



International Cadmium Association

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Comments on the UNEP DTIE/Chemicals
'Review of Scientific Information on Cadmium'
Draft of 18 August 2006
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General Comments on the draft report

- Much of this document still contains policy statements and opinion rather than concentrating on presenting scientific data. For some sections of the draft one can note a strong resemblance to the Nordic Council of Ministers Cadmium Review of several years ago. If UNEP is to produce a credible scientific review on cadmium, the report must reflect global scientific reviews, and not the opinion of a specific region or sub-region. As it is now, much of the information offered is opinion, and largely reflects the viewpoint of only certain countries. It still does not accurately reflect the global situation with respect to cadmium from a scientific point of view.
- The EU risk assessment is an important source of information for this review. It is noted once again that the ECB, 2003 version is referenced in the text. The final EU risk assessment on Cd and CdO environment of December 2005 (EU Cd RAR 2005) needs to be considered. This version contains the **full targeted risk assessment on NiCd batteries**, reviewing the environmental impact of the full life cycle of NiCd batteries. The reference was provided at the end of the ICdA comments submitted in July, and again at the end of these comments.

Chapter 3 Summary Section

- There is no clear discussion on occupational exposure to cadmium. To this end, the ICdA had a guideline document "Managing risks to workers exposed to chronic exposure to cadmium and its compounds" which may be useful. The guidance document provided both a thorough review of the recent literature on the topic, and guidance on how to reduce exposure and monitor workers for cadmium exposure.
- *Point 10* : A transparent summary needs to be included to explain the discrepancy in scientific views on cadmium effects in the general population, and its further statistical extrapolation to an exposure, and further how the PTWI level has been determined by JECFA in its 2005 revision. It is clear that there are diverging views as to the level at which *effects* from cadmium exposure start to occur in the general population. The section 3-1 on health effects discusses *sub-effects* of cadmium and *effects* of cadmium to the kidney interchangeably without properly discussing the difference. A clear review of the well known progression of sub-effect levels of low molecular weight protein excretion to when such increased excretion results in proteinuria, and the relation this has to the biomarkers of exposure (cadmium in urine expressed as $\mu\text{g/g}$ creatinine) is needed.

Chapter 4 Summary Section

- *Point 15* : Cadmium is utilised as an essential element in some particular cases as



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is mentioned in section 7.2. This should be included in this section. Furthermore, the impacts of cadmium are related to the bioavailable fraction of cadmium levels, and not to the total cadmium levels. A thorough review of the literature on the parameters influencing bioavailability of cadmium in soil, water and sediment is needed in this chapter.

- *Point 16* : The statements that since 1990, the decrease in cadmium levels is less pronounced is misleading. What is the reference for such a statement? What is the significance of such a statement if not related to the background level for a natural occurring substance such as cadmium? What about other parts of the world? Some description is needed related to the documented levels in water, soil, sediment at or above known biological effects. From our knowledge, these are mainly caused by point sources (see comments from Canada on the first draft report), or local areas geologically rich in metals including cadmium, or historically contaminated areas (see descriptions outlined in the EU Cd RAR 2005).

Chapter 5 Summary Section

- *Point 22* : The persistence of cadmium in the environment should be discussed in the context of its bioavailable form. Cadmium binds to organic and sulphide substances in sediment rendering it no longer bioavailable.
- *Point 27* : Emission patterns can be quite different from 1 country or region to the next (e.g. figure 2) and is largely dependent of the type of industries present in the region. A general global pattern on relative importance of non-ferrous metal production versus fossil fuel combustion, vs iron and steel, ect.. can not be made.
- *Point 28* : What is the basis for the last statement in this paragraph?
- *Point 30* : This paragraph is historical information only. This should be made clear that it does not represent the current emissions patterns.
- *Point 34* : No conclusions can be drawn on the importance of atmospheric emissions to agricultural soil at a global scale as is done in this paragraph. The ‘many countries’ providing information are limited to 5 European countries, for which emission patterns vary greatly. Furthermore, the statement is in contradiction with the estimations made for Europe in the EU Cd RAR 2005, estimating that the main source of cadmium to agricultural soil is phosphate fertilisers.
- *Point 36-37* : It should be noted that in the marine environment, the contribution of anthropogenic inputs from surface waters is small in comparison to the oceanic reservoir of cadmium (see Chapter 7).

Chapter 6 Summary Section

- *Point 39* – The relevant information should be where cadmium is smelted and refined into metal, not where it is originally mined. Mining occurs all over the world (but not in Belgium or Germany anymore!), but smelting of the zinc concentrate and cadmium production are really confined to only a few countries – mainly China, Japan, Korea, Canada and Mexico. Some cadmium production (about 1000 T/yr) is still being produced in Europe.



