: >500 g/l at 20 °C pH 8.9: >500 g/l at 20 °C (all 99.5%)
Solubility in organic solvents (in g/l or mg/l, state temperature) ‡	Acetone < 0.25 Acetonitrile < 0.25 1,2-dichloroethane < 0.25 dimethyl sulfoxide 48.9 ethyl acetate < 0.25 *n*-heptane < 0.25 methanol 5730 *p*-xylene < 0.25 (all 99.2%)
Partition co-efficient (log POW) (state pH and temperature) ‡	pH 5: -3.77 pH 7: -4.01 (all with 96.6% radiochemical pH 9: -4.07 purity and at 25 °C)
Hydrolytic stability (DT50) (state pH and temperature) ‡	pH 5: >300 d mass balance >98% pH 7: >300 d mass balance >98% pH 9: >300 d mass balance >98% (all at 25 °C)
Dissociation constant ‡	pK_a = 9.15±0.07 at 23 °C Calculated value 9.66±0.01

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

UV/VIS absorption (max.) (if absorption > 290 nm state ε at wavelength) ‡	Neutral: 193 nm, 382.02 L/mol*cm 291 nm, 3.12 L/mol*cm Acidic: 207.25 nm, 57.05 L/mol*cm 291 nm, 0.31 L/mol*cm Alkaline: 216.75 nm, 108.67 L/mol*cm 291 nm, no absorption Spectra pH-dependant. Virtually no absorption over 200 nm
Photostability (DT50) (aqueous, sunlight, state pH) ‡	Stable (Sterile water) 1.3-2.2 years in gravel-pit water
Quantum yield of direct phototransformation in water at Σ > 290 nm ‡	n.a.
Flammability ‡	Not flammable
Explosive properties ‡	Not explosive

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

List of representative uses evaluated (glufosinate-ammonium)*

Crop and/ or situation (a)	Member State or Country	Product name	F, G, or I (b)	Pests or Group of pests controlled (c)	Formulation		Application				Application rate per treatment			PHI (days) (l)	Remarks: (m)
					Type (d-f)	Conc. of as (i)	method kind (f-h)	growth stage & season (j)	number min max (k)	interval between applications (min)	kg as/hl min max	water l/ha min max	kg as/ha min max		
Pome fruits (apple)	**EU**	**Basta SL18**	**F**	**weeds**	**SL**	**200 g/L**	**spray**	**44 and 14 days before harvest**	**2**	**30 days**		**200-600**	**1.5* + 1.0 or 1.0* + 1.0**	**14**	
Potato	**EU**	**Basta SL18**	**F**	**desicc-ation**	**SL**	**200 g/L**	**spray**	**BBCH 90 ***	**1**	**-**	**0.2 – 0.4**	**150-400**	**0.6**	**7 - 14**	*beginning of sennescence
Maize	**EU**	**Liberty SL18**	**F**	**weeds**	**SL**	**200 g/L**	**spray, splitting**	**BBCH 14 (up to 4 leave stage) + BBCH 18 (up to 8 leave stage)**	**2**	**10 days**	**0.2 – 0.4**	**200-400**	**0.8 + 0.8**	*	* The PHI is covered by the application conditions and/or by the remaining growth period between application and subsequent use of the crop (e.g. harvest)
Pome fruits (apple)	**EU**	**Basta SL14**	**F**	**weeds**	**SL**	**150 g/L**	**spray**	**44 and 14 days before harvest**	**2**	**30 days**		**200-600**	**1.125* + 0.75 or 0.75* + 0.75**	**14**	
Potato	**EU**	**Basta SL14**	**F**	**desicc-ation**	**SL**	**150 g/L**	**spray**	**BBCH 90 ***	**1**	**-**	**0.1 – 0.3**	**150-400**	**0.45**	**7 - 14**	*beginning of sennescence

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Remarks:	*	Uses for which risk assessment could not been concluded due to lack of essential data are marked grey	(h)	Kind, *e.g.* overall, broadcast, aerial spraying, row, individual plant, between the plants - type of equipment used must be indicated
	(a)	For crops, the EU and Codex classifications (both) should be used; where relevant, the use situation should be described (*e.g.* fumigation of a structure)	(i)	g/kg or g/l
	(b)	Outdoor or field use (F), glasshouse application (G) or indoor application (I)	(j)	Growth stage at last treatment (BBCH Monograph, Growth Stages of Plants, 1997, Blackwell, ISBN 3-8263-3152-4), including where relevant, information on season at time of application
	(c)	*e.g.* biting and suckling insects, soil born insects, foliar fungi, weeds		
	(d)	*e.g.* wettable powder (WP), emulsifiable concentrate (EC), granule (GR), water soluble concentrate (SL)	(k)	The minimum and maximum number of application possible under practical conditions of use must be provided
	(e)	GCPF Codes - GIFAP Technical Monograph No 2, 1989		
	(f)	Method, *e.g.* high volume spraying, low volume spraying, spreading, dusting, drench	(l)	PHI - minimum pre-harvest interval
	(g)	All abbreviations used must be explained	(m)	Remarks may include: Extent of use/economic importance/restrictions

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.2: Methods of Analysis

Analytical methods for the active substance (Annex IIA, point 4.1)

Technical as (principle of method)	HPLC / UV and HPLC / fluorescence detection
Impurities in technical as (principle of method)	Combustion, Argentometric titr., IC and Karl Fisher titr.
Plant protection product (principle of method)	HPLC / UV and HPLC / fluorescence detection

Analytical methods for residues (Annex IIA, point 4.2)

Food/feed of plant origin (principle of method and LOQ for methods for monitoring purposes)	GC; LOQ for each of test compounds (GA, MPP, NAG): 0.05 mg/kg
Food/feed of animal origin (principle of method and LOQ for methods for monitoring purposes)	GC; LOQ for each of test compounds (GA, MPP, NAG) Milk: 0.02 mg/kg Eggs, muscle, fat: 0.05 mg/kg Liver: 0.01 mg/kg
Soil (principle of method and LOQ)	GC; LOQ: 0.05 mg/kg
Water (principle of method and LOQ)	GC / FPD or MS; LOQ: 0.05 µg/l (well and surface water)
Air (principle of method and LOQ)	GC / MS; LOQ: 5 µg/m^3
Body fluids and tissues (principle of method and LOQ)	Not presented

Classification and proposed labelling (Annex IIA, point 10)

with regard to physical/chemical data	None

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.3: Impact on Human and Animal Health

Absorption, distribution, excretion and metabolism in mammals (Annex IIA, point 5.1)

Rate and extent of absorption ‡	Rapid (maximum blood concentration within 0.5 to 1 hr after administration) but low (ca. 10% absorption across all studies)
Distribution ‡	Highest levels in kidney, liver and testes
Potential for accumulation ‡	None
Rate and extent of excretion ‡	> 95% 96 hours post administration, mainly in faeces
Metabolism in animals ‡	In all species tested, glufosinate ammonium (GA) is primarily metabolised through oxidative de-amination and decarboxylation to produce 3-methylphosphinco-propionic acid (MPP). In addition, GA is reversibly acetylated resulting in low levels of N-acetyl-glufosinate (NAG).
Toxicologically significant compounds ‡ (animals, plants and environment)	In plants and animals, GA, MPP and NAG. In the environment, GA.

