Economic Incentives in the Management of Hazardous Wastes

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The management of hazardous waste in the United States is currently the responsibility of local, state and federal agencies, with the U.S. Environmental Protection Agency (EPA) having overall responsibility for setting standards, coordinating activities, and approving plans under the terms of the Resource Conservation and Recovery Act (RCRA) of 1976 as subsequently amended.[1,2]

* I am grateful for the extensive comments Dick Stewart made on an earlier draft.

1. 42 U.S.C. § 6901 (1982 & Supp. III 1985).

2. Hazardous waste management began at the federal level with control of solid waste under the Solid Waste Disposal Act of 1965... [That] law focused on garbage, particularly on restricting open burning, which was considered a fire hazard. In 1970, then-President Nixon signed an amended version of the solid waste law and renamed it the Resource Recovery Act. This law provided funds for collecting and recycling materials and required a comprehensive investigation of hazardous waste management practices in the United States. . . . In 1976, [Congress] passed the Resource Conservation and Recovery Act of 1976 (PL 94-580), which completely replaced the language of the Resource Recovery Act. The new law contained provisions on solid waste and resource recovery, including disposal of used oil and waste, and it closed most open dumps; it redefined solid waste to include hazardous waste and ordered EPA to require "cradle to grave" tracking of hazardous waste and controls on hazardous waste facilities. The Act required standards to be set for hazardous waste treatment, storage, and disposal facilities to provide for "the maintenance of operation of such facilities and requiring such additional qualifications as to ownership, continuity of operation, training of personnel, and financial responsibility as may be necessary or desirable". . . . The [Love Canal] event triggered the discovery of thousands of other dumpsites, alarming the public and mobilizing the Administration and the Congress. . . . [EPA] issued the first two portions of the RCRA hazardous waste rules in 1980 . . . in an attempt to prevent creation of more toxic waste dumps. Also in 1980, Congress passed what is a logical complement to RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (PL 96-510) (CERCLA), also known as the "superfund law", which assures financial responsibility for the long term maintenance of hazardous waste disposal facilities, and provides for the containment and cleanup of old, abandoned hazardous waste disposal sites that are leaking or endangering the public health.

Regulations governing the transport of hazardous wastes were developed jointly by EPA and the Department of Transportation (DOT). . . . Major provisions of the 1984 RCRA amendments (PL 98-616) call for banning land disposal of untreated hazardous waste within five and one-half years. . . . The new law also closed "loopholes" in previous hazardous waste rules. . . . Increasing the breadth of EPA's regulatory program, the amendments require the agency for the first time to regulate an estimated 600,000 generators of small quantities of hazardous substances and petroleum products.

This paper will briefly explore the management system created under the authority of RCRA, suggest why society can expect that system to be inadequate, evaluate arguments for the type of system established and suggest alternative approaches, in particular, the use of economic incentives that in certain important situations will better promote compliance with the disposal goals of RCRA.

Regulations promulgated by EPA define hazardous wastes as wastes displaying one or more of four properties: ignitability, corrosivity, reactivity and toxicity.[3] Thus, a household's waste lubricating oil and cadmium batteries, the service industry's spent solvents and pesticide residues, and manufacturing's pickling acids, plating wastes and drilling muds are all categorized as hazardous. But industry is by far the largest source of such wastes.[4] Table 1 shows the estimated amounts of hazardous wastes generated in 1983 by industrial sources, where the wastes are categorized by type. Table 2 shows the estimated distribution of the mean 1983 industrial generation across industries.

The major elements of the management system established by RCRA and corresponding regulations are:

- a manifest system[5] for tracking hazardous wastes that leave the premises of the generator, designed to discourage illegal disposal;

BUREAU OF NATIONAL AFFAIRS, U.S. ENVIRONMENTAL LAWS 173-76 (1986).

3. Identification and Listing of Hazardous Waste, 40 C.F.R. § 261.20-4 (1987). In RCRA the definition of hazardous waste is broader, reading:

> The term "hazardous waste" means . . . waste . . . which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—
>
> (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
>
> (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Resource Conservation and Recovery Act § 1004(5), 42 U.S.C. § 6903(5) (1982 & Supp. III 1985).