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- *Point 40* – The figures presented here are exaggerated. It should be noted that 22,000 mt represents the maximum consumption while the lower figure of 6,000 mt in 1950 does not include consumption figures for the Soviet Bloc nations, China or Korea. The earlier figures were only for the USA, UK, Germany and Japan because little other information was available at the time. A more balanced view would be to state that cadmium consumption has gradually increased from approximately 10,000 mt in the 1950's and 60's to 20,000 mt today.
- *Point 42* – The amount of recycled cadmium produced per year has been estimated for 2005-2006, and now increased to 4,000 mt per year, or roughly 19% of the total global supply.
- *Point 43* – The cadmium impurity levels in recycled materials are generally far lower than in naturally-occurring materials. Cadmium may indeed be found in zinc, lead and copper materials but since the specifications for almost all of these materials require low cadmium contents, the cadmium content in these metals and alloys when recycled will be even lower as cadmium volatilizes from them during the melting processes and is captured as bag house dust in air emission control systems. This final sentence in this paragraph is speculation and should be removed.
- *Point 44* – Cadmium consumption in NiCd batteries is 82% of total cadmium consumption for 2005 (and is estimated at 82,5 % for 2006). The only 2 significant alloying applications for cadmium are in the copper-cadmium thermal and electrical conductivity alloys and in the silver-cadmium oxide electrical contact alloys. Silver brazing alloys (silver-zinc-copper-nickel-cadmium composition) is the only brazing and soldering alloy still in use in highly specialized situations. Most cadmium-containing brazing and soldering alloys have been replaced by cadmium-free alloys.
- *Point 45* – The conclusion could be discussed in more detail per product line. NiCd batteries are manufactured in a global manner in that raw materials originate in one country, the batteries are produced in another, incorporated into a product in yet another, and sold into a final market and used by the consumer in yet another. This is much less the case for cadmium pigments which are produced in only a few countries but which may be sold to consumers in many countries, normally for incorporation into products and use in that same country. Stabilizers, coatings and alloys are not generally utilised on an international scale but tend to be much more national in their productions, use and disposal.
- *Point 46* – This paragraph only presents speculative information. What would be far more relevant to this report is a summary of the EU targeted risk assessment on Cd from NiCd batteries. Detailed information is provided below in the comments by RECHARGE. Furthermore, this paragraph does not belong under a Chapter heading "Production, use and trade patterns".

Chapter 8 Summary Section

- It is not clear why this chapter is included in this review, since this is already a discussion on risk management strategies and seems to be beyond the scope of this exercise. In any case, some general comments are made.



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- *Point 67* – Reducing or eliminating the use of cadmium in products does not change the fact that cadmium would still be extracted as a by-product, and would therefore only change the environmental pathway and fate.

Comments on Chapter 2

- *Point 7* – This paragraph only presents data for soil. What about water?

Comments on Chapter 3

- *Points 132- 138* : The authors outline a series of studies that provide information on various manners by which effects have been noted in the general population. Some studies include occupational exposure, others conclude that there is no effect discerned at the exposed levels discussed. Furthermore, at times these refer to cadmium urine levels and at times to kidney cortex levels. The lack of context and variety of manners in which results are presented throws the reader into total confusion as to what the different experts have determined as an effect, and at what level they have statistically related it to an exposure. See comment under summary of Chapter 3 above as to a suggested way forward to improve this chapter.

Comments on Chapter 4

- *Point 168* : Given the importance of bioavailability in the determination of toxicity of cadmium in aquatic environments, and in its ability for toxicity and plant uptake in soils, this section needs to be discussed in much more detail. Some further details are provided in the EU Cd RAR, 2005.
- *Point 175* : On the other hand, studies on wildlife have shown that some mammals accumulate very high levels of cadmium in their kidneys and liver (Moose, ringed seals) from naturally high cadmium environments (e.g. some parts of the Canadian Arctic, Greenland). These high levels were tolerated by the animals, and no adverse effects were noted (AMAP, 2002)
- *Point 177* : The natural variability in cadmium levels should be described. To this end, a good source of information for Europe is FOREGS (Forum of European Geological Survey: www.gtk.fi/Pub/foregsatlas/maps_table.php) which provides a general idea of the variability of ambient dissolved cadmium concentration in aquatic and soil in European environments.
- *Point 197* : Please see comments on bioavailability in the Chapter 4 summary above. Furthermore, rather than stating general statements such as ‘which is close to common levels in European soils’ which is ambiguous, the actual levels can be mentioned (refer to the updated EU Cd RAR 2005).
- *Point 199* : The large uncertainty related to this type of modelling work should be acknowledged when discussing the results (as discussed in the UNECE WGE and TFEI workshops).
- *Point 207* : These values mean little without discussing the parameters influencing the bioavailability of cadmium in a given environment. The PNEC_{sediment} mentioned here is outdated (a value of 8.1-56.4 mg/kg dw PNEC_{sediment}-



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bioavailable) is now the reference levels in the EU Cd RAR 2005. The large range is dependent on conservative default AVS (Acid Volatile Sulfide) levels found in specific European environments, to account for a bioavailable fraction of cadmium.

- Table 4-5 : These values mean little without discussing how they were derived. For example in the remark column, it should be mentioned that the PNEC_{water} value is based on the HC5 of an SSD (Species Sensitivity Distribution) with an additional safety factor of 2. The PNEC_{sediment} level was derived based on 1 NOEC value with a safety factor of 50. Furthermore, these levels should be discussed in the context of the parameters influencing the bioavailability for a given environment.

