HERA
Human and Environmental Risk Assessment
on ingredients of household cleaning products

ABSTRACT FROM PROCEEDINGS OF THE XXXI CED ANNUAL MEETING :

ENVIRONMENTAL RISK ASSESSMENT UNDER HERA: CHALLENGES AND SOLUTIONS

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RESUMEN

La evaluación del riesgo medioambiental en HERA se basa en el Documento Guía Técnica para Substancias Nuevas y Existentes (TGD)[1], que es la base para la evaluación del riesgo medioambiental de substancias químicas en Europa. Uno de los mayores retos en la evaluación del riesgo medioambiental en HERA es el de mejorar la metodología usada en el TGD a la hora de estimar la cantidad de sustancia química que se libera al alcantarillado por uso doméstico, y por tanto llega a los sistemas depuradores posteriormente.

El TGD incluye unas tablas que se usan para el cálculo de una concentración medioambiental "en el peor caso razonable", tanto para la región standard de la Unión Europea como para la planta depuradora local standard. Se proponen tablas correspondientes a diferentes combinaciones de Categorías Industriales (IC) como la categoría 5, Uso Personal y Doméstico, y Categorías de Uso (UC), como la categoría 9, Agentes de Limpieza / lavado y Aditivos. Aunque estas tablas intentan ser conservadoras, el Doc. ECB4/TR2/98[2] recomienda que se deberían usar, si están disponibles, datos de emisiones reales, tanto desde el punto de vista regional como continental, para re-definir los supuestos por defecto contenidos en las tablas.

La solución HERA estima una descarga máxima regional de productos detergentes / limpiadores de uso doméstico en las regiones más densamente pobladas de la UE, proveniente de datos de consumo de producto facilitados por la AISE. Una "regla del 7%" en lugar de una "regla del 10%" representa mejor el caso de emisiones regionales IC5, IC9, que son las que están más directamente conectadas con un uso personal más que con centros de producción o de formulación. Se determina por tanto una estimación, para "el peor de los casos", de la cantidad de ingrediente descargada en la planta depuradora localizada en la región que representa "el peor caso". El TGD asume que esto supondrá 4 veces la descarga media.

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En la solución HERA se están usando datos de descarga experimentales para un ingrediente de un producto detergente representativo, boro, de 50 plantas depuradoras en 4 países de la UE para mostrar que en “el peor caso“ el 90 percentil de las plantas depuradoras recibe menos de 1,5 veces la descarga media regional. Estos factores de descarga experimentales son propuestos para su uso en el TGD IC5, UC9, y se usan en la evaluación de riesgos medioambientales en HERA.

ABSTRACT

The HERA environmental risk assessment is based upon the Technical Guidance Document for New and Existing Substances[1] (TGD), which is the basis for the risk assessment of chemical substances in Europe. One of the major challenges of the HERA environmental risk assessment is to refine the methodology used in the TGD to estimate the amount of a chemical substance released to sewer from use in the home, which then reaches the sewage treatment works.

The TGD includes tables which are used to calculate a “reasonable worst case” environmental concentration, both for the standard EU region, and for the standard local sewage treatment facility. Appropriate tables are proposed for different combinations of Industry Category (IC), such as category 5, Personal and Domestic Use, and Use Category (UC), such as category 9, Cleaning/Washing Agents and Additives. Although these tables are intended to be conservative, Doc. ECB4/TR2/98[2] recommends that real data on regional and continental emissions, if available, should be used to overwrite the default assumptions contained in the tables.

The HERA solution estimates maximum regional release data for ingredients in household cleaning products (IC5, UC9) for the most densely populated EU regions, from product consumption data supplied by AISE. A “7% rule”, rather than a “10% rule”, best represents IC5, UC9 regional emissions, which are directly connected to personal use rather than to a production or formulation facility. The “worst case” estimate for the amount of an ingredient reaching a sewage treatment facility located in this “worst case region” is then determined. The TGD assumes that this will be four times the average release. In the HERA solution, experimental release data for a representative detergent product ingredient, boron, from 50 sewage treatment plants in 4 EU countries is used to show that the 90th percentile “worst case” treatment plant receives less than 1.5 times the regional average load. These experimentally based release factors are proposed for use for the TGD IC5, UC9 release scenario, and are used for the HERA environmental risk assessments.

