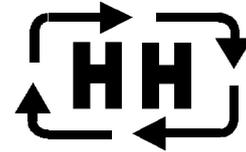


NH/HH-Recycling



Verein zur Förderung des umweltgerechten Recycling von abgeschalteten NH/HH-Sicherungseinsätzen e.V.

FUSE RECYCLING IN GERMANY – AN INITIATIVE FOR EUROPE

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The association NH-HH-Recycling e.V. is officially accredited as a non-profit association. It was founded in 1995 and since then the association is busy with the recycling of LV and HV HRC fuse-links in Germany and that on a non-profit basis.

The association was founded by German fuse manufacturers with the aim to return utilizable raw materials from LV and HV fuse links to the cycle of resources again.

In addition the target is, that only those fuses will be produced in future, which can be recycled without any problems.

The task of the Verein zur Förderung des umweltgerechten Recycling von abgeschalteten NH/HH-Sicherungseinsätzen e.V., a non-profit association established by German fuse manufacturers, is to process the various materials of which fuse links are made so that they can be returned to the cycle of manufacture for further use. In 2006, for example, the association collected and recycled more than 216 tonnes of materials.

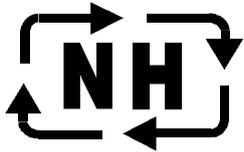
As far as the electrical industry is concerned, a ground-breaking initiative has been taken by the German manufacturers of low-voltage and high-voltage high-breaking-capacity fuse links. Even before the most recent German legislation on recycling came into force customers had begun asking the manufacturers of fuse links if they could set up a methodical system which would allow used fuse links to be returned for environmentally-compatible disposal. As a result, several fuse manufacturers began offering and charging for a disposal service for used fuse links.

Then, in 1995, with the aim of putting the subject of environmentally-compatible disposal on a regular footing, a number of the manufacturers involved (Fritz

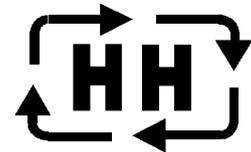
Driescher KG, EFEN GmbH, Lindner GmbH, Jean Müller GmbH, M. Schneider-Annaberg GmbH, Siba GmbH and Siemens AG) joined forces with the ZVEI (Zentralverband Elektrotechnik- und Elektronik-industrie) and, through an initial working party, established the non-profit-making "Verein zur Förderung des umweltgerechten Recycling von abgeschalteten NH/HH-Sicherungseinsätzen", otherwise known as "NH/HH-Recycling", registered in Regensburg and with its Head Office in Frankfurt.

Recycling the products and materials of 20 years ago

For many applications, fuse links represent a relatively cheap and safe way of providing protection for electrical systems and equipment. L.v. h.b.c. (NH) fuse links (low-voltage high-breaking-capacity) are used in low-voltage installations and h.v. h.b.c. (HH) (high-voltage high-breaking-capacity) fuse links in medium-voltage installations. The volume of the l.v. h.b.c. fuses varies between 45 and 900 cm³ (5 to 15 cm long and 3 to 10 cm wide). The h.v. h.b.c. fuses, on the other hand, are substantially larger: 20 to 65 cm long and 5 to 8.5 cm in diameter. The service life of these fuses, provided they are not called upon to blow, is approximately 20 years, which is well above the average life of most other types of electrical equipment. This means that, with these long-life products, recyclers are having to deal with materials that were in common use 20 years ago. In "old" fuse links, for example, asbestos was still being used as a jointing material. Fig. 1 shows a cross section through an l.v. h.b.c. fuse link and lists the other materials used in its construction; similarly Fig. 2 illustrates an h.v. h.b.c. fuse link.