Comments on Chapter 5

- Regarding section 5.1 -natural sources, there is missing a reference to hydrothermal vents that occur all along the oceanic spreading zones, such as the Mid-Ocean Ridge. There is mention of this in Chapter 7 under point 373. Hydrothermal vents form where there is volcanic activity. Basically water seeps through cracks in the ocean floor and is heated by molten rock deep below the ocean crust to as high as 400°C. The hot fluid rises to the surface and gushes out of the vent openings. This hydrothermal fluid carries with it dissolved metals and other chemicals from deep beneath the ocean floor. Most of the vents are along the Mid-Ocean Ridge. There are vents on the Loihi Seamount, the newest underwater volcano in the Hawaii chain. Vents are also found along some subduction zones. Vents can also occur on land. Two of the most famous are the hot springs and geysers in Yellowstone National Park in the USA and on the North Island of New Zealand (Bruland and Lohan, 2004).
- *Point 220* : This paragraph only presents the significance of anthropogenic versus natural emissions of 40 years ago, further stating that anthropogenic emissions have steadily decreased since then. There is a need to evaluate the current significance of anthropogenic versus natural emissions. As it is currently presented, the reader is left confused on this point.
- *Point 224* : On the one hand, one can speculate that waste incineration may be underestimated, especially where less developed waste disposal systems are present, on the other hand, it is known that in industrialised countries, cadmium emissions from large industrial plants (including waste incineration plants) continue to decrease because of continued legislative pressure (e.g. in Europe, the Integrated Pollution Prevention and Control (IPPC), 4th Daughter Directive on Air includes target levels for cadmium are still to come into force). Both of these situations should be considered when discussing the numbers in Table 5-2.
- *Table 5-3* : Replace Pb/year by Cd/year in the headers of the table.
- *Table 5-7* : Clearly any statements based on this table are of historical value only, given that it dates back almost 25 years, and given the extensive changes in emission patterns for cadmium since then.
- *Table 5-8* : This table is a bit confusing since it seems to consider waste to landfills as “releases to land”. Without neglecting the concern for old landfills (and their future), this table should be treated with caution if used from a human exposure



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point of view, in which case a direct release to soil is more important, even if the amount is far less.

- *Point 236* : Why mention a source if it is negligible and will not be discussed further?
- *Point 239* : The list provided here based on HELCOM is of little value if not regarded along with quantified or estimated emission contributions. Much more relevant is such information as outlined in Table-10, where efforts were made to quantify the emissions from different sources of cadmium in different countries. More country specific information would be useful if available.
- *Point 247* : Given that cadmium in agricultural soils is mainly discussed with respect to cadmium uptake, and consequently, human consumption, the importance of agricultural practices (without per se adding cadmium to soil) should be highlighted. As an example, it was demonstrated in Flanders that 1) applying excessive manure increases the uptake of cadmium in corn and 2) that even in soils containing background cadmium (<0,6 mg/kg), salsifies tend to contain too much cadmium due to agricultural practices (changes in soil pH, in the organic matter present in the soil,..). In this sense the former maximum allowable cadmium concentration in soils, set up by EU member states in the context of the former sludge directive (now under review) were totally misleading. This point is made to highlight that this section (and the section on human exposure) needs to regard agricultural practice (and eventual cadmium uptake) as a fundamental factor in cadmium exposure, and not solely cadmium inputs to soil, or else, the efforts may be in vain. The results from the SCOPE workshop may be useful in this sense (www.icscope.org/Cdmeeting/workshopsummary.html).
- *Point 258* : The protection level used in the Finnish risk assessment should be mentioned to understand what risks have been identified. This paragraph only mentions 3 studies, all from Scandinavian countries. Surely other parts of the world have also analysed this issue (e.g. EU Cd RAR 2005, ...)?

Comments on Chapter 6

- *Point 263*: See previous comments under point 42. Recycled cadmium is now estimated at 4,000 mt per year or 19% of total supply.
- *Point 264*: See previous comments under point 40. Cadmium production figures in the 1950s, 60's and even 70's did not include the Soviet Bloc, China or Korea. It would also be correct to state that the decrease in primary cadmium production has been partially compensated by an increase in secondary or recycled cadmium. In the past 5 years, primary cadmium production has been decreasing much faster than secondary cadmium production has been increasing.
- *Figure 6-2*: Production and consumption figures have now been prepared through 2006, with estimates for 2006 based on partial figures. These are showing the same trends – decreasing primary production and virtually flat cadmium consumption. These latest figures are available from the ICdA.
- *Figure 6-3*: Likewise, revised figures through 2006 are also available from the



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ICdA.

- *Point 266 and Table 6-1:* It is not clear what the purpose of this paragraph and table are. The reserve figures reflect amounts of cadmium contained in zinc sulphide ores, however, given the trends described above- that less and less primary cadmium is being produced- the relevance of presenting cadmium contained in zinc ores becomes increasingly diminished. More and more zinc producers in Europe are separating their cadmium from the zinc and then disposing of it as hazardous waste. Whereas in 1996, there were 14 Cd and CdO producers, there are only 4 still producing Cd and CdO today (EU RAR 2005). From discussions held with the industry, this trend is likely to continue. Similarly, the sentence about cadmium contained in zinc-bearing coals does not represent a viable source of cadmium production or supply, but only a source of cadmium air pollution through fossil fuel combustion. We would recommend deleting this paragraph and table as containing no really relevant information for current and future cadmium production and use.