Acute toxicity (Annex IIA, point 5.2)

Rat/mouse LD_{50} oral ‡	1510 mg/kg bw (rat) **R22** 416 mg/kg bw (mouse)
Rat/rabbit LD_{50} dermal ‡	> 4000 mg/kg bw (rat) > 2000 mg/kg bw (rabbit, m) < 2000 mg/kg bw (rabbit, f)
Rat LC_{50} inhalation ‡	1.26 mg/l **R20**
Skin irritation ‡	Non-irritating
Eye irritation ‡	Non-irritating
Skin sensitization ‡ (test method used and result)	Not a sensitizing agent (Buehler and maximization tests)

Short term toxicity (Annex IIA, point 5.3)

Target / critical effect ‡	Clinical signs (sedation, lateral recumbency, hunched posture, spasm, hyperactivity and lacrimation), inhibition of glutamine synthetase activity
Lowest relevant oral NOAEL / NOEL ‡	NOAEL 4.5 mg/kg bw/day **R48/22** (1 yr dog)
Lowest relevant dermal NOAEL / NOEL ‡	100 mg/kg bw/day (rat)
Lowest relevant inhalation NOAEL / NOEL	0.012 mg/l (rat) **R48/23**

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Genotoxicity (Annex IIA, point 5.4) ‡

Not genotoxic

Long term toxicity and carcinogenicity (Annex IIA, point 5.5)

Target/critical effect ‡	Mortality (mouse) Increased kidney weight (rat)
Lowest relevant NOAEL / NOEL ‡	NOAEL 11 mg/kg bw/day (mouse) / NOEL 2 mg/kg/d (rat)
Carcinogenicity ‡	Not carcinogenic

Reproductive toxicity (Annex IIA, point 5.6)

Reproduction target / critical effect ‡	Pre- and post-implantation losses, premature deliveries and abortions
Lowest relevant reproductive NOAEL / NOEL ‡	NOAEL 7.5 mg/kg bw/day (rat) **Cat 3, R62**
Developmental target / critical effect ‡	Premature deliveries, abortions and dead fetuses
Lowest relevant developmental NOAEL / NOEL ‡	NOAEL 6.3 mg/kg bw/day (rabbit) **Cat 2, R61**

Neurotoxicity / Delayed neurotoxicity ‡ (Annex IIA, point 5.7)

Acute and repeat dietary neurotoxicity in rat	Single dose NOAEL 100 mg/kg bw
Delayed neurotoxicity	There was no indication of delayed neurotoxicity

Other toxicological studies ‡ (Annex IIA, point 5.8)

Metabolites NAG, MPP and MPA	**NAG** is the major plant metabolite in glufosinate ammonium (GA) tolerant crops. NAG is rapidly absorbed and excreted in the rat. *In vitro* studies show that NAG does not affect glutamine synthetase (GS). However, it has been proven that in mammals, GA and NAG interconvert; therefore, in *in vivo* studies, animals administered NAG do show a level of GS inhibition caused by de-acetylation to GA. NAG is of low acute toxicity. It is not genotoxic or carcinogenic. NAG is not teratogenic, nor does it adversely impact reproductive performance. The lowest short term and long term NOAELs are >> than those of parent GA. **MPP** is the major plant metabolite in susceptible plants. It is rapidly excreted in the rat. MPP is of low acute toxicity (LD50>2000 mg/kg bw) and has no effect on GS in animals or presumably plants. It is not genotoxic. MPP is not teratogenic. The lowest short term NOAELs are >> than those of parent GA.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

	MPA is an environmental metabolite. It results from further degradation of MPP. It has been observed at low levels in rat metabolism studies, presumably *via* MPP. It is not acutely toxic (LD50> 2000 mg/kg bw). MPA is not genotoxic. The short term toxicity profile is similar to its precursor MPP. In conclusion, metabolites of GA are all less toxic than parent compound. Therefore, use of GA toxicology endpoints in risk assessments, which include levels of metabolites, introduces an additional conservatism/margin of safety.

Medical data ‡ (Annex IIA, point 5.9)

	No adverse effects were reported in manufacturers or operators during production of application of the product. So far, clinical toxicological experience with glufosinate-ammonium arises exclusively from suicidal cases and very few incidences of accidental misuse of the herbicide formulation. In all instances, intoxication occurred exclusively with the formulated product. Almost all attempts to commit suicide with glufosinate-ammonium occurred in Japan. Initial effects seen are nausea, vomiting and diarrhoea. Later neurological symptoms are trembling, convulsions, coma and respiratory failure. The therapy of Basta intoxications is strictly symptomatic and supportive. No specific antidote is known for the active substance glufosinate.

Summary (Annex IIA, point 5.10)	**Value**	**Study**	**Safety factor**
ADI ‡	0.021 mg/kg bw/day	developmental study, rabbit	300[§]
AOEL ‡	0.0021 mg/kg bw/day	developmental study, rabbit	3000[§]*
ARfD, women of child bearing potential ‡	0.021 mg/kg bw/day	developmental study, rabbit	300[§]
ARfD, general population and toddlers ‡	0.045 mg/kg bw/day	1 yr dog study and overall NOAEL from the dog studies	100

[§] Extra factor of 3, due to severity of toxicity (reproduction)
* Correction for low oral absorption (10%)

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Dermal absorption (Annex IIIA, point 7.3)

Preparation Basta SL18/ Liberty SL18:	
undiluted	7 % (10-h exposure *in vivo* rat)
as spraying dilution	9 % (10-h exposure *in vivo* rat)
	Penetration factor human vs rat skin: 1
Preparation Basta SL14:	
undiluted	16 % (10-h exposure *in vivo* rat)
as spraying dilution	14 % (10-h exposure *in vivo* rat)
	Penetration factor human vs rat skin: 1

Acceptable exposure scenarios (including method of calculation)

Operator	Weed control in apple orchards Application rates for Basta SL14: 1.5 kg a.s./ha and Basta SL18: 1.125 kg a.s./ha The estimated exposure was below the AOEL when PPE was used for tractor mounted hand held pressure sprayers with hose and spray lance with shields and apple orchards for tractor mounted with small booms and single nozzle and protective wings for both formulations Without PPE Basta SL14 400% of AOEL Basta SL18 310% of AOEL With PPE Basta SL14 93% of AOEL Basta SL18 65% of AOEL Potatoe desiccation Application rates for Basta SL14: 0.45 kg a.s./ha and Basta SL18: 0.6 kg a.s./ha The estimated exposure was exceeding the AOEL even when PPE was used (German model) for both formulations Without PPE Basta SL14 4800% of AOEL Basta SL18 3400% of AOEL With PPE (gloves during M/L and coverall during A) Basta SL14 150% of AOEL Basta SL18 130% of AOEL Transgenic maize

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

	Application rate for Liberty SL18: 0.8 kg a.s./ha The estimated exposure was exceeding the AOEL even when PPE was used (German model)-for the scenario with tractor mounted boom sprayers. Without PPE Liberty SL18 7600% of AOEL With PPE (gloves during M/L and coverall during A) Liberty SL18 150% of AOEL
Workers	Weed control in apple orchard, potato desiccation and transgenic maize Not relevant since re-entry is considered not necessary shortly after spraying.
Bystanders	The estimated exposure was below the AOEL for Basta SL14 and SL18 as well as for Liberty SL18. However, for Basta SL14 in apple orchards, the AOEL was exceeded (125%).