4. 11 COUNCIL ON ENVT'L QUALITY ANN. REP. 216 (1981).

5. A "manifest system" was contemplated in RCRA as a means "to assure that all such hazardous waste generated is designated for treatment, storage, or disposal in, and arrives at treatment, storage, or disposal facilities (other than facilities on the premises where the waste is generated) for which a permit has been issued as provided in this subchapter. . . ." 42 U.S.C. § 6922 (a)(5) (1982 & Supp. III 1985). The word "manifest" specifically refers to the form used to identify the waste being transported, its origin and its destination. 42 U.S.C. § 6903(12) (1982 & Supp. III 1985). Transporters are not supposed to accept wastes from generators without a proper manifest, nor are storage or disposal facility operators supposed to accept wastes from a transporter without that manifest. 42 U.S.C. §§ 6923(a), 6924(a) (1982 & Supp. III 1985).

TABLE 1. ESTIMATED GENERATION OF INDUSTRIAL HAZARDOUS WASTE IN 1983, RANKED BY WASTE QUANTITY (in thousands of metric tons)

Waste Type	Estimated Range Lower	Estimated Range Upper	Mean Quantity	Percent of Total
Nonmetallic Inorganic Liquids	68,102	96,420	82,261	31
Nonmetallic Inorganic Sludge	23,285	32,837	28,061	11
Nonmetallic Inorganic Dusts	19,455	22,784	21,120	8
Metal-Containing Liquids	14,125	25,394	19,760	7
Miscellaneous Wastes	14,438	16,393	15,415	6
Metal-Containing Sludge	13,246	15,748	14,497	6
Waste Oils	9,835	18,664	14,249	5
Nonhalogenated Solvents	11,325	12,935	12,130	5
Halogenated Organic Solids	9,321	10,246	9,784	4
Metallic Dusts and Shavings	6,729	8,738	7,733	3
Cyanide and Metal Liquids	4,247	10,520	7,383	3
Contaminated Clay, Soil, and Sand	5,092	5,830	5,461	2
Nonhalogenated Organic Solids	4,078	5,078	4,578	2
Dye and Paint Sludge	4,035	4,438	4,236	2
Resins, Latex, Monomers	3,451	4,585	4,018	2
Oily Sludge	2,965	4,502	3,734	1
Halogenated Solvents	2,774	4,185	3,479	1
Other Organic Liquids	2,866	4,003	3,435	1
Nonhalogenated Organic Sludge	2,179	2,305	2,242	1
Explosives	508	933	720	<1
Halogenated Organic Sludge	583	848	715	<1
Cyanide and Metal Sludge	537	577	557	<1
Pesticides, Herbicides	19	33	26	<1
Polychlorinated Biphenols	1	1	1	<1
TOTAL	223,196	307,997	265,595	

Source: Congressional Budget Office, 1985. *Hazardous Waste Management: Recent Changes and Policy Alternatives*. Washington, USGPO, p. 18.

- design and performance standards for treatment, storage and disposal facilities that will handle hazardous wastes;
- post-closure, financial responsibility and liability insurance requirements for such facilities.[6]

The amendments of 1984 expanded the scope of the regulations by bringing into the system an estimated 600,000 additional generators—those which generate between 100 and 1,000 k.g. per month, a group that had been exempted previously.[7,8] Further, the amendments indicated a change in regulatory approach,

6. *See generally*, F. GRAD, ENVIRONMENTAL LAW 646-51 (3d ed. 1985) (overview of RCRA); *see also* 40 C.F.R. §§ 262, 263, 264 (1987).

7. BUREAU OF NATIONAL AFFAIRS, *supra* note 2, at 175.

8. 42 U.S.C. § 6921(d) (1982 & Supp. III 1985).

