SESSION 8

THE DESIGN OF PACKAGING SYSTEMS TO REDUCE THE PROBLEM OF PACKAGING WASTE ON FARM

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WATER SOLUBLE PACKAGING AS AN AMENITY PACKAGING SOLUTION

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ABSTRACT

Herbicides have been used by managers within the Amenity Market to maintain public areas such as pavements and roadways in a weed free state. The bulk of products used are based on flowables or liquids which inevitably are packed in plastic bottles. Product development has focused on removing the need for plastic packaging and replacing it with paper or cardboard. In addition products like Zapper take the approach one step further by using WSB technology with PVA film, to ensure the end user is left with pesticide free packaging for disposal.

These solutions are more costly and it remains to be seen if the customer is prepared to pay for this approach to solving the disposal issue.

BACKGROUND

Unlike the agricultural market which is defined as the hard areas of the UK that sustains the production of food, the amenity market definitions often differ widely. For this paper Amenity areas are defined as parks, sportsturf, pavements, roadways and various industrial installations. Pesticides used in these areas are approved for use by the Pesticides Safety Directorate (BCPC 1996) under the following use areas phases:-

- Land not intended to bear vegetation
- Amenity vegetation
- Amenity grassland
- Managed amenity turf

Herbicides, Insecticides and Fungicides are the main groups of actives used in the market. Despite the recent revocations of some of the herbicide actives the proportions and overall use of actives has not changed greatly. Some 623 tonnes of pesticides are used (Figure 1 - DOE 1996).

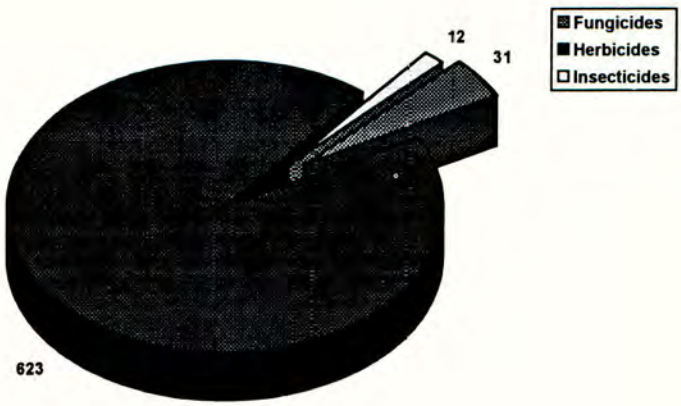

Figure 1 Proportion and levels of pesticide usage (tonnes) in the UK Amenity market. (DOE).

Herbicides make up about 93% of the pesticide tonnage used. Clearly this is a small and specialist market compared to agriculture, unlike agriculture where the number of users continues to decline year on year as, with privatisation, the number of potential pesticide users continues to increase.

Current packaging status

Accurate market information on this niche is rarely available. In packaging terms the 675 tonnes of active are produced in a number of formulations (BCPC 1996) :-

liquids

CB	-	bait concentrate
EC	-	emulsifiable concentrate
EW	-	oil in water emulsion
RH	-	ready to use spray in hand operated sprayer
SC	-	suspension concentrate
SL	-	soluble concentrate
UL	-	ultra low volume liquid

granules

GR	-	granules

Wettable powders

WP - wettable powder

Others

WB - Water soluble bags

Using both the number of approvals granted combined with market knowledge it is estimated that 70% of the actives are produced as liquids. The majority of these liquid formulations are packed in high density polyethylene (HDPE) packaging. Since most products have an active ingredient concentration of 50% and are packed in 5L packs it is estimated that some 189,000 packs are used each year

Since the overwhelming proportion of amenity sites are publicly owned barring packaging as a means of disposal has not been an option for several years. This major difference is reflected in the British Agrochemical Association (1997) advice which recommends the use of professional waste disposal contractors. Local Authorities are still able to dispose of their own waste packaging via either incineration or landfill.

Pesticide users are often used to paying the disposal of packs. Again it is challenging to produce a definitive disposal cost, however, the current cost ranges from £0.80 to £1.20 per 5L container. So the potential cost tot he industry as a whole is in the order of £200,000 per annum.

Developing a packaging strategy

Given the ever increasing legislative pressure on waste packaging with the waste packaging directive. A strategy to meet the imposed objectives within the directive has been developed .