M/L= mixing and loading, A.= Application

Classification and proposed labelling (Annex IIA, point 10)

with regard to toxicological data	Proposal during the peer review: **T:** Toxic **R20/22:** Harmful by inhalation and in contact with skin **R48/22:** Harmful: danger of serious damage to health by prolonged exposure if swallowed **R48/23:** Harmful: danger of serious damage to health by prolonged exposure through inhalation **Cat. 2, R61:** May cause harm to the unborn child **Cat. 3, R62:** Possible risk to impaired fertility

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.4: Residues

Metabolism in plants (Annex IIA, point 6.1 and 6.7, Annex IIIA, point 8.1 and 8.6)

Plant groups covered:	Non-selective use: Pome fruit (apple) Crop desiccant use: Potatoes Selective use in transgenic crops: Cereal grain (maize)
Rotational crops:	-
Plant residue definition for monitoring:	Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate equivalents. This definition covers apples, potatoes and transgenic maize.
Plant residue definition for risk assessment:	As above
Conversion factor (monitoring to risk assessment):	1

Metabolism in livestock (Annex IIA, point 6.2 and 6.7, Annex IIIA, point 8.1 and 8.6)

Animals covered:	Lactating goat and laying hens
Metabolism in rat and ruminant the same?	Yes
Animal residue definition for risk assessment:	Sum of glufosinate, its salts, 3-methyl-phosphinico-propionic acid, and N-acetyl-glufosinate expressed as glufosinate equivalents
Animal residue definition for monitoring?	As above
Conversion factor (monitoring to risk assessment):	1
Fat soluble residue: (yes/no)	No

Residues in succeeding crops (Annex IIA, point 6.6, Annex IIIA, point 8.5)

In case of crop failure which requires destruction of the crop before harvest, major residues that could be available to succeeding crops include parent glufosinate, MPP (and MPA which fell below 10 % of TRR). Results indicate that glufosinate and its metabolites are not likely to accumulate and reach significant levels of residue in succeeding crops. One unknown metabolite (metabolite A) of polar nature was present in plants grown after an ageing period of 28 days but at extremely low levels (around 0.01 mg/kg)

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Stability of residues (Annex IIA, point 6 introduction, Annex IIIA, point 8 introduction)

Residues in potato are stable for one year under frozen conditions. Residues in apple and transgenic maize are stable up to 24 months under frozen conditions. For poultry and cattle residues are stable for a period up to 15 months.

Residues from livestock feeding studies (Annex IIA, point 6.4, Annex IIIA, point 8.3)

Intakes by livestock ≥ 0.1 mg/kg diet/day:	Ruminant	Poultry	Pig
	Conditions of requirement of feeding studies		
Intakes by livestock ≥ 0.1 mg/kg diet (dry weight basis) (yes/no - If yes, specify the level)	Yes 5.0 and 6.0 mg/kg diet dairy cows and beef cattle resp.	Yes 0.7 mg/kg diet	Yes 3.5 mg/kg diet
Potential for accumulation (yes/no):	No	No	No
Metabolism studies indicate potential level of residues ≥ 0.01 mg/kg in edible tissues	Yes	Yes	Yes
	Feeding study with a mixture of GA and MPP (Cattle: 3.0 and 1.0 mg/kg dry diet Poultry: 3.5 and 1.0 mg/kg dry diet) Residue levels in tissues, Mean mg/kg, expressed as glufosinate eq.		
Muscle	<0.1	<0.1	not required
Liver	1.2	<0.2	not required
Kidney	0.48		not required
Fat	<0.1	<0.1	not required
Milk	<0.04		
Eggs		<0.1	
	Feeding study with a mixture of GA and NAG (Cattle: 1.4 and 7.7 mg/kg dry diet Poultry: 0.06 and 0.35 mg/kg dry diet) Residue levels, Mean mg/kg, expressed as glufosinate eq.		
Muscle	<0.1	<0.1	not required
Liver	<0.2	<0.2	not required
Kidney	<0.2		not required
Fat	<0.1	<0.1	not required
Milk	<0.02		
Eggs		<0.1	

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Summary of critical residues data (Annex IIA, point 6.3, Annex IIIA, point 8.2)

Crop	Northern or Mediterranean Region	Trials results relevant to the critical GAP (a)	Recommendation/comments	MRL	STMR (b)
Apple	Northern	9 x (<0.05,<0.05) mg/kg Figures in brackets refer to glufosinate and MPP respectively		0.1* mg/kg	0
Apple	Southern	8 x (<0.05,<0.05) mg/kg Figures in brackets refer to glufosinate and MPP respectively		0.1* mg/kg	0
Potato	Northern	(0.07,<0.05), 2 x (0.11,<0.05), (0.23,<0.05), 3 x (0.1,<0.05), 2 x (0.08,<0.05), 2 x (0.05,<0.05), (0.15,<0.05), (<0.05,<0.05), 2 x (0.21,<0.05), (0.44,<0.05), (0.19,<0.05), (0.32,<0.05), (0.43,<0.05), (0.34,<0.05), (0.37,<0.05) Figures in brackets refer to glufosinate and MPP respectively		0.5 mg/kg	0.16
Potato	Southern	(0.1,<0.05), (0.34,<0.05), (0.37,<0.05), (0.21,<0.05) Figures in brackets refer to glufosinate and MPP respectively		0.5 mg/kg	0.16
Maize grain	Northern	18 x (<0.05,<0.05) mg/kg Figures in brackets refer to the sum of glufosinate and NGA, and MPP respectively 8 x (<0.05,<0.05,<0.05) mg/kg Figures in brackets refer to glufosinate, NGA, and MPP respectively		0.1* mg/kg	0

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Crop	Northern or Mediterranean Region	Trials results relevant to the critical GAP (a)	Recommendation/comments	MRL	STMR (b)
Maize grain	Southern	21 x (<0.05,<0.05) mg/kg Figures in brackets refer to the sum of glufosinate and NGA, and MPP respectively 4 x (<0.05,<0.05,<0.05), (<0.05,<0.05,0.05), (<0.05, 0.10, 0.06) mg/kg Figures in brackets refer to glufosinate, NGA, and MPP respectively	Result at (<0.05, 0.10, 0.06) mg/kg considered as outlier	0.1* mg/kg	0.05

(a) Numbers of trials in which particular residue levels were reported *e.g.* 3 x <0.01, 1 x 0.01, 6 x 0.02, 1 x 0.04, 1 x 0.08, 2 x 0.1, 2 x 0.15, 1 x 0.17
(b) Supervised Trials Median Residue *i.e.* the median residue level estimated on the basis of supervised trials relating to the critical GAP

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Consumer risk assessment (Annex IIA, point 6.9, Annex IIIA, point 8.8)

ADI	0.021 mg/kg bw day (temporary)
TMDI (European Diet) (% ADI)	WHO European diet : 14% German model 4-6 year old girl : 14% Swedish 90 percentile model diet : 19%
NEDI (% ADI)	Not relevant
Factors included in NEDI	Not relevant
ARfD	0.021 mg/kg bw/d for woman of child bearing potential 0.045 mg/kg bw for general population which is adults and toddlers
Acute exposure (% ARfD)	Woman of child bearing potential apples 5 %, potatoes all 54 %, maize 10%, potato crisps 2% General population *Adults:* apples 2%, potatoes 25%, maize 4%, Potato crisps 1% Toddlers apples 12%, potatoes 114%, maize 1%, potato crisps 4%

Processing factors (Annex IIA, point 6.5, Annex IIIA, point 8.4)

Crop/processed crop	Number of studies	Transfer factor	% Trans-ference *
Potatoes (representative crop)		Boiled potatoes: 1 (4 studies) Chips and flakes: 2 and 3 respectively (1 study)	100 % 50%
Apples (representative crop)		Residues in apples from trees treated with Basta are below the limit of quantification and thus below the trigger value of 0.1 mg/kg. Therefore no processing studies are required for apples.	
Maize (glufosinate tolerant) (representative crop)		2 processing studies are available with exaggerated rate of application indicating that at normal rate no residues are expected in maize flour and oil.	