1. INTRODUCTION

HERA, the Human and Environmental Risk Assessment project, has been established as a voluntary initiative of the European detergent industry and its suppliers and is jointly sponsored by their associations A.I.S.E. and CEFIC. The aim is to provide a more efficient, focussed channel for risk assessment of household detergent and cleaning products, with emphasis on their use in Europe. For this reason the HERA environmental risk assessment is based upon the Technical Guidance Document for New and Existing Substances[1] (TGD), which is the basis for the risk assessment of chemical substances in Europe. One of the major challenges of the HERA environmental risk assessment is to refine the methodology used in the TGD to estimate the amount of a chemical substance released to sewer from use in the home, which then reaches the sewage treatment works.

The TGD defines both a standard EU region, and a standard EU sewage treatment plant which is located within this standard EU region. The amount of a chemical which reaches the local sewage treatment plant is based on the amount of chemical which is released in the standard EU region, as shown in Figure 1.

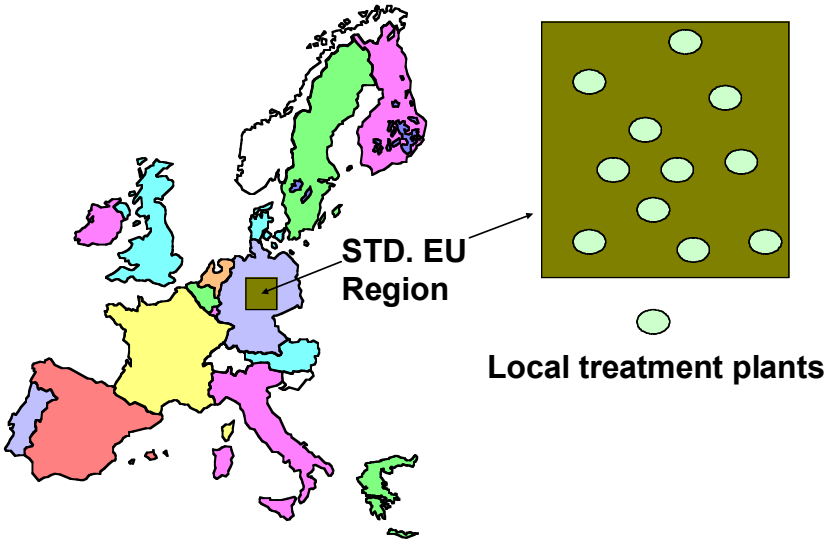

Figure 1. The standard EU local standard sewage treatment plant input load is a multiple of the average load released in the standard EU region.

The TGD proposes conservative default emission scenarios for both regional and local risk assessment of detergent and household cleaning substances.

The regional risk assessment uses the standard EU region, defined as a "densely populated area of 200 x 200 km with 20 million inhabitants" (See Reference 1, EEC, 1996, Part II, Section 2.3.8.7). The population density in this region is 500 people per km^2, which is approximately five times the European average. The number of inhabitants in the region corresponds with 5.4% of the total EU population. However, chemical releases into this region are assumed to be 10% of the total EU tonnage, "unless specific information on use or emission per capita is available" (See Reference 1, EEC, 1996, Part II, Section 2.3.8.7). This increase of the regional tonnage by a factor of 1.85 is done to take into account "reasonable worst case regions" where per capita detergent consumption is assumed to be higher than the EU average.

The TGD default load reaching the standard local sewage treatment plant is increased by a factor of four from the load which would be expected from 10 000 people living in the standard EU region. This is done to allow for variation in the loads reaching specific sewage treatment facilities, and to provide a reasonable worst case sewage treatment plant. The TGD methodology thus multiplies the substance load from a reasonable worst case regional release by the factor of four representing a reasonable worst case sewage treatment plant located in that

region to give a conservative overall calculation of the amount of a substance reaching the sewage treatment facility.