Product development was focused on total herbicides which was the largest volume of actives used in the market. Ideally, a packaging solution which once used uncontaminated waste for disposal was sought. Several options were considered including the use of poly vinyl alcohol in water soluble bags. BR Destral was launched in 1991. This product packed in 0.5kg bags made from a single film. Heat sealed at the top and bottom and along a central spine and placed in individual cardisealed bags. Each of these bags carries a paper label. Finally, 10 of the 0.5kg bags are packed in a suitable labelled cardboard box. A comparison of the packaging weights and materials used are shown in Table 1 between BR Destral and Freeway.

Table 1 Packaging comparison of BR Destral and Freeway.

	Packaging weights (kg)	
	BR Destral 10 x 0.5kg	**Freeway 4 x 5L**
Plastic Bottle	0	0.96
Plastic Cap	0	0.064
Plastic Bag	0.2	0
Paper Label	0.15	0.097
Cardboard Outer	0.6	0.7
TOTAL	**0.95 kg**	**1.82 kg**

Freeway can be considered to be a comparable product to BR Destral at 7.5kg/ha when used at an application rate of 15L/ha. So to ensure the correct comparison the weights of packaging materials in table 1 need to be adjusted to reflect the unit area of weed control. Treating 1ha of Amenity land with Freeway generates 1.82 ÷ 4 = 0.45 kgs of pesticide contaminated packaging where as using the water soluble packaging of BR Destral no contaminated packaging is created.

The 0.95 x 0.75 = 0.71 kgs of cardboard can be theoretically disposed of as domestic waste. In practice this cardboard is either burnt or moved to landfill.

New Product Packaging

Weed control on Amenity hard surfaces such as pavement has moved away from a single application of a residual herbicide once a year towards multiple applications of glyphosate. Up to 5 sprays as part of a weed management programme has potentially created five empty 5L packs (2.275 kg) are generated during the year in managing 1 ha.

New products such as Zapper which has recently been approved have been developed with the waste packaging directive in mind. As with BR Destral the formulation is a wettable powder packed in a water soluble bag. Each poly vinyl alcohol bag is placed in a sealed plastic outer and then 12 are packed in a cardboard box. Not only is the initial weight of packaging reduced it is not contaminated by pesticide.

By building a barrier acting active into Zapper the potential number of treatments is reduced to two applications at most. Table 2 gives a summary of the packaging generated in treating 1 has of amenity land.

Table 2: Zapper and glyphosate products compared in terms of packaging waste generated when treating 1 hectare of Amenity land.

	Packaging weights (kg)	
	Zapper	**Spasor**
Rate of use	15 kg/ha	5 L/ha
Packaging Used	20 x 750g WSB cardboard outer	1 x 5L bottle ¼ x cardboard outer
Plastic bottle kg		0.24
Plastic cap kg		0.016
Paper label	0.024	0.024
Cardboard Outer	0.52	0.175
Plastic Bag		
TOTAL	**0.549**	**0.455**

To control the weeds on 1 ha of non crop land using glyphosate, some 2.275 kg of contaminated plastic packaging is generated. Managing the same area using Zapper would generate 1.098 kg of uncontaminated paper based packaging.

Packaging waste

In packaging terms it appears that Zapper or similar products have a series of undeniable benefits. However, WSB technology is expensive. The cost / benefits of using this approach is now discussed.

Cost / benefits of WSB technology

Amenity managers now are faced with a choice, should they select a "bottle" of cheaper pesticide or a box containing water soluble bags?

In Table 3 an attempt is made to quantify the "pack to pavement" costs of the product selection challenge. Often the basic cost is increased by logistical factors involving the collection of small quantities of contaminated packaging.

Table 3: Cost analysis of packaging in the Amenity market.

Cost per unit	5L Plastic Container	Water Soluble Bag
Disposal	1	0

Other costs:

transport:	£1.50
consignment note:	£35.00
minimum order:	£250.00

Disposal via a reputable waste disposal company is the BAA recommended route. Given that triple rinsed containers are not classed as special waste they can be handled without the need for consignment. Should this situation change the cost and difficulty of disposing of contaminated pesticide waste will rise dramatically to approximately £37.50 / 5L. This makes the use of water soluble packaging even more effective!