* Calculated on the basis of distribution in the different portions, parts or products as determined through balance studies

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Proposed MRLs (Annex IIA, point 6.7, Annex IIIA, point 8.6)

Apple	0.1*
Potato	0.5
Maize grain	0.1*
Foodstuff of Animal Origin Milk	0.1*
Eggs of poultry	0.1*
Meat of poultry	0.1*
Meat of ruminant	0.1*
Fat of poultry	0.1*
Fat of ruminant	0.1*
Liver of ruminant	2.0
Kidney of ruminant	1.0

*) LOQ

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.5: Fate and Behaviour in the Environment

Route of degradation (aerobic) in soil (Annex IIA, point 7.1.1.1.1)

Mineralization after 100 days ‡	20 – 62% after 120 days (n=7)
Non-extractable residues after 100 days ‡	11 - 38% at 120 days (n=7)
Relevant metabolites ‡ - name and/or code, % of applied (range and maximum)	3-methylphosphinico propionic acid (**MPP**) (at 20°C, max 47% after 7 days) 2-methylphosphinico acetic acid (**MPA**) (at 20°C, max 26% after 14 days)

Route of degradation in soil - Supplemental studies (Annex IIA, point 7.1.1.1.2)

Anaerobic degradation ‡	Slower degradation at anaerobic conditions compared to aerobic studies. No major metabolites observed.
Soil photolysis ‡	Essentially no degradation over equivalent of 32 days outdoor conditions (sterile soil conditions)

Rate of degradation in soil (Annex IIA, point 7.1.1.2, Annex IIIA, point 9.1.1)

Method of calculation	First order kinetics
Laboratory studies ‡ (range or median, with n value, with r^2 value)	DT_{50lab} (corrected to 20 °C, aerobic, 1st order): Glufosinate: n=10, range 6 - 11 days, mean 7.8, median 7.4 d, r^2>0.7 MPP (AE F061517) (20 °C, aerobic, 1st order): Studies with MPP as parent: n=6, range 6.1 - 14 days, mean 10, median 8.5 d , r^2>0.7 Studies with Glufosinate as parent: n=5, range 13 – 24 days, mean 18, median 17.5 d, r^2>0.7 MPA (AE F064619) (20 °C, aerobic, 1st order): Studies with MPA as parent: n=4, range 8.1 - 23 days, mean 13, median 9 d, r^2>0.90 Studies with MPP as parent: n=2, 28 and 50 days, mean 39, median 39, r^2>0.90 Studies with glufosinate as parent: n=2, 17 and 18 days, mean 17.5, median 20, r^2>0.90 NAG (AE F099730) (20 °C, aerobic, 1st order): Study with NAG as parent: n=2., 0.5 and 1.0 days, mean 0.75, median 0.75, r^2>0.7
	DT_{90lab} (corrected to 20°C, aerobic)*: Glufosinate only, n=10, range 19 - 35 days, mean 25 d, median 24 d, r^2>0.7

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

	DT_{50lab} (10°C, aerobic): GA only, n=1, 18 days, r^2>0.99
	DT_{50lab} (20°C, anaerobic): >125 days (study duration) at 20°C
	Degradation in the saturated zone: was not investigated, not required.
Field studies ‡ (state location, range or median with n value)	DT_{50f}:field dissipation studies not required DT_{90f}: field dissipation studies not required
Soil accumulation and plateau concentration ‡	Soil accumulation study not required

Soil adsorption/desorption (Annex IIA, point 7.1.2)

K_f /K_{oc} ‡ K_d ‡ pH dependence ‡ (yes / no) (if yes type of dependence)	The K_f values of glufosinate from the upper soil layers generally ranged from 0.2 – 3.4 (n=15), with one outlier of K_f=10. Mean 2.3. The range of 1/n was 0.77 – 1.0, mean 0.93. The K_f values of MPP were 0.16 – 1.1 (n=6), mean 0.54. The range of 1/n was 0.71 – 0.97, mean 0.86. The K_f values of MPA were 0.22 – 22 (n=6), mean 5.4. The range of 1/n was 0.85 – 0.98, mean 0.90. There was no correlation between the sorption coefficients (K_f-values) of glufosinate or metabolites MPP and MPA and the organic carbon content of the test soils. Therefore, it is not pertinent to calculate a K_{oc}-value. Experiments with pure clay minerals indicated that the sorption of glufosinate was correlated to the clay content of the soil. For the metabolites MPP and MPA, partly due to fewer data, the correlation was more uncertain. For glufosinate, based on n = 56 sorption values (top soil and deeper soil layers), the majority of the values fit the regression: K_f(GA) = 0.136 x %clay with the correlation r^2 = 0.67. For MPP, correlation with the clay content of the soils was found resulting in the regression K_f = 0.048 x %clay + 0.2 with r^2 = 0.51. For MPA, the best correlation of the K_f-value was found with the pH-value and the clay fraction yielding the equation: K_f = 0.165 x %clay – 1.57 pH + 9.8 with r^2 = 0.93.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Mobility in soil (Annex IIA, point 7.1.3, Annex IIIA, point 9.1.2)

Column leaching ‡	No data required.
Aged residues leaching ‡	No data required.
Lysimeter/ field leaching studies ‡	Two lysimeters with sandy loam and silt loam soils in Germany. Lysimeter surface area 0.8 m^2 and 1.2-1.3 m depth. Two applications the first two years; 1.5+1.0 kg as/ha to vines in May 1987. Rainfall 660-750 mm/year. Terminated after 3 years. LOD = 0.05 µg/L Results: No detectable amount active substance or metabolite in leachate in any of the lysimeters. Field leaching study with two spring applications of 0.8 kg as/ha to glufosinate-tolerant maize in Germany. Annual precipitaion (rainfall+irrigation) was >800 mm. LOQ 0.05 µg/L. Results: No residues of glufosinate and its metabolites were found in the soil profile after half a year, generally no leaching of the test substance below a level of 30 cm was detected. Field leaching study with autumn and spring applications of 0.8 kg as/ha to glufosinate-tolerant oilseed rape in UK. Annual precipitaion (rainfall+irrigation) was >800 mm. Vertical suction samplers. LOQ 0.05 µg/L. Results: Glufosinate and MPP recovered in soil water at 120 cm depth at maximum concentrations of 0.11 and 26 µg/L, respectively, and at 150 cm depth <0.1 and 3.8 µg/L, respectively. MPA less mobile than GA and MPP. The annual average concentrations are <0.1 µg/L for GA and above 0.1 µg/L but <0.75 µg/L g/L for MPP at 150 cm depth. Field leaching study with autumn and spring applications of 0.8 kg as/ha to glufosinate-tolerant oilseed rape in Germany. Annual precipitation (rainfall+irrigation) was >800 mm. Horizontal suction samplers. LOQ 0.05 µg/L Results: No glufosinate or MPA found as >0.1µg/L below 30 cm depth. MPP found occasionally above 0.05 µg/L at 120 cm depth, but annual mean clearly <0.1 µg/L.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

PEC (soil) (Annex IIIA, point 9.1.3)

Parent

Method of calculation	First order kinetics based on a DT50 of 11 days (corrected to 20°C) for glufosinate, 22 days for MPP, 21 days for MPA. Correction for molecular weight.
Application rate	1.5 + 1.0 kg a.s./ha, 30 day application interval, 0% interception

PEC$_{(s)}$	Days after maximum	PEC glufosinate (mg/kg dw)		PEC MPP (mg/kg dw)		PEC MPA (mg/kg dw)	
		Actual	TWA	Actual	TWA	Actual	TWA
Initial	0	2.0	-	0.72	-	0.36	-
	1	1.9	1.9	0.70	0.71	0.35	0.36
	2	1.8	1.9	0.68	0.70	0.34	0.35
	4	1.6	1.8	0.64	0.68	0.32	0.34
	7	1.3	1.6	0.58	0.65	0.29	0.32
	14	0.83	1.3	0.46	0.58	0.23	0.29
	28	0.34	0.94	0.30	0.48	0.14	0.24
	50	0.09	0.61	0.15	0.36	0.07	0.18
	100	0.004	0.32	0.03	0.22	0.01	0.11

Route and rate of degradation in water (Annex IIA, point 7.2.1)

Hydrolysis of active substance and relevant metabolites ‡ (DT_{50}) (state pH and temperature)	pH 5: Glufosinate stable at 25 ºC (DT_{50} > 300 days)
	pH 7: Glufosinate stable at 25 ºC (DT_{50} > 300 days)
	pH 9: Glufosinate stable at 25 ºC (DT_{50} > 300 days)
Photolytic degradation of active substance and relevant metabolites ‡	Glufosinate is stable to aqueous photolysis at pH 5 to 9
Readily biodegradable ‡ (yes/no)	No data available
Degradation in water/sediment - DT_{50} water ‡ - DT_{90} water ‡ - DT_{50} whole system ‡ - DT_{90} whole system ‡	Glufosinate: range 1.4 – 13 days at 20º C (n=3) MPP: ca 150 days at 20º C (n=2) No data on other metabolites Glufosinate: range 5 - 44 days at 20º C (n=3) MPP: >>150 days at 20º C (n=2) No data on other metabolites Glufosinate: range 2 – 11 days at 20º C (n=3) MPP: >200 days at 20º C (n=2)

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

	No data on other metabolites Glufosinate: range 5 – 34 days at 20° C (n=3) MPP: >200 days at 20° C (n=2) No data on other metabolites
Mineralization	range 7 – 17% after 130 days (n=3)
Non-extractable residues	Generally less than 10% during the study period
Distribution in water / sediment systems (active substance) ‡	Predominantly in water phase; maximum 13% of applied radioactivity found as glufosinate in sediment during the first week of incubation.
Distribution in water / sediment systems (metabolites) ‡	MPP may reach a maximum of 46% of applied in the sediment. No other metabolites >10% in the sediment.