For substances used as ingredients in detergent and household cleaning products, the factors which define release to the standard EU region, and to the standard local sewage treatment facility are tabulated in the TGD. Appropriate tables are proposed for different combinations of Industry Category (IC), such as category 5, Personal and Domestic Use, and Use Category (UC), such as category 9, Cleaning/Washing Agents and Additives. Although these tables are intended to be conservative, a proposed update to the TGD, Doc. ECB4/TR2/98[2], recommends that real data on regional and continental emissions, if available, should be used to overwrite the default assumptions contained in the tables.

HERA has addressed the challenge to provide a more realistic substance release profile for detergent and household cleaning products by assembling information on product release to different areas in Europe. The variation in the amount of substances in detergents and cleaning products which reach sewage treatment plants has also been addressed, by comparison with experimental data. These two results have been combined to provide the HERA detergents scenario, which is described below.

REFINEMENT OF THE REGIONAL RELEASE SCENARIO

The major release pathway for detergents is through use by the population. Thus population density and per capita consumption should be used to calculate the release of detergent ingredients to the regional environment. If the average EU per capita detergent consumption were applied to the population of the standard EU region, only 5.4 % of the EU production tonnage would be released due to personal consumption within this region. Hence, the TGD assumes the per capita consumption in the region is 1.85 times higher than the EU average.

A.I.S.E. detergent product consumption data for European countries are available for 1998 (see Figure 2). These show that the European country with the heaviest per capita detergent consumption has less than 1.3 times the European average per capita detergent use, rather than 1.85 times the average as proposed in the TGD release scenario. However, the areas of several countries are larger than one EU region, as shown in Table 1. It is possible that some of these countries could contain areas of the size of an EU region with high population density and