TABLE 2. ESTIMATED NATIONAL GENERATION OF INDUSTRIAL HAZARDOUS WASTES RANKED BY MAJOR INDUSTRY GROUP (in thousands of metric tons)

Major Industry	Estimated Quantity in 1983	Percent of Total
Chemicals and Allied Products	127,245	47.9
Primary Metals	47,704	18.0
Petroleum and Coal Products	31,358	11.8
Fabricated Metal Products	25,364	9.6
Rubber and Plastic Products	14,600	5.5
Miscellaneous Manufacturing	5,614	2.1
Nonelectrical Machinery	4,859	1.8
Transportation Equipment	2,977	1.1
Motor Freight Transportation	2,160	0.8
Electrical and Electronic Machinery	1,929	0.7
Wood Preserving	1,739	0.7
Drum Reconditioners	45	<0.1
TOTAL	265,595	100.0

Source: Congressional Budget Office, 1985. *Hazardous Waste Management: Recent Changes and Policy Alternatives*. U.S. Government Printing Office: Washington, D.C. p. 20.

from what some saw as a bias toward (cheap) land disposal to a definite anti-land disposal approach. This shift was accomplished by requiring that a waste could only be disposed of in a land fill operation, however carefully designed, if the EPA Administrator certified by a certain future date that such disposal would satisfy some very restrictive safety requirements. In addition, the amendments imposed a set of tight deadlines by which the Administrator was to promulgate rules establishing performance standards governing these requirements.[9]

It is too early for a full evaluation of a management system that is still being put in place, but thoughtful commentators and experience with the act to date suggest a few observations:

— The manifest system apparently neither applies to much of the waste being generated nor produces information crucial to discovering dumping violations.[10]

9. 42 U.S.C. §§ 6924, 6925 (1982 & Supp. III 1985).

10. The Congressional Budget Office estimates that 96 percent of industrial hazardous wastes are dealt with on the site of generation and thus are not now subject to manifesting.

— Advance disposal techniques that meet EPA performance criteria (such as 99.99 percent destruction of hazardous chemicals in incineration) and sites fitted with these technologies may not be available soon enough to prevent the required land disposal bans from effectively closing all legal disposal options for some generators in some places.[11]

Even if sites are found and equipment approved, problems with obtaining required liability insurance for operational and post-operational periods may well result in severe pinching of legal disposal capacity over the next five to ten years.[12]

All together, there is reason to be concerned that under the existing RCRA management system, pressures for illegal disposal of hazardous wastes are building.

Note that there is a contrast between what is (or will be, after regulations are finalized) illegal with respect to hazardous waste disposal and what is illegal in the context of more conventional pollutants. For the most part, hazardous waste disposal is limited by regulations directing where such wastes may be disposed and by what method the disposal may proceed, but not limiting the quantities disposed of.[13] Discharges of more conventional pollutants, such as biochemical oxygen demanding organic material in waste water streams or particulate matter in combustion of gases, are limited to quantities specified in discharge permits. While the permit terms may by based on hypothetical application of particular technologies to plant raw waste loads, the actual choice of source reduction strategies is up to each source.[14]

This is not to say they will always be stored where generated; in the long run, shipment to incinerators or other advanced disposal facilities will have to be undertaken. CONGRESSIONAL BUDGET OFFICE, U.S. CONGRESS, HAZARDOUS WASTE MANAGEMENT: RECENT CHANGES AND POLICY ALTERNATIVES 26 (1985). The United States General Accounting Office could not find, in its study of four states, any illegal disposal cases identified through manifest exception reports (reports to EPA indicating that a transported waste may not have reached a designated storage or disposal facility). U.S. GEN. ACCOUNTING OFFICE, RCED-85-2, ILLEGAL DISPOSAL OF HAZARDOUS WASTE: DIFFICULT TO DETECT OR DETER iii-iv (1985).

11. *See generally*, 6 INSIDE EPA (Inside Washington Publishers) No. 7, at 12-13 (Feb. 15, 1985).

12. *Cf.* U.S. GEN. ACCOUNTING OFFICE, RCED-88-2, HAZARDOUS WASTE: ISSUES SURROUNDING INSURANCE AVAILABILITY 2-5 (1987) (noting general unavailability of insurance).