PEC (surface water) (Annex IIIA, point 9.2.3)

Parent and metabolite MPP

Method of calculation	First order kinetics based on a DT_{50} of 13 days for glufosinate, 150 days for MPP. For other metabolites, initial PEC only, based on maximum amounts found in water/sediment systems (MPP 80%, MPA 17%, MPF 22%, P-X 12%, NAG 12% of applied, correction for molecular weight).
Application rate	1.5 + 1.0 kg a.s./ha, 30 days application interval, 0% crop interception.
Main routes of entry	Spray drift (Rautmann, 2001) + runoff. 0.5% of the hectare dose, field:water ratio 10:1. Depth of water body 0.3 m.

PEC$_{(sw)}$	Glufosinate Actual (mg/L)	Glufosinate Time weighted average (mg/L)	Metabolite MPP Actual (mg/L)	Metabolite MPP Time weighted average (mg/L)
Initial*	0.039	-	0.024	-
Short term				
2 days	0.035	0.037	0.024	0.024
4 days	0.032	0.035	0.024	0.024
7 days	0.027	0.033	0.023	0.024
Long term				
14 days	0.018	0.027	0.022	0.023
21 days	0.013	0.023	0.022	0.023
28 days	0.009	0.020	0.021	0.022

*maximum concentration after the first application.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

$PEC_{(sw)}$	Metabolite MPA (mg/L)	Metabolite MPF (mg/L)	Metabolite P-X (mg/L)	Metabolite NAG (mg/L)
Maximum	0.0046	0.0054	0.0035	0.0053

SL14 and SL18 formulations (expressed as active ingredient)

Method of calculation	First order kinetics based on a DT_{50} of 13 days for the formulations.
Application rate	Maximum single application, 1.5 kg a.s./ha, 0% crop interception.
Main routes of entry	Spray drift only, 2.8% of the hectare dose.

$PEC_{(sw)}$ (µg / l)	Single application Actual	Single application Time weighted average	Multiple application Actual	Multiple application Time weighted average
Initial	0.015	-		
Short term				
2d	0.014	0.014		
4d	0.012	0.014		
7d	0.011	0.013		
Long term				
14d	0.007	0.011		
21d	0.005	0.009		
28d	0.003	0.008		

PEC (sediment)

Parent

Method of calculation	Initial values only, based on maximum amount 13% of glufosinate partitioned to sediment in one water/sediment system. For MPP, a maximum amount of 46% is assumed. Assumptions: 0.3 m deep water body at a distance of 1 m from the target crop, and an assumption of 13% in the sediment is used. Maximum concentration in the 0 - 5 cm sediment layer (bulk density of sediment 0.8 g/cm^3).
Application rate	1.5 + 1.0 kg a.s./ha, 30 day application interval, 0% interception

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Main routes of entry	Spray drift (Rautmann, 2001) + runoff. 0.5% of the hectare dose, field:water ratio 10:1. Depth of water body 0.3 m.

PEC$_{(sed)}$	Glufosinate Actual (mg/kg ww) / (mg/L)	Glufosinate Time weighted average (mg/kg ww)	MPP Actual (mg/kg ww) / (mg/L)	MPP Time weighted average (mg/kg ww)
Maximum	0.03/0.02	-	0.18/0.14	-

PEC (ground water) (Annex IIIA, point 9.2.1)

Method of calculation and type of study (*e.g.* modelling, monitoring, lysimeter)	Modelling with PELMO version 1.1.1; FOCUS scenarios and laboratory data Lysimeter study (spring + early autumn application) Field leaching study, oilseed rape crop scenario
Application rate	(2 x 0.8 kg/ha) to (1.5 + 1.0 kg/ha)
PEC$_{(gw)}$	
Maximum concentration	Glufosinate and MPA < 0.1 µg/L in FOCUS simulations, MPP ca 0.5 µg/L in one scenario (Jokioinen) Field leaching study in UK oilseed rape, autumn + spring application (2 x 0.8 kg/ha): Glufosinate max 5.5 µg/L at 75 cm depth MPP max 56 µg/L at 75 cm depth, 3.8 µg/L at 150 cm (mean concentrations of MPP over the two year study exceeded 0.1 µg/L for one of the five replicate samplers) MPA max 0.76 µg/L at 75 cm depth Annual average <0.1 ug/L for GA and MPA, <0.75 ug/L for MPP. New study available early 2003: Field leaching study in Germany oilseed rape, autumn + spring application (2 x 0.8 kg/ha): Glufosinate <0.1 µg/L below 30 cm depth MPP max 0.12 µg/L at 120 cm depth (one sample out of five >0.1 µg/L), <LOQ at 150 cm. Annual average of MPP <0.1 µg/L. MPA <0.1 µg/L below 30 cm depth

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Average annual concentration (Results quoted for modelling with FOCUS gw scenarios, according to FOCUS guidance)	80%ile of the annual averages < 0.1 µg/L in FOCUS simulations for parent and metabolites, except for MPP in Jokioinen (ca 0.5 µg/L). Supported by field data. Agreed during the Peer Review that the realistic worst case annual average for MPP is >0.1 µg/L but <0.75 µg/L from field study in UK.

Fate and behaviour in air (Annex IIA, point 7.2.2, Annex III, point 9.3)

Direct photolysis in air ‡	Not required; vapour pressure of product low
Quantum yield of direct phototransformation	Zero.
Photochemical oxidative degradation in air ‡	Standard Atkinson calculation: DT_{50} = 0.5 days. (European scenario with 106 radicals/m³ and a time frame of 24 hours/day)
Volatilization ‡	from plant surfaces: not expected due to low v.p. from soil: not expected due to low v.p.

PEC (air)

Method of calculation	Not relevant.

$PEC_{(a)}$

Maximum concentration	Not calculated. Low vapour pressure.

Definition of the Residue (Annex IIA, point 7.3)

Relevant to the environment	Soil: Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid (MPP) and 2-methylphosphonico-acetic acid (MPA), L-2-acetamido-4-methylphosphinato-butyric acid (NAG) and their salts. Definitions for monitoring: Glufosinate and their salts expressed as glufosinate free acid equivalents. Surface water: Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid (MPP), 2-methylphosphonico-acetic acid (MPA) and methylphosphinico-formic acid (P-Y = MPF) and their salts. Definitions for monitoring: Sum of glufosinate, 3-methylphosphonico-propionic acid (MPP) and their salts expressed as glufosinate free acid equivalents (3-methylphosphonico-propionic acid is pending on further data and it is expected to be removed from the residue

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

	definition for monitoring if low risk is confirmed by these data). Sediment: Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid and their salts. Groundwater: Definitions for risk assessment: Glufosinate, 3-methylphosphonico-propionic acid (MPP) and 2-methylphosphonico-acetic acid (MPA) and their salts. Definitions for monitoring: Sum of glufosinate and their salts expressed as glufosinate free acid equivalents. Air: Definitions for risk assessment: Sum of glufosinate and their salts. Definitions for monitoring: Sum of glufosinate and their salts expressed as glufosinate free acid equivalents.