Financial benefits are relatively simple to quantify. In a world which is becoming ever more sensitive to environmental issues the intangible benefits within the Amenity market where the leisure surfaces being managed are often owned by public bodies such as Local Authority's political pressure has a direct impact. Lobby and interest groups do apply pressure on their Amenity managers. Even where WSB products are more expensive LA's may well be persuaded to take this option.

Experience from both France and Spain has shown that WSB products, even if they are more expensive, do offer justifiable benefits. Customers have moved towards products using this technology.

Evidently, not all actives are suitable for presentation in this format. WSB, however, can make a significant contribution to reducing the packaging waste within the Amenity market. If WSB were to take a 30% share of the herbicide market packaging waste will be reduced from 85 tonnes of contaminated plastic to 52 tonnes. This would be a potential saving of £56,000 to the industry as well as a major environmental benefit.

Operator Safety

Finally, when it comes to minimising the potential for operator exposure water soluble packaging offers many benefits. There is no need for measuring the pesticide, cleaning measuring vessels or risking spilling concentrated material prior to mixing. Water soluble packaging gives the potential for higher levels of safety and what price can be placed on safety?

ACKNOWLEDGEMENTS

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REFERENCES

Anon. (1997) *Guidelines on pesticide waste packaging disposal*. BAA, Peterborough.

Whitehead R (1996) *The UK Pesticide Guide*. BCPC/CAB International.

DOE, (1996) *The non-agricultural Use of Pesticides in England and Wales*. Prepared for the Department of the Environment by Produce Studies Ltd.

ASPECTS OF MODERN AGROCHEMICAL PACKAGING

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SUMMARY

The first stage of modern agrochemical packaging begins with the proper formulation of the active ingredient. The second step requires finding an optimal compromise between technical performance, ecological and economic aspects with maximum safety for the user, the environment and the product. Product and package form a system optimized for the user.

1. Introduction

The following summarizes some important and sometimes contrary requirements for modern crop protection product (CPP) containers:

• no packaging waste	UN approved packaging systems
• very easy to handle	minimum spatial requirement
• easy to open	tamper proof (child resistant) closure
• cheap	closed transfer and integrated metering system
• increasing label information	decreasing container sizes
• „analogue" metering of product	„digital" metering of product

At the first glance these requirements appear contradictory. However, in the market there exist many containerisation systems that meet - at least - some of these requirements, but not all. There are available optimized standard containerisation systems, water soluble bags, multi trip containers (MTCs) with or without closed transfer systems (CTS) and metering systems for liquid and solid crop protection products. The following highlights a few aspects of the modern development and design of CPP containerisation systems.

It is obvious that the chemical nature of the active ingredient determines the possible type(s) of formulation and primary packaging system(s) (e. g. container). The primary package must protect the environment of the product and vice versa, in order to minimize the ecological impact. At the same time the way of dosing of the product and the preparation (and in some instances also the application) of the spray mixture influence the design of the containerization system (fig. 1).

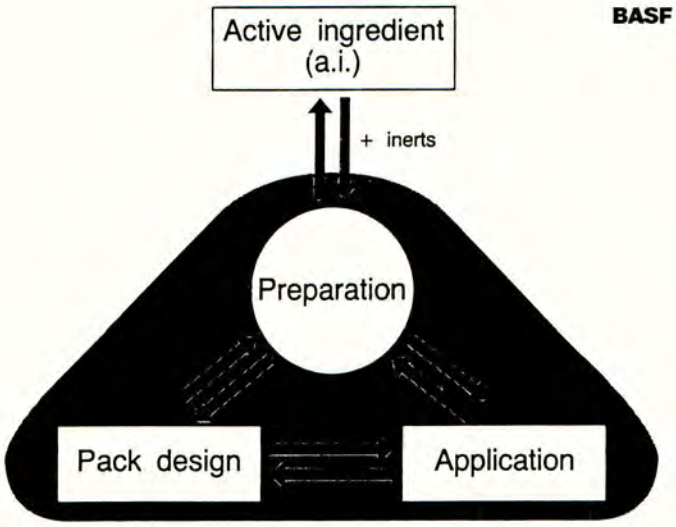

Fig. 1.: Choice and design of packaging material are determined by the actual preparation (formulation) and application

Besides technical performance, modern agrochemical containers must comply with ecological and economic aspects with maximum safty for the user, environment and the product (fig. 2).