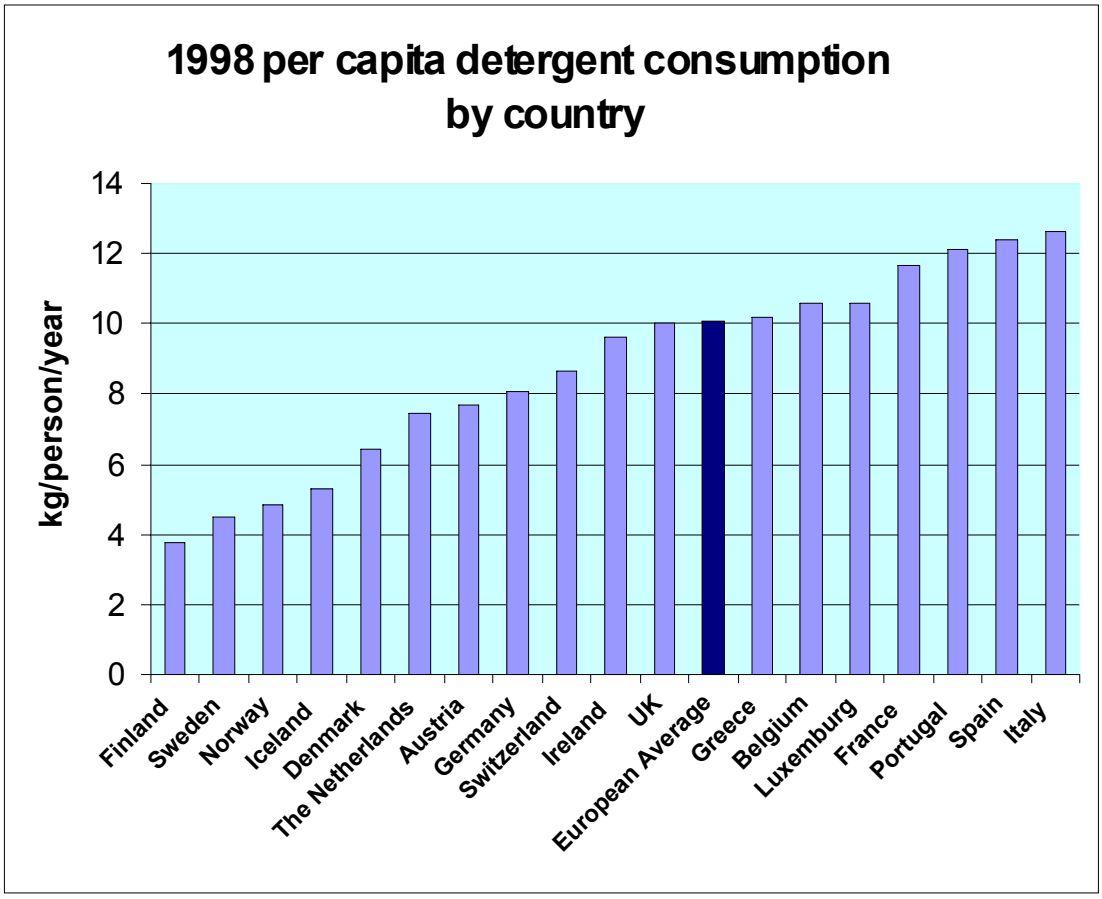

Figure 2. 1998 detergent consumption per person for several European countries, compared with the European average consumption.

consequently higher regional detergent ingredient release. In table 1, some of the most heavily populated regions of Europe are listed, in order of population density. In some cases, these regions have been compiled by focussing on the major European cities, combining their population and area with enough of the surrounding population and area to approach a size of 40000 km^2. Representative population data for countries of approximately the size of an EU region are also given in the table. Care has also been taken to include regions from the countries with the highest per capita detergent usage.

It can be seen from Table I that the German Land of Nordrhein – Westfalen has the highest population density for a region approximating the area of an EU region. However, the higher detergent consumption in the UK means that the highest regional detergent release will occur in London and Southeast England. If this region were scaled to the size of an EU region, 5.5% of the total EU detergent usage would take place in this region. Thus the most conservative regional release factor, based on measured population density and detergent consumption data, should be 5.5% of the EU tonnage.

A regional release of 5.5% of the production tonnage is entirely appropriate for the calculation of the regional PEC. However, use of this figure may cause difficulties in local PEC calculation, especially if the local sewage treatment plant is located in one of the higher *per capita* consumption regions such as Spain or Italy. This is because the EUSES methodology calculates the local sewage treatment plant influent loading from a *per capita* consumption figure which is based upon the tonnage used in the EU region. Although this is appropriate for, and indeed probably defines, a standard EU sewage treatment plant, the HERA methodology should reflect the highest actual *per capita* product usage, in order to be applicable to a sewage treatment plant in Italy or Spain. Thus in the HERA detergent scenario the maximum (Italian) *per capita* consumption of 1.25 times the EU average has been multiplied by the maximum regional release of 5.5%, to give a 7% regional release figure. Although this is overly conservative for the regional calculation, it will generate an appropriate per capita input for local sewage treatment plants in the areas of heaviest *per capita* product usage.

The consumption data used in this analysis is the product consumption information which is available to AISE. Although the use pattern for most detergent product ingredients is expected to be similar, this will be considered on a case by case basis for each ingredient during the HERA environmental risk assessment. Different use patterns may be appropriate for ingredients, including speciality product ingredients, which are included in products to meet the requirements of consumers in specific areas, but which do not have a general European distribution. The detergent formulators in the HERA substance groups will identify any regions of high ingredient use, and modify the regional release figure in the EUSES program appropriately. As a default value appropriate for most detergent ingredients, HERA uses 7% of the formulation tonnage as the regional tonnage, to enable the local sewage plant input to reflect the areas of highest per capita consumption.

Region	Population	Area km2	# EU Regions	Population Density	Detergent usage, kg/person/y	Regional release Relative to EU Avg.	% of EU production
Entire EU	370000000	3560000	89	104	10.06	1	0.011
Switzerland	7325000	39550	0.99	185	8.64	1.53	0.017
Madrid + All Castilla Leon population	7534000	40000	1.00	188	12.40	2.23	0.025
Cataluña (Barcelona)	6089000	32113	0.80	190	12.40	2.25	0.025
Piedemonte + Liguria	5920600	30815	0.77	192	12.61	2.32	0.026
Berlin + Brandenburg	6010000	30368	0.76	198	8.10	1.53	0.017
Bremen+ Hamburg + Niedersachsen	10200000	48771	1.22	209	8.10	1.62	0.018
Baden - Württemberg	10370000	35752	0.89	290	8.10	2.25	0.025
Belgium	10213000	32820	0.82	311	10.60	3.15	0.035
Lombardia + Veneto	13490000	42221	1.06	320	12.61	3.85	0.043
Paris, Picardie, Upper Normandie	14500000	43000	1.08	337	11.67	3.76	0.042
Campania + Lazio	11048000	30899	0.77	358	12.61	4.31	0.048
Yorkshire +Humber +North West / West Midlands	17243000	42580	1.06	405	10.02	3.88	0.043
The Netherlands	15739000	33920	0.85	464	7.44	3.30	0.037
EUSES Standard Region	20000000	40000	1.00	500			0.100
London and SE +E	**20452000**	**39794**	**0.99**	**514**	**10.02**	**4.93**	**0.055**
Nordrhein – Westfalen	17950000	34079	0.85	527	8.10	4.08	0.046