Monitoring data, if available (Annex IIA, point 7.4)

Soil (indicate location and type of study)	No data submitted.
Surface water (indicate location and type of study)	No data submitted.
Ground water (indicate location and type of study)	National regional monitoring in France, Burgundy region. Ongoing program. No residues of Glufosinate found in ground water. Limited value.
Air (indicate location and type of study)	Not data submitted.

Classification and proposed labelling (Annex IIA, point 10)

with regard to fate and behaviour data	None

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.6: Effects on non-target Species

Effects on terrestrial vertebrates (Annex IIA, point 8.1, Annex IIIA, points 10.1 and 10.3)

Acute toxicity to mammals ‡	Moderate, LD 50 mouse 416 mg/kg bw (most sensitive relevant species)
Acute toxicity to birds ‡	LD_{50} >2000 mg/kg bw on 4 species
Dietary toxicity to birds ‡	LC_{50} 1100 mg/kg bw day for bobwhite quail
Reproductive toxicity to mammals ‡	NOAEL 6.3 mg as/kg bw day for rabbit (developmental study)
Reproductive toxicity to birds ‡	NOAEL 122 mg as/kg bw day for bobwhite quail

Toxicity/exposure ratios for terrestrial vertebrates (Annex IIIA, points 10.1 and 10.3)

Application rate (kg as/ha)	Crop	Category (*e.g.* insectivorous bird)	Time-scale	TER	Annex VI Trigger
1.5	apple orchard	large sized herbiv. bird	acute	>54	10
1.5	apple orchard	medium sized omnivore bird	acute	>182	
0.8	GMO maize	medium sized herbiv. bird	acute	>27	10
0.8	GMO maize	small insectivorous bird	acute	>47	10
0.6	potatoes	medium herbivorous bird	acute	>100	10
0.6	potatoes	small insectivorous bird	acute	>63	10
1.5	apple orchard	large sized herbiv. bird	short term	30	10
1.5	apple orchard	medium sized omnivore bird	short term	117	10
0.8	GMO maize	medium sized herbiv. bird	short term	32	10
0.8	GMO maize	small insectivorous bird	short term	46	10
0.6	potatoes	medium herbivorous bird	short term	121	10
0.6	potatoes	small insectivorous bird	short term	61	10
1.5	apple orchard	large sized herbiv. bird	long term	14	5
1.5	apple orchard	medium sized omnivore bird	long term	42	10
0.8	GMO maize	medium sized herbiv. bird	long term	8.7	5
0.8	GMO maize	small insectivorous bird	long term	5.1	5
0.6	potatoes	medium herbivorous bird	long term	55	5
0.6	potatoes	small insectivorous bird	long term	6.8	5
1.5	apple orchard	small herbivorous mammal	acute	3.5	10

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Application rate (kg as/ha)	Crop	Category (*e.g.* insectivorous bird)	Time-scale	TER	Annex VI Trigger
0.8	GMO maize	medium sized herbiv. mammal	acute	15	10
0.6	potatoes	medium herbivorous mammal	acute	57	10
0.6	potatoes	insectivorous mammal	acute	157	10
1.5	apple orchard	small herbivorous mammal	long term	0.13	5
0.8	GMO maize	medium sized herbiv. mammal	long term	0.86	5
0.6	potatoes	medium herbivorous mammal	long term	4.5*	5
0.6	potatoes	insectivorous mammal	long term	3.25	5

*the scenarios are considered acceptable; the assumption of 100% of the diet obtained from the treated field is considered as an extreme worst case, since potato leaves are not attractive as food.

Toxicity data for aquatic species (most sensitive species of each group) (Annex IIA, point 8.2, Annex IIIA, point 10.2)

Group	Test substance	Time-scale	Endpoint	Toxicity (mg/l)
Laboratory tests ‡				
Oncorhynchus mykiss (rainbow trout)	glufosinate-ammonium	96 hours	LC50	710
Oncorhynchus mykiss (rainbow trout)	glufosinate-ammonium	21 days	NOEC	100
Daphnia magna (water flea)	glufosinate-ammonium	48 hours	EC50	668
Daphnia magna (water flea)	glufosinate-ammonium	21 days	NOEC	18
Mysidopsis bahia (mysid shrimp)	glufosinate-ammonium	48 hours	EC50 NOEC	7.5 0.75**
Pseudokirchneriella subcapitata (green alga)	glufosinate-ammonium	72 hours	ErC50 / EbC50 NOEC	>80/5.0 2.5
Lemna gibba (higher aquatic plant)	glufosinate-ammonium	14 days	EbC50 NOEC	1.5 0.8
Oncorhynchus mykiss (rainbow trout)	MPP	96 hours	LC50	>100
Oncorhynchus mykiss (rainbow trout)	MPP	28 days	NOEC	21

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Group	Test substance	Time-scale	Endpoint	Toxicity (mg/l)
Daphnia magna (water flea)	MPP	48 hours	EC50	>100
Daphnia magna (water flea)	MPP	28 days	EC5 /EC10	1.3/2.1*
Scenedesmus subspicatus (green alga)	MPP	72 hours	ErC50 / EbC50 NOEC	>1000 1000
Lemna gibba (higher aquatic plant)	MPP	7 days	ErC50 / EbC50 NOEC	>78 78
Oncorhynchus mykiss (rainbow trout)	MPA	96 hours	LC50	>76
Daphnia magna (water flea)	MPA	48 hours	EC50	911
Scenedesmus subspicatus (green alga)	MPA	72 hours	ErC50 / EbC50 NOEC	>180/69 18
Lemna gibba (higher aquatic plant)	MPA	7 days	ErC50 / EbC50 NOEC	>76 76
Oncorhynchus mykiss (rainbow trout)	NAG	96 hours	LC50	84
Daphnia magna (water flea)	NAG	48 hours	EC50	>298
Scenedesmus subspicatus (green alga)	NAG	72 hours	ErC50 / EbC50 NOEC	>277 277
Lemna gibba (higher aquatic plant)	NAG	7 days	ErC50 NOEC	No data
Oncorhynchus mykiss (rainbow trout)	MPF	96 hours	LC50	>78
Daphnia magna (water flea)	MPF	48 hours	EC50	>74
Pseudokirchneriella subcapitata (green alga)	MPF	96 hours	ErC50 / EbC50 NOEC	>74 74
Lemna gibba (higher aquatic plant)	MPF	7 days	ErC50 NOEC	No data
Oncorhynchus mykiss (rainbow trout)	SL18	96 hours	LC50	1.9***
Cyprinodon variegatus (sheepshead minnow)	SL14	96 hours	LC50	2.6***
Oncorhynchus mykiss (rainbow trout)	SL18 / SL14	21 days/28 days	NOEC	0.09/ 0.11***
Daphnia magna (water flea)	SL18 / SL14	48 hours	EC50	2.7 / 2.5***
Daphnia magna (water flea)	SL18 / SL14	21 days	NOEC	0.59 / 0.42***

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Group	Test substance	Time-scale	Endpoint	Toxicity (mg/l)
Scenedesmus subspicata (green alga)	SL18	72 hours	ErC50 / EbC50 NOEC	11-19/ 6.8*** 6.1/1.9
Pseudokirchneriella subcapitata (green alga)	SL14	96 hours	ErC50 / EbC50 NOEC	8.9/7.4*** 4.5
Lemna gibba (higher aquatic plant)	SL18	7 days	ErC50 / EbC50 NOEC	2.3/1.8*** 0.57
Lemna gibba (higher aquatic plant)	SL14	7 days	ErC50 / EbC50 NOEC	1.7/1.3*** 0.42

Microcosm or mesocosm tests
As the acute and long-term toxicity exposure values are above 100 and 10, microcosm or mesocosm studies are not necessary. Data from literature with outdoor testing confirm this assumption.