13. Resource Conservation and Recovery Act § 3002, 42 U.S.C. § 6922 (1982 & Supp. III 1985); 40 C.F.R. § 262-4 (1987).

14. For a discussion of strategy for the control of conventional air and water pollution, see Freeman, *Air and Water Pollution Policy*, in CURRENT ISSUES IN U.S. ENVIRONMENTAL POLICY 12 (1978).

The implication of this observation is interesting when assessing the systems and policies that guide the management of various types of currently generated wastes. To wit, it is in hazardous waste management, if anywhere in environmental policy, that the infamous "command and control" approach is to be found. That is, hazardous waste disposal facilities are required to meet very specific technological requirements—they are told how to do what they do—while conventional pollutant dischargers are told what result (discharge reduction) to achieve, but not how to achieve it.

Critics of the command and control approach, such as Charles Schultze, argue that such an approach is too rigid and coercive.[15] The concerns voiced by these critics lead one to look for more flexible methods of managing hazardous wastes. In particular, perhaps hazardous waste management, or at least some part of it, might be done better using economic incentives[16] that promote desired behavior rather than using bureaucratic orders.

The usual reaction to such a suggestion, however, has been that while economic incentives might be excellent tools for encouraging the reduction of conventional pollution discharges, their use would be out of place where hazardous wastes are involved.[17] This view apparently rests on three related assumptions:

— That because economic incentives allow sources flexibility, those sources cannot be counted on to achieve any particular discharge limitation goals.[18]

— That the effects of hazardous wastes on the natural environment or on human health exhibit thresholds, (i.e. concentrations below which no damages are observed, but above which very large damages occur).[19]

— That when regulations are imposed they will be obeyed, either because the sources are good citizens or because sufficient monitoring is done to induce compliance.

15. *See* C. SCHULTZE, THE PUBLIC USE OF PRIVATE INTEREST 5-6 (1977).

16. Economic incentives may take several forms in the context of pollution control, but a common suggestion is that each unit of pollutant discharged be subject to a charge payable to the environmental management agency. *See generally*, Bohm & Russell, *Comparative Analysis of Alternative Policy Instruments*, in HANDBOOK OF NATURAL RESOURCE AND ENERGY ECONOMICS (A. Kneese & J. Sweeney eds. 1985).

17. *See, e.g.*, W. BAUMOL & W. OATES, ECONOMICS, ENVIRONMENTAL POLICY, AND THE QUALITY OF LIFE 312-13 (1979).

18. *Id.*

19. R. DORFMAN & N. DORFMAN, ECONOMICS OF THE ENVIRONMENT 36 (2d ed. 1977).

Thus, if there is a threshold for damages, society will want to make sure that the threshold is not crossed. Discharge reduction or treatment method regulations can be written to ensure that the threshold is not crossed. Perfect compliance with such orders is assumed. But with an incentive system, sources may produce any discharge level, so the threshold might be passed. Charges become too dangerous to try.

Now, the assumption that under a system of charges sources might respond in unpredictable ways must in turn rest on one or the other of two alternative prior assumptions:

(i) That the agency setting the charge per unit of discharge does not know the marginal cost of discharge reduction for each source.[20]

(ii) That a source might act against its own self-interest by discharging more (or, indeed, less) pollution than would be economically optimal for it.[21]

It would be an unusual economic argument, to say the least, that rested on a premise of sustained perversity of the sort envisioned by alternative assumption (ii). Even if individuals, and even individuals in their roles as owners and managers of firms, do occasionally engage in cutting off their noses to spite their faces, it is a fundamental part of the argument for the social superiority of a free market economy that such behavior cannot be engaged in indefinitely. It is more palatable to accept assumption (i)—that the agency may not have enough information about discharge reduction costs to set charges correctly. But the auxiliary assumption of perfect compliance presents its own problems. The most important of these by far is that the assumption is at

20. It can be shown that if the environmental agency knows that the marginal social damages from additional units of pollution rise sharply with increasing pollution levels but is uncertain about the level of marginal discharge reduction costs, then setting a discharge standard is a risk-averting strategy relative to trying to use a charge (assuming perfect compliance, of course). That is, with a standard, the maximum possible social loss from being wrong about the marginal cost curve is less than with a charge. *See* Roberts & Spence, *Effluent Charges and Licenses Under Uncertainty*, 5 J. PUB. ECON. 193-208 (1976).