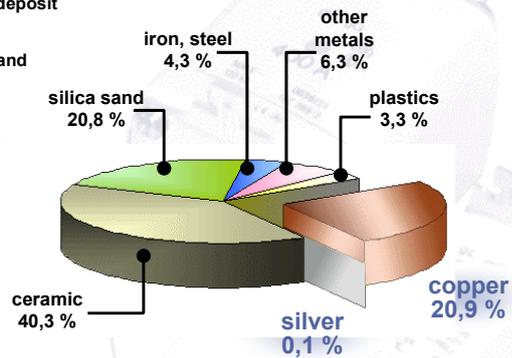
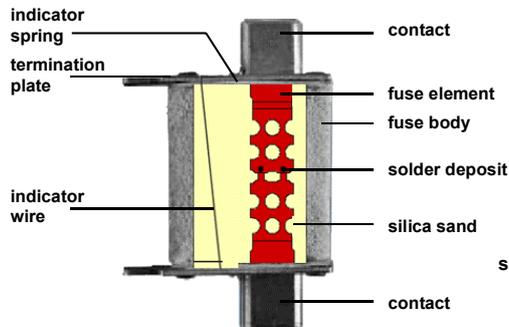


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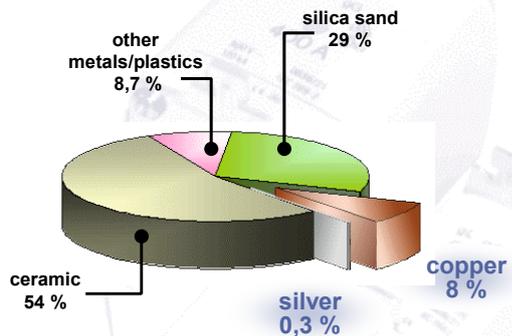
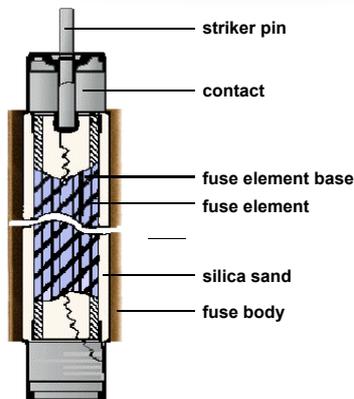
Structure of an LV HRC fuse link



- Values averaged over all sizes and types
- Depending on the year of construction and type, there may be slight amounts of cadmium (solder) and asbestos (seal)

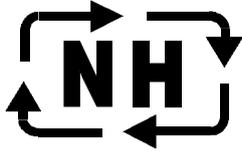
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Structure of an HV HCR fuse link

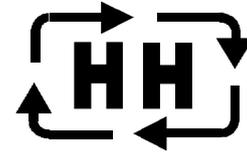


- Values averaged over all sizes and types
- Depending on the year of construction and type, there may be slight amounts of cadmium (solder) and asbestos (seal)

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The result: copper, silver and materials for the building trade and the chemical industry

The percentages of different materials also listed in Fig. 1 show that the recycling and re-use of copper and silver is thoroughly worthwhile and, as "valuables", do not deserve to be included amongst the residual waste or dumped on the refuse tip. The classic alternatives of disassembly or shredding offer the possible means by which the materials can be recovered.

Although disassembling these fuse links is a labor-intensive process, some successful projects have been set up, e.g. with power utilities and disabled people's organizations working together, in which the fuses are disassembled and the valuable materials they contain recovered so that they can be returned to the manufacturing cycle. The actual cost of disassembly is not covered by the profit obtained from the raw materials so the disabled people's organizations have to make a small charge for each fuse. The asbestos joint gaskets mentioned previously also cause some problems with disassembly.

The strict rules that apply when working with asbestos make disassembly a complex and costly process - as also is shredding or processing by pan grinder (a crushing process producing coarser results than a shredder) with subsequent melting down in the blast furnace. This situation has led to further tests being carried out in conjunction with a copper smeltery which have demonstrated that fuse links can be processed directly in a converter without any pre-processing at all. Under normal circumstances it is necessary to add quartz sand during the process in order to produce slag and promote the precipitation of iron. Since the fuse links that are being melted down already contain around 30% quartz sand, however, this "waste product" actually helps in the process.