* extrapolated value, less reliable, confirmatory data requirement for new study
** estimated value, assessment factor 10 for long term effects.
*** values are expressed as content of active ingredient.

Toxicity/exposure ratios for the most sensitive aquatic organisms (Annex IIIA, point 10.2)

Calculations based on predicted initial aquatic concentrations after the worst case application rate of 1.5 + 1.0 kg as/ha, 30 days interval between treatments. TER values based on initial concentrations. Aquatic half-life of GA 13 days, MPP 150 days.

Application rate (kg as/ha)	Crop	Organism	Time-scale	Distance (m)	TER	Annex VI Trigger
1.5 + 1.0	apple orchard	Fish, GA	short term	1**	18200	100
30 days interval		Fish, GA	long term	1**	2564	10
		Fish, MPP	short term	1**	4170	100
		Fish, MPP	long term	1**	875	10
		Fish, MPA	short term	1**	16500	100
		Fish, NAG	short term	1**	2333	100
		Fish, MPF	short term	1**	14400	100
		Fish, SL18	short term	1*	127	100
		Fish, SL18	long term	1*	14	10
		Fish, SL14	short term	1*	173	100
		Fish, SL14	long term	1*	11	10
	apple orchard	Daphnia, GA	short term	1**	17100	100
		Daphnia, GA	long term	1**	461	10

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Application rate (kg as/ha)	Crop	Organism	Time-scale	Distance (m)	TER	Annex VI Trigger
		Mysidopsis, GA	short term	1***	192	100
		Mysidopsis, GA	long term	1***	19	10
		Daphnia, MPP	short term	1**	1750	100
		Daphnia, MPP	long term	1**	88	10
		Daphnia, MPA	short term	1**	19800	100
		Daphnia, NAG	short term	1**	8278	100
		Daphnia, MPF	short term	1**	13700	100
		Daphnia, SL18	short term	1*	167	100
		Daphnia, SL18	long term	1*	47	10
		Daphnia, SL14	short term	1*	180	100
		Daphnia, SL14	long term	1*	66	10
	apple orchard	Algae, GA	short term	1**	2050	10
		Algae, GA	long term	1**	64	-
		Algae, MPP	short term	1**	41600	10
		Algae, MPP	long term	1**	41600	-
		Algae, MPA	short term	1**	39130	10
		Algae, MPA	long term	1**	3910	-
		Algae, NAG	short term	1**	7690	10
		Algae, NAG	long term	1**	7690	-
		Algae, MPF	short term	1**	13700	10
		Algae, MPF	long term	1**	13900	-
		Algae, SL18	short term	1*	593	10
		Algae, SL14	short term	1*	467	10
	apple orchard	Lemna, GA	short term	1***	38	10
		Lemna, GA	long term	1***	20	-
		Lemna, MPP	short term	1**	3250	10
		Lemna, MPP	long term	1**	3250	-
		Lemna, MPA	short term	1**	16500	10
		Lemna, MPA	long term	1**	16500	-

*for formulated products, spray drift only was considered as exposure route to surface water.
**based on Step 1 exposure assessment, spray drift and runoff/drainage included.
***based on Step 2 exposure assessment, spray drift and runoff/drainage included.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Bioconcentration

Bioconcentration factor (BCF) ‡	Study not triggered, since log Pow < 3 for both parent compound and metabolites. Nevertheless a study is available and presented. BCF < 1.
Annex VI Trigger:for the bioconcentration factor	1000 for readily biodegradable substances 100 for not readily biodegradable substances
Clearance time (CT_{50}) (CT_{90})	Rapid elimination of GA and degradation products in 24 hours. Kinetic parameter cannot be calculated.
Level of residues (%) in organisms after the 14 day depuration phase	Total radioactive residues < 0.01 mg/kg.

Effects on honeybees (Annex IIA, point 8.3.1, Annex IIIA, point 10.4)

Acute oral toxicity ‡	> 600 µg as/bee in studies with active ingredient 46 µg as/bee in studies with SL14 >100 µg as/bee in studies with SL18
Acute contact toxicity ‡	> 345 µg as/bee in studies with the active ingredient 154 µg as/bee in studies with SL14 >100 µg as/bee in studies with SL18

Hazard quotients for honey bees (Annex IIIA, point 10.4)

Application rate (kg as/ha)	Crop	Route	Hazard quotient	Annex VI Trigger
Laboratory tests				
Basta SL18/Basta SL14				
1.5/1.125	apple orchard	Oral	< 15/24.5	50
1.5/1.125	apple orchard	Contact	< 15/7.3	50
Liberty SL18				
0.8	GMO maize	Oral	< 8.0	50
0.8	GMO maize	Contact	< 8.0	50
Basta SL18/Basta SL14				
0.6/0.45	Potatoes	Oral	< 6/9.8	50
0.6/0.45	Potatoes	Contact	< 6/2.9	50

Field or semi-field tests
As the hazard quotients for the contact and the oral exposure QHC and QHO to the formulated products are less than 50, further tests are not required.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Effects on other arthropod species (Annex IIA, point 8.3.2, Annex IIIA, point 10.5)

Species	Stage	Test Substance	Dose (kg as/ha)	Endpoint	Effect	Annex VI Trigger
Laboratory tests ‡						
Aphidius rhopalosiphi	adults	SL18	0.6, 1.6, 2.5	mortality	at all rates: 100% mortality	30 %
Typhlodro-mus pyri	adults	SL18	0.6, 1.6, 2.5	mortality	at all rates: 100% mortality	30 %
Typhlodro-mus pyri	proto-nymphs	SL18	five doses	reproduction	LR_{50}: 0.3 g as/ha	-
Pardosa spp.	adults	SL18	0.6, 1.6, 2.5	mortality, reproduction	at all rates: 100% mortality	30 %
Chrysoperla carnea	larvae	SL18	0.6, 1.6, 2.5	mortality, reproduction	at all rates: >97% mortality	30 %
Chrysoperla carnea	larvae	SL18	0.04 0.008	mortality, reproduction	no significant effects	30 %
Poecilus cupreus	adults	SL18	0.6, 1.6, 2.5	condition, feeding activity	at all rates: 0% mortality	30 %
Aleochara bilineata	adults	SL18	0.6 1.6 2.5	parasitisation rate	25% 58% 65% red.of paras. rate	30 %

*: The same series of laboratory studies was conducted with the SL14 preparation, showing similar results.

Species	Stage	Test substance	Dose (kg as/ha)	Endpoint	Effect		Annex VI Trigger
extended laboratory tests ‡							
Aphidius rhopalosiphi	adults	SL18	0.04 0.06 0.75 0.125 0.8	mortality, parasitisation	corr. mortality 0 0 0 65 100	parasit. rate (%) 96 71 29 4 -	30 %

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Species	Stage	Test substance	Dose (kg as/ha)	Endpoint	Effect		Annex VI Trigger
Aphidius rhopalosiphi	adults	SL14	0.03 0.045 0.56 0.094 0.6 0.9	mortality, parasitisation	corr. mortality 10 15 75 80 100 100	parasit. rate (%) 51 24 2 - - -	30 %
Hypoaspis aculeifer	proto-nymphs	SL18	0.007 0.014 0.04 0.07 0.7 1.4	juvenile mortality, egg production	% mortality 0 -7.8 9.8 -5.9 -5.9 29		30 %
Hypoaspis aculeifer	proto-nymphs	SL14	0.005 0.01 0.03 0.05 0.5 1.0	juvenile mortality, egg production	% mortality 38 38 5 31 18 9		30 %
Typhlodromus pyri	adults, natural substrate	SL18	five doses	mortality	LR_{50}: 1.42 g as/ha		-
Typhlodromus pyri	adults, natural substrate aged residues	SL18	16.6 22.2	mortality, fecundity	75 - 83% mortality from exposure of residues up to 1 week after treatment. 11-13% mortality from exposure of residues at 3 weeks after treatment.		-
semi-field tests							
Typhlodo-mus pyri	adults	SL18	0.04 0.075 0.8	mortality	at all rates: 100% mortality		30 %
Typhlodromus pyri	adults	SL14	0.03 0.056 0.6	mortality	at all rates: 100% mortality		30 %