21. From each source's point of view, the economically optimal response to a charge per unit of a certain kind of pollution discharge is to reduce its discharge level until the charge equals the additional cost of reducing discharges by one further unit (the marginal cost of discharge reduction). For qualifications and complications, see generally Bohm & Russell, *supra* note 16.

odds with the evidence, which suggests widespread and serious violations of discharge permit terms.[22]

It is important to emphasize that this evidence applies almost entirely to stationary sources of conventional pollutants as described above—that is, to such high volume and easily located discharges as particulates from coal-burning power plants and biochemical oxygen demanding organics from municipal and industrial waste water treatment plants. The problem is not that environmental agencies lack the technical ability to monitor such sources or that they lack information about where these sources are located. Such evidence as is available strongly suggests that the problem is simply one of lack of resources to devote to monitoring and enforcement.[23] If this is a problem for conventional, stationary, point-source pollution, it is likely to be an even greater one for the prototypical hazardous waste setting in which the volume of waste generated is small enough that the waste need not be "discharged" or treated where and when it is generated but can be containerized, concealed and "discharged" anywhere.[24] Examples include waste oil from service stations, sludge from batch-process chemical reactors, spent solvent from electronic part-cleaning operations and biologically contaminated solid wastes from hospitals.[25, 26]

This paper concentrates on these small volume situations. For these wastes, monitoring is no longer a matter of measuring the output of an unconcealable smoke stack or even of an easily located if not so obvious river discharge pipe. It is in principle more a matter of poking bayonets into hay carts looking for escaping "prisoners"—searching everything that leaves a plant to

22. For a catalog of evidence of the extent of violations of pollution discharge permit terms based on government reports, see Russell, *Monitoring and Enforcement*, in ENVIRONMENTAL REGULATION IN THE U.S.: PUBLIC POLICIES AND THEIR CONSEQUENCES (P. Portney ed. 1988) (forthcoming from Resources for the Future, Wash., D.C.).

23. *Id.*; *see also* C. RUSSELL, W. HARRINGTON & W. VAUGHAN, ENFORCING POLLUTION CONTROL LAWS 16-44 (1986).

24. In reality, there are a number of different hazardous waste management situations. One is very similar to that of conventional pollutants: the hazardous substance is entrained in a water or gas stream. While there may be special technical problems of measurement and control, such cases do not present management problems that are conceptually different from those of conventional pollutants.

25. Other possibilities exist. For example, the hazardous material may become an environmental pollutant in the very act of use, as with a pesticide or herbicide, or, in a different way, as with asbestos in brake linings.

26. U.S. GEN. ACCOUNTING OFFICE, *supra* note 10, at 32-36.

discover the concealed drums and checking every existing tank or rubbish truck for waste composition. Exacerbating the problem are the unfortunate facts that many toxic wastes can cause damage in tiny concentrations, do not break down in the natural environment and can be transported through the environment by ground or surface water—whether because the chemical enters into solution or because it somehow becomes suspended in the water column. Thus, if the bayonets miss even one prisoner, society may suffer significant losses.

As a matter of fact, very little monitoring that would correspond to the bayonetting image seems to be occurring. Inspections of hazardous generators and transporters are reported to be largely of the administrative and safety varieties. The point is made by responsible state officials that to substantially increase the probability of detecting illegal transportation and dumping of hazardous wastes would be enormously expensive.[27] While it is almost by definition impossible to know the extent of the illegal dumping that is going on in the current circumstances, the few spectacular reported incidents seem unlikely to be the whole of the problem.[28,29]

One possible reaction to the situation just described is to look for an alternative system for encouraging compliance with desired goals. If the goal is to discourage disposal in unapproved sites and encourage it at approved facilities, perhaps a promising alternative is a positive incentive system. Rather than fining a generator or transporter for instances of detected improper disposal, why not pay for proper disposal?[30] The idea would be to change

27. *Id.* at 35.