Following an inquiry among various copper smelters and recycling companies throughout the country, the Norddeutsche Affinerie in Hamburg was eventually chosen because of its capacity and environmental capabilities. As a second waste handler the NH/HH-Recycling entered into a contract with the copper smelter Brixlegg, Austria.

For direct processing in copper converters the fuse links must normally satisfy the following specification:

- Plastics content less than 3.5%
- Asbestos content less than 0.05%
- Cadmium content less than 0.005%

The plastics are utilized to produce heat with continuous monitoring of the flue gas. During the melting, any zinc that originates from, say, brass contact blades is converted into zinc dust and collects in the plant filters. However, this is not a problem provided the total amount of zinc remains below 50 tonnes per annum - as it will given the total amount of recycling anticipated. The ceramic body of the fuses and the quartz sand are converted to slag that can be used again for road building and in the concrete industry. Another end-product, sulfuric acid, can be re-utilized by the chemical industry. The asbestos is rendered harmless by being incorporated into the slag.

Research benefits from the profits

Most of the l.v. and h.v. h.b.c. fuse links come from the country's power utilities and general industry. They are usually collected in "egg box" pallets placed at specified collecting points. The various sales organizations, which also function as collecting points, provide information for smaller users, such as electrical contractors and installers, on the recycling facilities that are available. DHL, with branches all over Germany, has been awarded the contract for collecting the egg-box pallets when they are full and transporting them to the company's own buffer store. When a collecting point has full pallets to be collected it notifies the transport company by fax and the pallets are then collected within three days and replaced with new empty pallets.

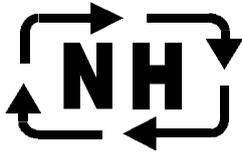
When a sufficient quantity of fuse links has accumulated in the buffer store, the haulier delivers them to the copper smeltery and invoices "NH/HH-Recycling" for its work. There are no charges to users for any aspect of the logistics involved or the recycling process.

After deduction of the costs for logistics, recycling and advertising etc., in accordance with the statutes of the association, the revenue is donated to a research agency to promote research in the area of fuse link technology and environmental compatibility. The agency is asked to publish results in appropriate manner.

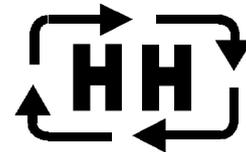
Spreading throughout Europe

In 2006, approximately 216 tonnes of used l.v. and h.v. h.b.c. fuse links were collected and recycled (Fig. 3).

"NH/HH-Recycling" intends to also enable foreign customers of the member companies to have their old fuse links disposed of by environmentally-compatible means. The organization's trade-marks have already



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been registered in approximately 30 countries and inquiries about the concept of the recycling process have been received from Austria, Sweden and recently England.

Memorandum on the European activities of NH/HH Recycling (members' meeting resolution of 17.05.00)

1. The main tasks of NH/HH Recycling involve recycling fuse links that are manufactured or distributed either by members of the Association or by companies which use its sign. If these fuse links can be collected from foreign customers or at foreign production locations, they may also be included in the recycling concept.

2. Based on a legal assessment by ZVEI (German electrical industry), there are unlikely to be any benefits from operating NH/HH Recycling as a European association.

3. As a German nonprofit making association, it is not a primary objective of NH/HH Recycling to extend the system beyond Germany's borders.