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Species	Stage	Test substance	Dose (kg as/ha)	Endpoint	Effect		Annex VI Trigger
Pardosa spp *:interval 10 days	adults	SL18	 0.04 0.04 + 0.04* 0.075 0.075 + 0.05* 0.8 0.8 + 0.8* 1.5 1.5 + 1	mortality	% mortality 14 10 21 21 76 91 100 86		30 %
Pardosa spp *:interval 10 days	adults	SL14	 0.03 0.02 + 0.02* 0.056 0.056+0.038* 0.6 0.45 + 0.45* 1.1 1.1 + 0.8*	mortality	% mortality 17 34 61 49 95 88 90 90		30 %
Chrysoperla carnea *:interval 13 days	larvae	SL18	 0.04 0.04 + 0.04* 0.075 0.075 + 0.05* 0.8 0.8 + 0.8* 1.5 1.5 + 1*	mortality, fecundity	Corr. mort. (%) 20 9 58 58 64 67 84 69	red. of c. repro (%) 6.3 54 49 40 79 77 55 77	30 %
Chrysoperla carnea *:interval 10 days	larvae	SL14	 0.03 0.02 + 0.02* 0.056 0.056 + 0.04* 0.6 0.45 + 0.45* 1.1 1.1 + 0.8*	mortality, fecundity	Corr. mort. (%) 38 21 61 59 66 74 89 77	red. of c. repro (%) 0 35 63 80 85 45 77 78	30 %

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Species	Stage	Test substance	Dose (kg as/ha)	Endpoint	Effect		Annex VI Trigger
Orius laevigatus *:interval 10 days	nymphs	SL18	 0.04 0.03 + 0.03* 0.075 0.075 + 0.05* 0.8 0.6 + 0.6* 1.5 1.5 + 1*	mortality	Corr. mort. (%) 22 12 28 15 12 27 21 16	red. of c. repro (%) 23 52 38 14 30 34 23 34	30 %
Orius laevigatus *:interval 10 days	nymphs	SL14	 0.03 0.02 + 0.02* 0.056 0.056 + 0.04* 0.6 0.45 + 0.45* 1.1 1.1 + 0.8*	mortality	Corr. mort. (%) 22 12 28 15 12 27 21 16	red. of c. repro (%) 23 52 38 14 30 34 23 34	30 %
Typhlodro-mus pyri	proto-nymphs	SL18	1500 g as/ha sprayed on the ground. Exposure to apple leaves detached after 1 day.	mortality after exposure to dried residues on the leaves for 7 days.	35% mortality statistically different from control. Lower mortality in the toxic reference.		-

Field tests

The results from Oellrich et al, 2000a, performed under realistic worst case conditions for the transgenic maize scenario, indicate that the treatments with Liberty SL18 at 2 x 0.8 kg as/ha will cause effects on a number of non-target arthropod species in the treated field. For the majority of the affected species, however, recovery can be expected in a few weeks. For the dominant species of leaf-dwelling spiders, time to recovery was longer, 2 – 3 months. Also in supplementary studies, spiders were shown to be a sensitive group. In a study with autumn treatment with Liberty, the effects remained until the next season. The most sensitive species from laboratory data, predatory mites, were not included in the field studies.

Field test in orchards is ongoing (Bakker, 2004), submitted in December 2005, not evaluated.

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

Effects on earthworms (Annex IIA, point 8.4, Annex IIIA, point 10.6)

Acute toxicity ‡	14 days LC50 >1000 mg/kg dw for a.s. 14 days LC50 >1000 mg/kg dw for MPP 14 days LC50 >760 mg/kg dw for MPA 14 days LC50 >300 mg/kg dw for NAG 14 days LC50 >1000 mg formulation/kg dw for Basta SL18 14 days LC50 >1000 mg formulation/kg dw for Basta SL14
Reproductive toxicity ‡	Not required.

Toxicity/exposure ratios for earthworms (Annex IIIA, point 10.6)

Application rate (kg as/ha)	Crop	Time-scale	TER	Annex VI Trigger
1.5 + 1.0 30 days interval	apple orchard	14 days	>500 for GA >1390 for MPP >2110 for MPA	10 10 10
0.8 + 0.8 10 days interval	GMO maize	14 days	>625 for GA >1750 for MPP >2620 for MPA >166 for NAG	10 10 10 10
0.6	potatoes	14 days	>1250 for GA >3450 for MPP >5430 for MPA	10 10 10

Effects on soil micro-organisms (Annex IIA, point 8.5, Annex IIIA, point 10.7)

Nitrogen mineralization ‡	Less than 25% effect for parent and metabolites at 1x field rate. Only transient effects at appr. 10 x field rate.
Carbon mineralization ‡	Less than 25% effect for parent and metabolites at 1x field rate. Only transient effects at appr. 10 x field rate.

Classification and proposed labelling (Annex IIA, point 10)

with regard to ecotoxicological data	None

‡ Endpoint identified by the EU-Commission as relevant for Member States when applying the Uniform Principles

APPENDIX 2 – ABBREVIATIONS USED IN THE LIST OF ENDPOINTS

ADI	acceptable daily intake
AOEL	acceptable operator exposure level
ARfD	acute reference dose
a.s.	active substance
bw	body weight
CA	Chemical Abstracts
CAS	Chemical Abstracts Service
CIPAC	Collaborative International Pesticides Analytical Council Limited
d	day
DAR	draft assessment report
DM	dry matter
DT_{50}	period required for 50 percent degradation / dissipation
DT_{90}	period required for 90 percent degradation / dissipation
ε	decadic molar extinction coefficient
EC_{50}	effective concentration, median
EEC	European Economic Community
EINECS	European Inventory of Existing Commercial Chemical Substances
ELINCS	European List of New Chemical Substances
EMDI	estimated maximum daily intake
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FOCUS	Forum for the Co-ordination of Pesticide Fate Models and their Use
GAP	good agricultural practice
GCPF	Global Crop Protection Federation (formerly known as GIFAP)
GS	growth stage
h	hour(s)
ha	hectare
hL	hectolitre
HPLC	high performance liquid chromatography or high pressure liquid chromatography
ISO	International Organisation for Standardisation
IUPAC	International Union of Pure and Applied Chemistry
K_{oc}	organic carbon adsorption coefficient
L	litre
LC	liquid chromatography
LC-MS	liquid chromatography-mass spectrometry
LC-MS-MS	liquid chromatography with tandem mass spectrometry
LC_{50}	lethal concentration, median
LD_{50}	lethal dose, median
LOAEL	lowest observable adverse effect level
LOD	limit of detection
LOQ	limit of quantification (determination)
µg	microgram
mN	milli-Newton
MRL	maximum residue limit or level
MS	mass spectrometry
NESTI	national estimated Short Term Intake
NIR	Near-Infrared-(Spectroscopy)
nm	nanometer
NOAEL	no observed adverse effect level

NOEL	no observed effect level
PEC	predicted environmental concentration
PEC_A	predicted environmental concentration in air
PEC_S	predicted environmental concentration in soil
PEC_{SW}	predicted environmental concentration in surface water
PEC_{GW}	predicted environmental concentration in ground water
PHI	pre-harvest interval
pK_a	negative logarithm (to the base 10) of the dissociation constant
PPE	personal protective equipment
ppm	parts per million (10^{-6})
PPP	plant protection product
r^2	coefficient of determination
STMR	supervised trials median residue
TER	toxicity exposure ratio
TMDI	theoretical maximum daily intake
UV	ultraviolet
WHO	World Health Organisation
WG	water dispersible granule
yr	year