- *Figure 6-4:* The updated figure for cadmium price is also available from the ICdA.

- *Point 269 :* The latest estimated figures for 2006 place cadmium consumption in batteries at 82,5% with stabilizers decreasing to 1%, and coatings, pigments and other uses remaining the same as they did in 2005. Given that the total consumption is stable, the increase in % of consumption in NiCd batteries is consistently at the expense of cadmium consumption in other applications, especially coatings, stabilisers and alloys.

- *Figure 6-6 :* This figure should be deleted; It gives the erroneous impression that cadmium consumption decreased markedly after 2003 (despite the footnote). In fact, if consumption of secondary cadmium were added to the chart, the curve would be asymptotically levelling off at 20,000 mt / yr level. More and more NiCd battery producers are, in fact, having their cadmium supply requirements met through private tolling arrangements with NiCd battery recyclers. An updated example of the cadmium supply chain for NiCd battery manufacturing in Europe is presented in the EU Cd RAR 2005. At global level, the total amount of recycled cadmium produced (approximately 4,000 mt) is being utilised for cadmium consumption. Thus, this amount of recycled cadmium must be added to the amount of primary cadmium consumption shown in Figure 6-6 to obtain an accurate estimated picture of worldwide cadmium consumption.

- *Table 6-3:* A general comment on this table is that the “extent of current use” provides very little information on the ‘extent of current use’ of the cadmium containing product. The comments below try to put more perspective for this column. NiCd batteries: only a small amount of metallic cadmium is actually used in NiCd batteries. Most of the cadmium employed is in the form of cadmium oxide, prepared from metallic cadmium. Cadmium nitrate is also used in some battery systems. This is, by far, the largest use of cadmium. Plating on Iron and Steel: Cadmium consumption for coatings is at approximately 6% of total cadmium consumption, its extent of use can hardly be described as “widespread”. Furthermore, it is largely prohibited in the EU (Restricted under 91/338/EC) and only sparingly used in Japan.



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The only areas where cadmium coatings are still used to any degree are the Americas and Asia (excepting Japan). Alloying element in Copper Wires and Sheets: These alloying elements have not been prohibited under 91/338/EC, and we are not aware of any countries in which they have been “phased-out”. Which countries are the authors referring to? In any case, it appears ludicrous to have restrictions given the amount of the alloys produced, their respective cadmium levels, the lack of emissions during use, and the fact that they are generally recycled. Sacrificial Zinc Anodes for Steel Structures: Cadmium is not generally used as a deliberate addition to sacrificial zinc anodes any longer. This reference appears to have been taken from a 1978 publication. This is no longer relevant. Today, zinc anodes, firstly, are not a major volume application, and secondly, contain less than 0,001% cadmium as an impurity. This application should be removed from the table as it is irrelevant. Other Alloys: Since the silver-cadmium oxide electrical contact alloys have already been included under cadmium compounds in the lower half of the table, the word “seldom” under “other alloys” should be changed to “rarely to never”. Control Rods: This is a very low volume application, so low that we don’t keep any figures on its use. It should be removed from this table or stated as such. Fuses in Electrical and Electronic Equipment: Cadmium-containing heat-sensitive alloys formerly used in fire safety devices have been replaced with cadmium-free compositions because of the obvious issue of generation of cadmium fumes during a fire or temperature excursion. This application is obsolete information. Pigments in Plastics, Ceramics, Paints, Ect.: Pigments based on cadmium sulphide are normally used for plastics, glasses, ceramics and enamels. They are not used in commercial paints except for red, orange and yellow artists’ colours which is an extremely limited market. Cadmium pigments are used where either high temperature or high stress processing or application conditions require their excellent resistance to these factors. They are only restricted in the EU. Coloured Glass: This category is simply a subset of the pigments application above. Stabilizers in Plastics: The use of cadmium laureates and stearates as weathering and ultraviolet stabilizers in PVC has significantly decreased and virtually disappeared. It is now approximately 1% of total cadmium consumption. It is prohibited in the EU and is subject to voluntary industry phase-out programs in the USA and the EU. Its use can hardly be described today as “widespread”. A more appropriate description would be “limited and rapidly disappearing”. Laboratory Analysis Reagents: The amounts used in this application are probably in the order of 0,0002% of total consumption. If this is to remain in the table, it should be noted as such. Opto-electronic Devices and Coating for Phosphorescence: Both of these applications, which should include CdTe solar cells as well, are examples of electronic applications of semiconducting cadmium compounds. The amounts are very small. Biocides and Antiseptics: Cadmium chloride herbicides have been outlawed in the USA for at least 25 years, and, to the best of our knowledge, have not been used in these applications since about 1980. This application should not be listed. Contact Material: The silver-cadmium oxide electrical contact alloys not only represent a very small volume



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application, but are normally collected and recycled by a very limited number of users and alloy producers because of the high cost of silver.

- *Point 273* : Change the word “Paints” to “Artists’ colours”. Cadmium pigments are not used in commercial paints for consumer or industrial applications. Their use in dyes and paints is obsolete.