28. *Id.* at 10-11.

29. The logical difficulty is that obtaining the information on which to base a sound estimate of the extent of illegal dumping activity would itself involve a substantial increase in some sort of monitoring activity and thus would only tend to show how much illegal dumping would go on if the monitoring effort were greater than it currently is.

30. Another alternative, the "waste reduction" movement, holds some appeal in the current situation because if there is less waste generated, there will be less to dispose of in whatever way. *E.g.*, Office of Technology Assessment, U.S. Congress, Serious Reduction of Hazardous Waste (1986). And one can hope that that translates into less waste disposed of illegally. The central questions, of course, are how and how much reduction will come about. If waste reduction always paid off in profit increases (or cost decreases to publicly owned facilities) and if it continued to pay off as percentage reduction approached 100, there would be no problem today. But if it requires public intervention to achieve large scale waste reductions, as in the imposition of a waste end tax, we are back to the problem in which evading the charge may be relatively easy because of the nature of the wastes. For a discussion of different possible waste end taxes structured to encourage

the balance of cost considerations that currently may make an attempt at illegal disposal attractive: "If you do what we want with your specific toxic waste, we'll pay you for having done so." Then, if the amount of the payment is tuned correctly, the source should have an incentive not to try to conceal its waste—to sneak it out the back gate and have it dumped in some distant woods—but rather to work to collect the reward. Presto! The terribly difficult monitoring problems seem to be solved. Toxic wastes all end up in the right places, whether these be recycling centers, high temperature incinerators, or specially designed landfills.

The essence of the contribution made by shifting from a stricture (or a tax) on an undesirable activity to a reward for desirable activity is the shift in burden of proof it appears to make possible. A prohibition on dumping toxic waste material by the side of the road, enforced with a fine or an administrative penalty for violation, is only as effective as the effort put into discovering violations. The regulated party must be caught to be fined. The easier concealment, the tougher the challenge. With a reward, the party must prove that it has done the correct thing. Of course, the size of the reward must be large enough to make an action, including the proving of it, worthwhile.

However, it turns out that the key element, the burden on the regulated party, is not dependent on the existence of a reward. With an important qualification to be explained in a moment, the shift of the burden is compatible in incentive terms with a tax as well. Thus, if generation is known, a tax can be charged for material generated but not turned in to the approved disposal site. The problem is, of course, that generation must be known. Knowing generation requires knowledge of the processes used by the firm or facility (to know where and what to look for) and access to the facility so that unannounced random sampling of the particular residues may be undertaken. Thus, determining generation of raw waste loads is probably only slightly less difficult as a monitoring problem than measuring unapproved disposal directly. Thus we find ourselves talking monitoring again.

In short, the major advantage of the positive incentive is that it encourages the firm or facility to meet the conditions imposed by the agency, be these matters of disposal place, timing, or form, or

changes in disposal method, to encourage waste reduction, or to produce a steady stream of revenue for cleanup of abandoned disposal sites, see CONGRESSIONAL BUDGET OFFICE, *supra* note 10, at 64-83 (1985).

all three, and reduces the agency's need to measure what is being accomplished inside the establishment itself. There are, however, potential disadvantages as well. The two most serious seem to be:

— That the payments will be a drain on the treasury, and therefore taxes will have to be increased somewhere in the system to offset the incentive payments.
— That it may be difficult to arrive at an incentive level that is high enough to encourage the desired actions but not so high as to encourage what might be called counterfeiting of wastes.

The latter problem in its starkest form would involve a firm manufacturing a compound simply in order to claim the reward for turning it into an approved disposal site. But less drastic possibilities exist, such as diluting a mix that contains the waste so that, without measurement, the agency may be duped into paying for an amount larger than that actually disposed of. These problems will be discussed again below, but for now let us consider the matter of revenue.