Table I. Population densities and detergent releases for European areas similar in size to the standard EU region.

REFINEMENT OF THE LOCAL RELEASE SCENARIO

The local release scenario uses a per capita input derived from the regional tonnage, as described above. In addition, the TGD assumes that, as a reasonable worst case, four times the average amount of a detergent ingredient will reach the sewage treatment plant. This can be compared with monitoring data collected for boron, a detergent ingredient whose distribution is representative of other HPV detergent ingredients, in sewage treatment plant effluents. Because boron is not degraded or adsorbed or otherwise removed in the sewer, measurements at the sewage treatment plant inlet should reflect the amount of boron disposed to sewer[3]. This has been demonstrated[4] (Holt et al. 1998) in the UK, where regional detergent consumption figures agreed with 28 daily composite STP inlet samples, within the error of the measurement (95% confidence limits).

Boron monitoring data for 50 sewage treatment plants in four countries (UK, Italy, Germany, and the Netherlands) have been obtained which show that more than 90% of the plants receive less than 1.5 times the average predicted boron input[5] (Fox et al., 2000). The data obtained in during the UK monitoring exercise are shown in figure 3. In this monitoring study, 804 grab samples of effluent from 36 UK sewage treatment works were collected, over a two year period, and analysed for boron. The sewage treatment works were chosen by Yorkshire Water Plc to be representative of sewage treatment works in their region. The selected works covered the range of populations served, as well as the range of domestic to industrial effluent received. The mean per capita boron load determined at each sewage treatment works has been compared with the calculated UK boron loading of 0.22 g/person/day, which can be attributed to boron from washing powders (Holt et al. 1998)[4]. The mean of the measured to calculated boron ratios for these 36 treatment plants is 1.04. More than 90% of the observed boron mean concentrations are less than 1.5 times the calculated boron usage value. Only at Dewsbury, a sewage treatment works with a large industrial input which contains effluent from wool scouring and other textile finishing operations, is the mean boron per capita load in excess of twice the calculated boron per capita usage of 0.22 g/person/day.

As the TGD (EEC, 1996, Part II, p. 257) recommends that the 90th percentile of monitored exposure data be used as representative data for environmental risk assessment, this factor of 1.5 should be used for the local risk assessment of HPV detergent ingredients. The HERA detergent scenario uses this factor of 1.5 to allow for a reasonable worst case input to a local treatment facility, rather than the factor of 4 suggested in the TGD.