- *Point 276* : It should be added that the reason that voluntary industry programs have been initiated in the USA and the EU was because there were widely available substitutes for cadmium stabilizers which were equally effective, and because zinc-barium and organo-tin stabilizers were perceived as being less environmentally adverse than cadmium. These initiatives were not taken because of actual adverse effects of cadmium to human health or the environment.

- *Point 277* : See comments made on Table 6-3.

- *Point 278* : A more detailed reference for the electronic uses of cadmium sulfides, selenides and tellurides may be found in Cadmium Chemicals by Dr. Marie Farnsworth, ILZRO, 1980, New York. A copy is available from the ICdA and is to our knowledge, more accurate than the information by Hansen.

- *Point 279* : It is not clear what the point of table 6-4 and Point 279 are. If the point is to include information on releases from various sources, than what is it doing in this chapter? More comprehensive reviews of emission contributions are available at larger regional scales than Denmark (e.g. EU Cd RAR, 2005 for estimates of environmental releases to air from various sources to the environment at EU-16, UNECE LRTAP have emission inventories for wider Europe (44 countries), the TRAR on Cd from NiCd batteries, 2005 for information on the relative contribution of NiCd batteries to landfill and incinerators at EU scale, US EPA for USA,..). Furthermore, it is unclear how the authors relate ‘Consumption/Mobilisation’ to ‘releases’. The terms are thrown together and it is very unclear how to distinguish emissions from consumption patterns in this paragraph. One has very little to do with the other and surely what is required is a thorough evaluation of emission patterns and end-of-life fate prior to any sensible conclusions on actual releases. It is a very serious mistake to refer to consumption/mobilization in a table, with no reference to what these terms mean, and then to somehow refer to releases to the environment. We hope that the consultants realise that such a table and paragraph is extremely misleading and surely does not belong in a Chapter on ‘Production, use and trade patterns’.

- *Point 280* : It is unclear why the authors would try to draw global trends from historical consumption in one country (in this case Sweden) there are many studies available which present the information on other countries and areas (Europe, North America,..).

- *Point 281* : Rather than stating speculative statements as is done in this paragraph, the authors should refer to the comprehensive analysis that has been done on this subject. The EU TRAR on Cd from NiCd batteries does not conclude that NiCd batteries are an important source of cadmium release. Again, the authors somehow



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confuse total consumption with releases. Such simplistic and erroneous speculations should be removed from a Scientific Review. Further comments on the NiCd battery section are provided by RECHARGE (see RECHARGE comments).

Comments on Chapter 7

- *Point 325 and 326* : These paragraphs are speculative and based on the assumption that lead and cadmium have similar air transport mechanisms. What should certainly be highlighted is the lack of information for cadmium and that any conclusions drawn based on lead is pure speculation.

Comments on Chapter 8

- *Point 380* : The text mentions 4 groups of methods to control cadmium releases, but further only elaborates on 3. Why?

Comments on Chapter 9

- *Point 440* : The Moldova standard for cadmium in air should be expressed as $\mu\text{g}/\text{m}^3$ instead of mg/m^3 ?
- *Point 442* : a source of human exposure that is often overlooked is foodstuff imported from countries where no standards exist.

Comments on Chapter 10

Guidelines to manage existing cadmium contamination in soil.

References

1. risk assessment Cadmium metal and Cadmium oxide. Final reports available :

BE Rapporteur :Federal Public Service: Public Health, Safety of the Food Chain and Environment. DG Public Health: Environment

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2. risk assessment Targeted Report Cadmium (oxide) as used in batteries.

BE Rapporteur:Federal Public Service: Public Health, Safety of the Food Chain and Environment. DG Public Health: Environment



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3. Contribution of Spent Batteries to the Metal Flows of Municipal Solid Waste
Authors : EURAS. B-9052 Gent. Belgium. November 2005.
Available from RECHARGE's web site : <http://www.rechargebatteries.org/>

EU Risk Reduction Strategy on Cadmium and Cadmium Oxide. 2006. Final Proposal
by Belgium. Risk Management Federal Public Service: Public Health, Safety of the
Food Chain and Environment. March 2006.
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**UNITED NATIONS
ENVIRONMENT PROGRAMME
DTIE/CHEMICALS**

**Review of scientific
information on cadmium**

Revised draft of 18 Aug 2006
Circulated for comments to members of
the Lead and Cadmium Working Group
and
for review at the First meeting of
the Lead and Cadmium Working Group

Revised Draft received August 23 2006



The section on nickel-cadmium batteries is very similar to the Nordic Council report to which it refers. It lacks objectivity and seems to be written on the assumption that Cd in batteries is a bad thing and needs to be stopped as soon as possible. This is contradicted by the results of the Targeted Risk Assessment on the use of Cadmium in Batteries which confirms that collection and recycling is feasible and an appropriate policy option to control and reduce where necessary the presence of cadmium in the environment.

6.3.1 Particulars on cadmium in NiCd batteries

281. Constituting about 81 percent of the global market for cadmium and being a globally traded commodity, nickel-cadmium (NiCd) batteries is an important part of the flow of cadmium through society globally and a **potential** source of cadmium releases throughout the lifecycle of the batteries.