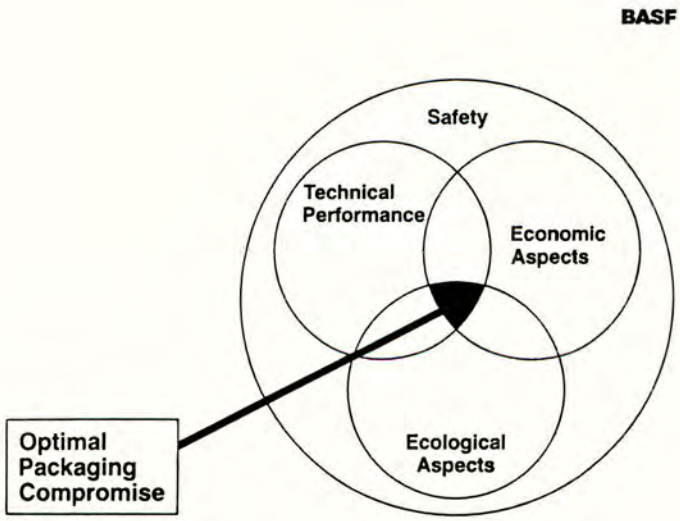

Fig. 2: Compromise of modern agrochemical pack design

2. Technical performance

The design of a modern CPP container is influenced by aspects of responsible care of the crop protection industry, by national and international legislation (e. g. for transport) and existing standards and recommendations. Among them the most important ones are:

- Recommendations for One-Way Agrochemical Packaging Design Criteria for Liquids and Solids (ECPA 1993a)

These recommendations were created by packaging experts of the agrochemical industry and state among many other items that modern CPP containers

- should drain and rinse well
- should not trap product
- facilitate simple and environmentally acceptable disposal

For the international transport of classified products

- Recommendations on the Transport of Dangerous Goods (Anon 1997), which are transformed in national and international legislation, e. g.

- ADR/RID regulations (ADR 1997, RID 1997), where Annex A contains the following points important for the development of containers for classified products

    - 3550: performance and frequency of tests
    - 3551: preparation of packagings for testing
    - 3552: drop test
    - 3553: leakproof test
    - 3554: internal pressure (hydraulic) test
    - 3555: stacking test
    - 3556: permeation test for drums and jugs made of plastic (limit value: 0,008 g/l*h)
    - 3558: approval of combination packs
    - 3559: test report

- The Guidelines for specifying the Shelf Life of Plant Protection Products (GCPF, 1993)

These guidelines specify the storage conditions for the container and the product to match realistic conditions. After such preconditioning the container can be used for testing as described above.

Thus, it is obvious that packaging design must start at a very early stage of product development to meet properly all these aspects.

There are many other legislations and recommendations that influence modern CPP container design, e. g. the EC directive on packaging and packaging waste (EC, 1994) with subsequent national legislation.

3. Ecological aspects

In the past many attempts were made to describe, quantify, and compare the ecological performance of products by life cycle analyses. Qualitative parameters are:

- type of packaging material and its production process
- type of containerisation system
- reduction of packaging waste
- route of disposal
- logistical aspects

The reduction of packaging waste has gained much attention which is reflected in the legislation almost worldwide in place or planned. The packaging waste can be reduced by

- avoiding primary packaging (e. g. by introducing water soluble bags)
- minimizing the primary packaging mass (e. g. combination packs, bag in box systems, MTCs with many trips per lifetime)
- increasing the concentration of the actual formulation (e. g. increasing the concentration of the formulation by a factor of 2 under otherwise the same conditions, cuts the packaging waste by 50 %)
- bigger container sizes reduce the specific mass of packaging material (the specific packaging mass of a 1 l HD-PE container is about 70 g, the one of a 10 l HD-PE jug 40 g; however, the 210 l STC has almost the same specific packaging mass), fig. 3