Because positive incentives, by themselves, mean a net increase in public spending, many, and I include myself in this group, have been drawn to deposit-refund (DR) systems.[31] Most people have had some experience with such an arrangement. For example, in most of the New England states today, when you buy a bottle or can of soda or beer you pay a deposit at the store. When that bottle is returned to a designated collecting facility, which will probably itself be a store but need not be the same one or even one in the same state, the person returning it collects the deposit as a refund, so the system creates no net call on the treasury. The idea of a deposit-refund for toxic wastes is often supported by appeals to experience of various U.S. states with bottle and aluminum can DRs, of Sweden and Norway with DRs for automobile hulks, and of West Germany with a lubricating oil tax and a waste oil rebate system.[32]

The bottle, can, and auto hulk systems seem quite to the point. When a purchase is made, a deposit is added to the price. When the object in question is returned to a designated place a refund is paid. The place of return for bottles may be any store or may be a

31. PETER BOHM, DEPOSIT-REFUND SYSTEMS (1981) (for a discussion of DR systems).

32. For a description of the latter two systems, see generally, ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT, ECONOMIC INSTRUMENTS IN SOLID WASTE MANAGEMENT (1981).

specific, designated receiving store; for auto hulks, a dismantler and press.

The German lubricating oil system is somewhat different. In that system a tax is charged on all lubricating oil purchases. The proceeds go to a reserve fund from which aid is paid to firms that engage in collection and non-polluting disposal of waste oil from various uses. The amount of aid depends on the fate of the oil, whether it is burned or cleaned up for recycling. The aid is designed to make up the difference between the firms' costs and their proceeds. Table 3 provides a summary of existing (in 1984) and proposed "product charges", including the DR systems discussed above.

TABLE 3. PRODUCT CHARGES AND DEPOSIT-REFUND SYSTEMS IN EUROPE[a]

CURRENT	PROPOSED
FRANCE	
Product charges are not currently used in France.	None
For a short period (1979-80) there was a charge on lubricants used to subsidize the re-refining industry. This was later replaced by a system of regulatory controls designed to provide regenerators with waste oil at low cost.	
GERMANY	
Waste oil charge. A levy is raised on all lubricants put on the market and the proceeds of this levy are used to provide financial assistance to waste oil collectors in order to facilitate recovery.	There are recurring proposals for a charge on beverage containers. The suggestion of its introduction has been used to encourage industry to operate container recovery and re-use systems.
This levy (and the subsidy scheme) is to be phased out gradually up to 1990. The scheme has helped to set up an established collection and recovery industry, and oil prices are now sufficiently high that the value of waste oil itself provides an incentive to recycling.	
NORWAY	
Charge on non-refundable beer and mineral water containers	Charge on heavy metal batteries
Deposit-refund system on automobile bodies. Deposit paid as part of import duty on new cars. (In 1979 this amounted to 1% of sales price). Refund paid at any of 100 collection points.[b]	Charge on chlorofluorocarbons

SWEDEN	
Charge on beverage containers. This was introduced in 1973, and intended to reduce the use of non-returnable beverage containers. This charge is to be discontinued and replaced by a more comprehensive deposit system.	The beverage container charge will be replaced by a deposit system to include cans as well as bottles. The scope of the deposit system will be larger than that of the container charges and deposits will be set at SKr. 0.25 rather than SKr. 0.10 which was the charge made.
Charge on fertilizers. A charge, which adds about 10% to the price, is levied on fertilizers based on nitrogen and phosphorus content. The intention of the charge is to encourage reduced fertilizer use. This charge is to be gradually increased over the next few years to 25% of fertilizer prices, and further increases to 50% in 1990 are under discussion.	The funds generated will be used to finance a collection and recycling system intended to recycle 75% of aluminum cans. Manufacturers have also guaranteed to maintain systems for recycling bottles.
Vehicle scrapping deposits. Since 1976 a charge of Skr. 250 has been made on sales of new cars. When a car is delivered to an authorized scrap dealer, the final owner receivers SKr. 300 and all liability to car tax comes to an end.	Charge on heavy metal batteries. A charge of SKr. 0.5 will be paid on each battery imported. Charge revenue will be paid to a collection and recycling company who will in turn offer an incentive to consumers to return used batteries.