This sentence mentions that batteries account for 81% of the global market for Cadmium. It fails to mention that Cadmium exists in the environment from natural sources, and that the 81% refers to the market for refined cadmium. It implies that if NiCd batteries ceased to be made and marketed, the alleged cadmium problem would disappear.

Applications of NiCd batteries

284. Other, smaller application areas (of which some have ceased in Denmark and likely in most of western Europe today) include the following:

- Emergency light devices;
- Cordless vacuum cleaners ("Dust busters");
- Cordless phones;
- Short range walkie-talkies;
- Other appliances for household and personal care (tooth brushes, shavers, trimmers etc.);
- Individual battery cells (consumer use replacing primary, non-rechargeable batteries);
- Solar lamps;
- Mobile phones (portable cell phones);
- Portable computer equipment;
- Video Cassette Recorder equipment (VCR);
- Specialised technical measuring devices (laboratory, medical etc.).

284. Reference to these applications having largely disappeared in Denmark, and likely to disappear from the rest of Europe is not accurate, nor is there any supporting logic or evidence for the comment.

285. Originally, NiCd batteries were the key factor in the success of all types of portable electric and electronic appliances, but today other types of rechargeable batteries have taken over a large part of the more technically advanced applications due to higher battery capacity per weight and some better performance characteristics. Nickel-metal-hydride (NiMH) batteries and lithium-ion (Li-ion) batteries are currently the most important alternatives. The main uses of NiCd batteries today are cordless power tools, because these require high discharge rates which have only been met by the alternative battery types for the last few years. Global supply data (see Figure 6-8) indicate that household and hobby uses (such as cordless vacuum cleaners) and cordless telephones (not to be confused with mobile "cell" phones) are also large uses.

285. This reference to the characteristics required by cordless power tools is over simplistic and misleading. It strongly implies that alternatives to NiCd for power tools do now exist, and that the only important characteristic is high discharge rate. This is not true.

287. Figure 6-9 shows in more detail the development of the consumption of NiCd batteries in Denmark (Maag and Hansen, 2005). As shown, other uses than power tools have been largely eliminated over the last five years. This is somewhat different to the pattern shown for the global situation in Figure 6-8 above. One of several possible reasons for this difference is the import fee on NiCd batteries



implemented in Denmark. A substantial fee is charged by the tax authorities per imported cell in order to allow the cadmium free alternatives to have a competitive market price and to set NiCd batteries and alternative batteries equal with regard to society's expenses for waste management; the collected fees are used for funding a national spent batteries collection system operated by private collection enterprises.

This paragraph makes believe that a tax on the sales of Ni-Cd batteries has a significant impact on the management costs of Municipal Solid Waste.

The authors do not mention what is the ratio of Ni-Cd batteries in MSW and their specific contribution to the cadmium flow of such waste streams. They do not mention that e.g. fly ash of MSW incinerators contains 100 times more zinc and 10 times more lead...

It is well known that cadmium represents approximately 1.0 % of the heavy metal content of MSW. Consequently its economic impact on the total costs of managing MSW is minimum.

287. This says "A substantial fee is charged by the tax authorities per imported cell in order to allow the cadmium free alternatives to have a competitive market price and to set NiCd batteries and alternative batteries equal with regard to society's expenses for waste management; the collected fees are used for funding a national spent batteries collection system operated by private collection enterprises." In fact the substantial fee charged by the tax authorities distorts the market, and places a disproportionate burden on NiCd batteries with respect to the cost of collection and recycling of all batteries as well as a disproportionate costs towards the environmental burden.

Substitution trends.

The substitution principle adopted a-priori by the author is based on hazard and not on risk assessments. This is unacceptable from a "neutral" consultant as it is a biased approach to the analysis of the issue.

290. For the largest single use of NiCd batteries, cordless power tools, a more recent survey of the market shares of power tools with cadmium-free batteries in the Nordic Countries was performed by the Nordic Council of Ministers in order to assess the future needs for NiCd batteries for this purpose (Maag and Skaarup, 2005). Data from the study show that NiMH (Nickel-Metal-Hydride) batteries has now gained substantial market shares both among professionals and private consumers in the Nordic countries. An overview of estimated market shares of NiMH-driven cordless power tools is given in Table 6-5. It is important to note a difference between the Nordic countries: Sweden and Denmark have specific taxes on NiCd batteries, including power tool batteries. This is not the case for Iceland, Finland and Norway. The Swedish and Danish markets have therefore been put under extra pressure to shift to NiMH batteries. It is however interesting in this perspective, to observe that NiMH batteries also have substantial market shares in Norway and Finland.

290. Here I would refer to our original comments on the Nordic Council report. Their estimates of market shares for various battery technologies seems to be based on very scanty evidence and does not tie in with data from at the largest two members of EPTA (Bosch and Black & Decker). In particular, reference to NiMH having substantial market shares in Norway and Finland is very misleading.