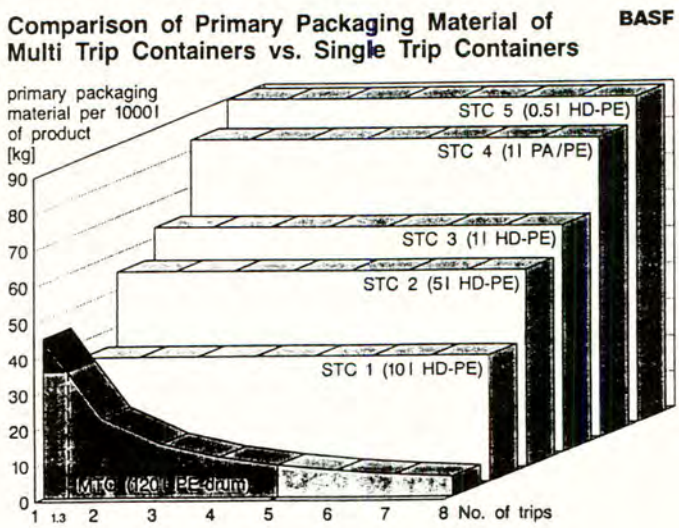

Fig. 3: Various sizes of primary containers for a given quantity of product (1000 l)

However, there are limiting factors:

- Water soluble films are very sensitive towards the product and the environment (e. g. humidity and low temperatures). These systems must be protected e. g. by an additional (laminated) outer. They work for some products, but not for all. In particular, liquid products are critical to be delivered in water soluble films.

- The crop protection industry observes an increasing trend to supply single CPP container or to split the combination packs by retailers to supply their customers. Under certain conditions (e. g. the container size for a classified product exceeds a limit value) the transport legislation may require UN approved (inner) packs. The stacking and drop test determine the lower limit of the primary packaging mass. At a given volume, for mechanical reasons the packaging mass of a „free standing" pack is usually higher than for an container of a combination pack. A closer cooperation between the transport and evironmental bodies is highly desirable. Packaging experts cooperate on national and international level (e. g. ECPA and CEFIC) to meet these requirements.

- The proper route of disposal depends on the options available. This is reflected in the container management strategy of ECPA (ECPA, 1997). For reasons of responsible care the crop protection industry insists on controlled - if posssible closed - loops of disposal. The best option - if available - is the recovery of the heat value of the primary packaging material (mainly HD-PE) under controlled conditions. To keep any environmental impact as low as possible, it is important to minimize the residue in the used container. An internal survey of rinsing trials conducted by ECPA members (ECPA, 1993b) showed that either by triple or pressure rinsing of CPP containers more than 90 % of the trials (out of 197) showed residues below 0,01 % .

Suitable barriers guarantee a minimum migration (and permeation) of the compounds of the formulation into the container walls. Thus, after proper rinsing a modern containerization/ formulation system - as far as the transport is concerned - should be considered as non contaminated.

4. Economic aspects

For the full cost analysis of various formulation/package options, the possible alternatives for different types of formulation, packaging (including filling), logistics, disposal and additional equipment (e. g. transfer and dispensing systems) have to be taken into consideration, choosing the same basis of reference (e. g. the active ingredient) in each case.

By optimization of the weight of the 1 l HD-PE bottle the amount of material could be reduced from 90 g to 63 g at the same technical performance. Saving of material and higher production capacity yield in lower cost per bottle. Replacing small pack sizes by bigger containers reduces the specific quantity of primary pack and reduces the cost of disposal, increases the filling capacity at the production line; lower specific cost is the result (fig. 4).

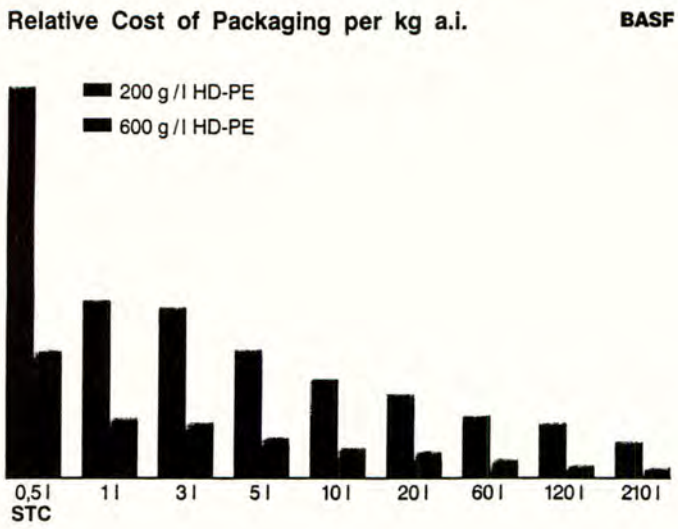

Fig. 4: Specific cost for a given formulation at various container sizes (includes packaging materials, labels, cost of filling, disposal)

It seems attractive to replace STCs by MTCs in order to reduce the quantity of primary packaging. Besides the cost for the packaging material, there are additional parameters to be considered, e. g.