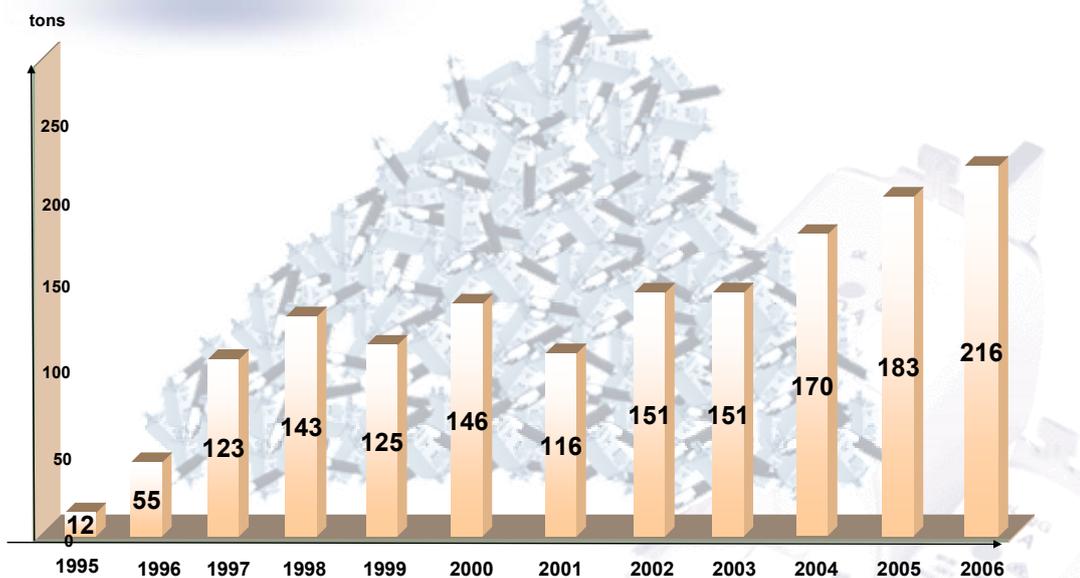
4. The legal opportunities of a German nonprofit making association are limited outside Germany.

5. It is part of NH/HH Recycling's basic philosophy to offer startup assistance for recycling systems in other countries under these countries' own leadership.

The manufacturers in Great Britain started also with a system like this. Colleagues from The Netherlands started and collecting fuses.

In a pilot phase the NH/HH – System, as we call it in Germany can be accommodated and extended to all European countries.

Recycling quantities



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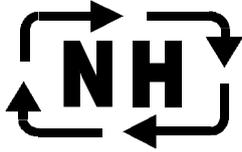
WEEE – Directive

The WEEE – Directive, it stands for “Waste electrical and electronic equipment” which became into force in August 2004 is the core of a taking back and recycling system.

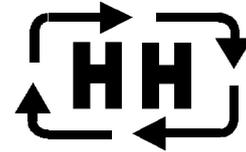
The countries have to install a collection and take back system free of charge for consumers that

ensures the return of the electronic equipment from August 2005.

The producers have to warrant financing of disposal take care for correct recycling and recovery of waste. In this case, the European legislation is the minimum for national legislation and it concerns also “... other



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monitoring and control instruments used in industrial installations (e.g. in control panels)” (Cat. 9).

The “Restriction of use of certain hazardous substances in electrical and electronic equipment,” (RoHS) became into force in August 2004, valid in July 2006. There are no national differences or exemptions with material restrictions. Today, the equipment category 9 “monitoring and control instruments” is exempted from RoHS, but the reviews every 4 years may lead to the cancellation of all exemptions. The expected limits are (07/2003), e.g. 0,1 wt.% for Pb, Hg and 0,01 wt.% for Cd.

The third column has to guarantee the design and production in an environmentally more efficient way. The Eco-design requirements for energy using products (EuP) are estimated 2008 for coming into force. The first official draft of the European Community is in preparation.

What effects have all these arising requirements on the Fuse Industry and what is to do? First of all, the critical substances in fuses have to be recorded already, today ! What kind of substances which are probably included in fuses are concerned? Well known are Pb, Cr(VI), Cd, Halogenide, - the polyprominated biphenyls (PBB) and polyprominated diphenylethers (PBDE). For the most of these mentioned before are technical solutions which are existing or developing. The producers have to qualify and to use them. In the next step, when the critical substances are identified, the producers should design a plan for acting and changing to non-hazardous substances.

And what is the matter with a “Taking back and recycling system” the WEEE asked for?

With the above mentioned system we have already an existing system in Europe for fuse links.

The different countries or manufacturers can easily copy the principle of this system, which is well known in Germany as “Association for the promotion of environmentally-compatible recycling of disused LV HRC/HV HRC fuse links.”