291. Besides in manufacturing, sealed NiCd batteries generally give rise to the largest cadmium releases to the environment in the waste disposal/treatment phase (Bio Intelligence, 2003; Drivsholm *et al.*, 2000). Many countries have implemented systems for separate collection of NiCd batteries in order to minimize the contamination of the general waste stream with cadmium. Yet, even countries which do make an effort to separate NiCd batteries from the general waste stream have found it difficult to achieve satisfactory collection rates, and they have discovered that separate collection and treatment implies significant extra costs to society. Some countries (e.g. the Netherlands, Denmark and Sweden)



have therefore worked goal-oriented towards minimizing NiCd battery consumption, among other means by introducing import fee systems which also have the role of covering society's costs for separate collection and treatment of waste batteries (Maag and Skaarup, 2005; European Commission, 2003).

The Netherlands have not worked goal-oriented towards minimizing Ni-Cd battery consumption

The authors are ignoring the fact that all batteries are containing chemicals (!). It is not correct to say that... *Many countries have implemented systems for separate collection of NiCd batteries in order to minimize the contamination of the general waste stream with cadmium...* This is only the case in Norway and Denmark!

In a increasing number of European Member States, the collection of all types of batteries has been initiated and collection programs are operating efficiently.

The new Directive on Batteries and Accumulators (2003/0282/COD) calls for the collection and recycling of all types of batteries.

It imposes a marketing restriction on portable Ni-Cd batteries for certain applications and exempts from this marketing restriction the following applications: emergency and alarm system, medical, military and space and cordless power tools.

In addition 291 seems to admit that the whole cost of collecting and recycling all batteries is funded by the fee placed on NiCd batteries in The Netherlands, Denmark and Sweden. If this is true, it is another example of gross market distortion without scientific justification.

292. The efficiency of NiCd battery collection is dependent on battery types. In the U.S.A., the U.S. Geological Service reports that "large industrial batteries are easy to collect and are recycled at a rate of about 80 percent", whereas "the small consumer NiCd batteries are frequently discarded by the public (U.S. GS, 2004)".

There is publicly available information on the quantity of Ni-Cd batteries collected in Japan and in USA. Those data should be added in this §. It is fallacious to let the reader believe that there is no collection in those countries.

Danish experience from 2004 with separate collection of small NiCd-batteries supported by a fee arrangement indicates a collection efficiency at about 50 percent. The percentage is estimated considering the effect of household practices of prolonged storage of batteries after end-of-life (the so-called "hoarding effect"), which may delay delivery of worn-out batteries by several years (Maag and Hansen., 2005). The experience in both countries is that a significant part of the batteries will be disposed of with municipal solid waste.

The authors do not mention the fact that in Denmark, the tax taken from the end user for financing the collection of Nickel-Cadmium batteries is not refunded to the end user (!) when it takes back its spent batteries (!).

This is a diversion of consumers and tax payers money.

The Danish system is not an example (it has not been adapted in other Member States) as it leads to the accumulation of cash by the State which does not refund the user for taking back spent batteries.

293. Table 6-6 provides other examples of collection rates for spent NiCd batteries from selected European countries. Presented collection rates based on NiCd sales range from 0.5 - 59 percent in these countries; some of which have made significant investments in separate battery collection schemes. Collection rates in percent of spent portable NiCd batteries "available for collection" - ranging from 46 - 70 percent - are also presented for selected countries where such estimates could be developed (Bio Intelligence, 2003). The difference between rates based on sold NiCd amounts and rates based on NiCd batteries "available for collection" is that the latter is an attempt to take into consideration the hoarding effect mentioned above. Note that the estimated collection rates based on NiCd batteries "available for



collection" are based on the assumption that all discarded NiCd batteries will be collected either separately or with controlled municipal solid waste collection (Bio Intelligence, 2003). This may be close to reality in the countries assessed, but will not a valid assumption in many developing countries, where significant parts of the generated general waste may be dumped or incinerated informally. Such hoarded NiCd batteries will ultimately either be collected with waste (separately or with municipal waste), or be lost to the environment, meaning that over time the collection rates based on NiCd sales should in principle illustrate the actual collection efficiency and are expected approach the rates based on batteries "available for collection".

With this statement..."meaning that over time the collection rates based on NiCd sales should in principle illustrate the actual collection efficiency"...the author is contradicting him- or herself.

In § 285, 286 and 288, the author clearly indicates that the market for portable nickel-cadmium batteries has changed with time. Today's markets are not representatives of sales 10 years ago.

He is asking to compare today's collection of spent batteries placed on the market 10 years ago and collected today (he acknowledges the "hoarding effect") with today's sales on a year to year basis. He is asking to compare pears with apples...

The comparison of collected quantities with sales quantities is only valid for consumable goods that have a short lifetime on the market (of a few weeks e.g.), like liquid beverage containers. As you have a high turnover on a yearly basis of 10 to 20, it is realistic to compare the quantities sold with the quantity returned on a yearly basis.

For equipment goods with a life of several years on the market, the comparison is irrelevant as there is no direct proportionality between sales and discarding.

This is a well known principle in macro-economy which is simply ignored by the author.

294. In the European situation most, or all, of the spent NiCd batteries collected separately are recycled for re-marketing of the metals (including cadmium; Bio Intelligence, 2003).