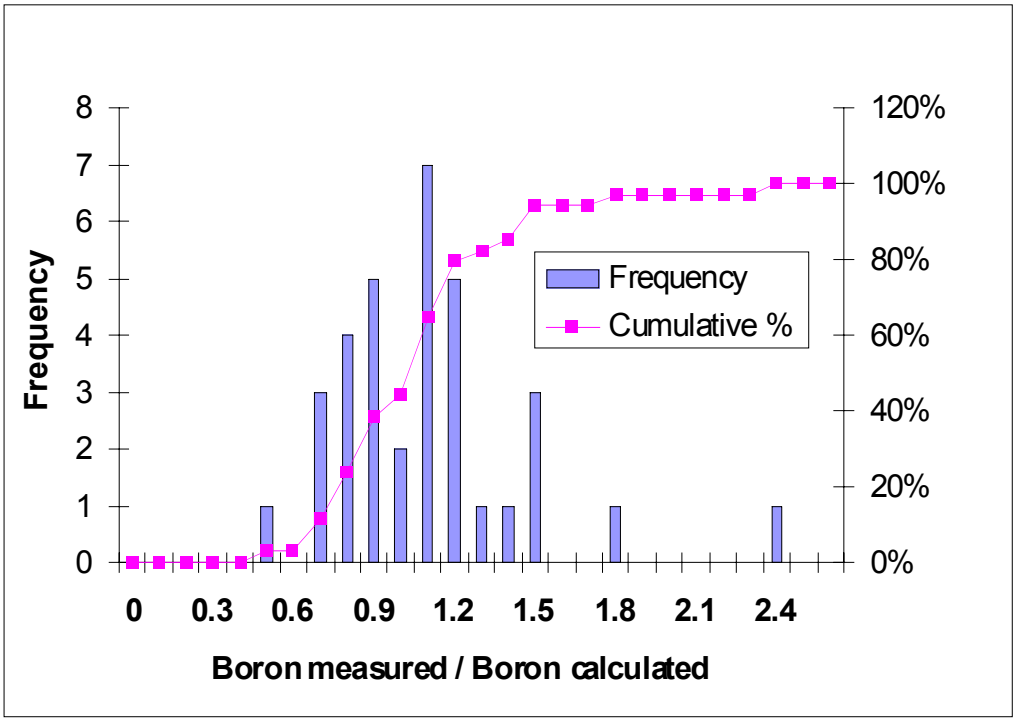

Figure 3. Frequency distribution of the boron per capita loading from 36 UK sewage treatment works, relative to the calculated usage of 0.22 g/person/day

It is possible that low tonnage speciality ingredients, *e. g.* perfume components or optical brighteners, may have greater variation in their distribution within a region, due to fashion, cost, or other factors. Thus for these ingredients, deviation from the recommended TGD factor of four should be justified on a case by case basis.

CONCLUSION

The HERA detergent scenario estimates maximum regional release data for ingredients in household cleaning products (IC5, UC9) for the most densely populated EU regions, from product consumption data supplied by AISE. A "7% rule", rather than a "10% rule", is shown to best represents IC, UC9 regional emissions, which are directly connected to personal use rather than to a production or formulation facility. The "worst case" estimate for the amount of an ingredient reaching a sewage treatment facility located in this "worst case region" is then determined. The TGD assumes that this will be four times the average release. In the HERA detergent scenario, experimental release data for a representative detergent product ingredient, boron, from 50 sewage treatment plants in 4 EU countries is used to show that the 90th percentile "worst case" treatment plant receives less than 1.5 times the regional average load. These experimentally

based release factors are proposed for use for the TGD IC5, UC9 release scenario, and are used for the HERA environmental risk assessments.

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REFERENCES

1. EEC (1996). Technical Guidance Document in Support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances and Commission Regulation (EC) No. 1488/94 on Risk Assessment for Existing Substances, The European Commission, Luxembourg.

2. ECB (1999). DRAFT Technical Recommendation TGD, Chapter 3, Section 2.3.8 Document ECB4/TR2/98.

3. Matthijs, E., Holt, M.S., Kieweit, A. and Rijs, G.B.J. (1999). Environmental monitoring for linear alkylbenzene sulfonate, alcohol ethoxylate, alcohol ethoxy sulfate, alcohol sulfate, and soap. *Environ. Tox. Chem*. **18**, 2634-44.

4. Holt, M. S., Fox, K. K., Burford, M., Daniel, M., and Buckland, H. (1998). UK monitoring study on the removal of linear alkylbenzene sulphonate in trickling filter type sewage treatment plants. Contribution to GREAT-ER project #2. *Sci.Total Environ.* **210/211**, 255-269.

5. Fox, K. K., Cassani, G., Facchi, A., Schröder, F. R., Poelloth, C. and Holt, M. S. (2000). Measured variation in boron loads reaching European sewage treatment works. Submitted to Chemosphere.

6. Saouter, E., Feijtel, T. C. J., Fox, K., Schröder, F. R., Tuccimei, L., and Van Hoof, G. (1999). Use of a detergent scenario for conducting environmental risk assessment via the EUSES model. Presentation at the SETAC-Europe 9th Annual Meeting, Leipzig, Germany, 25-20 May, 1999.