- size and material of the MTC
- number of trips per life time of the MTC
- logistic aspects
- additional equipment for tamper evidence, for transfer and metering of product
- additional measures to check the MTC for impurities (cross contaminants)
- additional cleaning after each cycle may be required
- qualitiy management of the product

All these parameters can increase the specific cost of the MTC system compared to a STC (see fig. 5). On the other hand the MTC system can offer additional features to the user such as closed transfer (CTS).

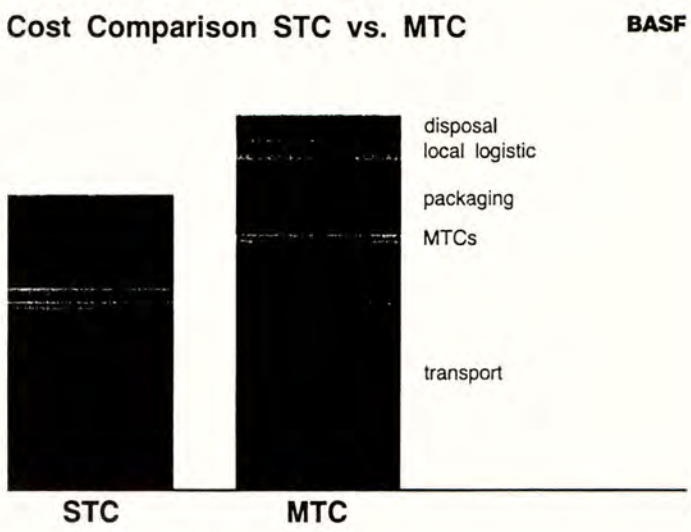

Fig. 5: Cost comparison STC vs. MTC including additional features of the MTC

Usually, the increase in cost is the higher the smaller the MTC is.

5. Summary

The design of modern CPP packaging systems is subject to different, in some cases not (yet) harmonised and contrary requirements. The general options are summarized in fig. 6.

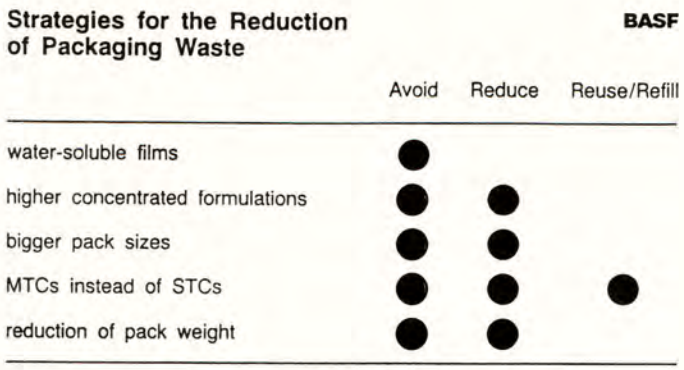

Fig. 6: Strategies for reducing the amont of packaging material for CPP containerization systems

Packaging design is more than just reducing the mass of packaging. It is the search for the optimum containerisation/product system that respects environmental, technical, safety, economic aspects, and meets the requirements of the logistic chain and the user.

Acknowledgement

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References:

ECPA (1993a) Recommendations for One-Way Agrochemical Packaging Design Criteria for Liquids and Solids, ECPA document C/93/MF/111, 17 September 1993

Anon (1997) Recommendations on the Transport of Dangerous Goods, United Nations, New York, 10. edition, 06/1997

ADR (1997) Accord Europeen Relative au Transporte Internaional des Marchandises dangereuses par Route

RID (1997) Reglement Consernant les Transporte International ferroviair des Marchandises Dangereuses

GCPF (1993) Guidelines for Specifying the Shelf Life of Plant Protection Products, GCPF (former GIFAP) technical monograph no. 17, May 1993

EC (1994) EC Directive 94/62/EC, 10 December 1994

ECPA (1997) ECPA Guidelines: Container Management Strategy. Doc. D/96/NM/730; revised August 1997

ECPA (1993b) Collection of Rinsing Data of used pesticide containers, ECPA/PTF survey, May 1993; unpublished document