295. As discussed in section 8.3 on waste management practices, cadmium releases to the environment from waste management may happen in several steps of waste management chain. Three dominant sources of short term releases of cadmium from treatment of municipal waste under controlled circumstances
- namely air and water releases from municipal waste incineration and leachate releases from landfills - were assessed for the industry association "Recharge" for the European situation (Euras, 2005). They found that air emissions from incineration of MSW only contributed 2.6 percent to the total reported cadmium emissions to the atmosphere (oil and coal combustions and ferrous metal production being the main sources of releases to the atmosphere). With regard to aquatic releases, the contribution of landfilling and incinerating MSW was also assessed as minor (2.3 percent of total reported releases). Based on their assessment of reviewed data, they found that NiCd batteries contributed with about 17 percent of the cadmium contents in municipal waste in the countries included, meaning that NiCd batteries only contributed with approximately 0.5 percent to overall cadmium emissions to air and water. The data used in the study appear to reflect extremely high separate collection rates (as compared to EU NiCd sales as well as to collection rates corrected for the hoarding effect), the relevance of which appear questionable in the global context. The study did not take other long term cadmium releases than leachate into consideration from landfills.

The EURAS study has considered the scenario where almost all batteries sold in a given year would be present into the waste streams.

In this scenario, the study concludes as follow...



For rechargeable batteries the case of a 10 % collection rate was calculated in the frame of the Targeted Risk Assessment Report on the use of cadmium in batteries (TRAR). It was calculated that the difference in potential emissions due to batteries between a country with a collection system in place and one with no collection system in place is a factor of 3.6.

If this factor is applied, it leads to an emission to air of 1.8 tonnes Cd (1.4 % overall Cd air emissions) and 0.5 tonnes Cd to the water (1.4 % overall Cd water emissions) which are still minor fractions of total emissions from anthropogenic sources.

We invite the author of this report to have an objective and constructive reading of the EURAS study.

Contribution of Spent Batteries to the Metal Flows of Municipal Solid Waste

296. Ecuador reports in its submission that batteries represent an estimated 48percent of the cadmium in waste in the country (Ecuador's submission, 2006)

297. The International Cadmium Association (ICdA comments, 2006) states that several EU risk assessments are available assessing the impact of the production use and disposal of products. Extensive information has been gathered on the different exposure routes and fate of these products. More specifically, a targeted risk assessment on NiCd batteries has been conducted in the context of EU regulation 793/93/EC, assessing the risk of NiCd batteries through the whole life cycle. The other main cadmium containing products have been assessed for the review of Directive 91/338/EC on Marketing and Use restrictions of cadmium in products – stabilisers, pigments and coatings. These extensive studies (of which most can be assessed at the European Commissions home pages) are a rich source of information.

298. [NOTE TO THE WORKING GROUP: AN ADDITIONAL BRIEF SUMMARY OF INFORMATION **ON EU RISK ASSESSMENT WORK ON CADMIUM-CONTAINING PRODUCTS** WILL BE ADDED LATER; CERTAIN ASPECTS OF EU RISK ASSESSMENT WORK HAVE HOWEVER ALREADY BEEN MENTIONED AT DIFFERENT PLACES IN THE REPORT]

NB Relevant to this Chapter is the targeted Risk Assessment Report on the use of Cadmium in Batteries.

The conclusions of this Report are presented in ANNEX 1 to those comments.

TRAR on CdO from manufacturing, use and disposal of NiCd batteries

August 2005

Environment

	Local sites	MSW incinerators Present Scenario	MSW incinerators Future Scenario	Landfills Present Scenario	Landfills Future Scenario	Risk Reduction Strategies Options
Water	<p>1. No Risk has been identified at 6 plants (1.1., 1.2., 1.5) === 2. Risk has been identified at one Cd recycling site (1.1.R)</p>	<p>There is no risk for micro-organisms if the hypothetical incinerator plant (equipped with an on-site WWTP) (dilution 100 to 1000) & when it is discharging to a STP. (1.4. & 1.7)</p>	<p>No risks have been identified (5.3. , 5.4. & 5.5)</p>	<p>1. No risk is anticipated for aquatic organisms at a hypothetical landfill currently releasing a leachate with 5 µg/L of cadmium directly or indirectly in the aquatic environment 2. No risk identified when indirect discharge (via STP) (1.3.) and (1.6)</p>	<p>1. No risk identified when leachate is discharged via an STP (5.1. & 5.2.) === 2. Risk has been identified assuming direct discharge to surface water at > 50µg/L leachate concentration (dilution factor 250). (5.1.R)</p>	<p>Revision of the Battery Directive, Treatment before discharge into landfill, IPPC, Water Framework Directive.</p>
Sediment	<p>No risk has been identified when considering bioavailability</p>	<p>No risk has been identified when considering bioavailability</p>	<p>No risk has been identified when considering bioavailability</p>	<p>No risk has been identified when considering bioavailability</p>		
STP/ WWTP	<p>No risks have been identified</p>	<p>No risks have been identified</p>	<p>No risks have been identified</p>	<p>No risks have been identified</p>		
Soil	<p>no risks have been identified</p>	<p>no risks have been identified</p>	<p>no risks have been identified</p>	<p>-</p>		

BLUE indicates that ICdA is in favor of this risk reduction strategy option