Notes:

[a] Adapted from table 3.6(a) in Environmental Resources Ltd, "Cost Effectiveness: Experience and Trends" prepared for the government of the Netherlands, June, 1984.

[b] Organization for Economic Cooperation and Development (OECD) 1981. *Economic Instruments in Solid Waste Management*. Paris, OECD.

So far so good. The available commentaries have positive tones, though no data on the before and after situations are offered.[33] There are other advantages of the DR systems as well—for example, that they can provide decentralized incentives to achieve the desired end.[34] That is, the refund on a bottle goes to the person who returns it, regardless of who purchased it. Thus, some people may spend time collecting littered bottles—even, conceivably, collecting auto hulks—as an income supplement. Applied to toxic wastes, this might mean that, with some specialized equipment, scavenging firms could pick up discarded drums and turn them in, either determining their contents or letting the collection center do so. Of course, that feature would not help if the toxic has been dispersed, as some have been, by spraying along rural roads, for example.

A natural question at this point is: what are the real chances that positive incentives, perhaps in the form of DRs, could be suc-

33. Economic Instruments in Solid Waste Management, *supra* note 32, at 42-45 and annexes.

34. Bohm, *supra* note 31, at 6.

cessfully applied to hazardous wastes? First, stressing the positive reward aspect rather than the self-financing via deposit, consider some of the attributes of bottles and auto hulks that can be presumed to contribute to the success of these systems. Most important, auto hulks and bottles are easy to identify. No sophisticated or lengthy chemical tests are necessary. There is no danger that a bicycle frame could be fraudulently passed off as an auto hulk or that a soup can could be a beverage bottle. Second, the auto hulk, at least, is most unlikely to be fabricated just to get the refund. That is, there is little risk of finding that an auto hulk producing industry has been created and is producing auto hulks purely for refunds or that car thefts would occur to produce hulks rather than drivable cars. With bottles there may be a fine line between a deposit high enough to pull in returns but not so high as to encourage counterfeiting. A final attribute worth mentioning is that it takes effort to destroy and dissipate hulks and bottles. The original object can survive some rough handling and still exist to be returned.

It seems possible that, in certain circumstances, refinements could be introduced into the DR system to reduce the chances that the agency will be defrauded. For example, the purchaser of a machine or compound could be given a piece of paper—a title or manifest—that would set out just how much of what was bought. This would have to be produced along with the actual item(s) to qualify for the refund. Then counterfeiting would involve both item and title. Chances of detection would be increased. Such a system would perhaps be justified for large purchases such as refrigerators (containing fluorocarbon compounds in their cooling systems). But it seems clear that at some point, as the cost of the item(s) purchased decreases, the system would cease to be justified.[35]

In thinking about applications of positive incentives in general and of DR systems in particular, it will be useful, if not essential to ensure the success of the system, to begin by cataloging the hazardous wastes that display the characteristics identified above. For example, refrigeration units containing freons (toxic only indirectly via their effect on ozone) seem to fit these categories.

35. Applying the manifest idea further up the chain, say at the wholesale level, would probably imply that the ultimate purchaser/user would have to bring the item to a particular place so that it could be matched against the wholesaler's record. This might not be a problem for, say, containers.

They are easy to identify, unlikely and difficult to counterfeit and difficult to destroy. Mercury batteries may be hard to destroy, but identifiability could be a problem and counterfeiting would seem a definite threat. Liquid chemicals and sludges—for example, the halogenated hydrocarbon solvents and chemical reactor "bottoms"—are more problematic still. It will be difficult to determine whether a compound presented at a disposal site is actually that for which the refund is offered. It will be harder still to tell whether the compound has been diluted or contaminated with other substances. It may be that counterfeiting will prove worthwhile for some compounds or at least that some cheap dilutant may be profitably substituted for the compound of greatest interest. In short, to the extent that the identity of the waste being returned is in doubt, monitoring will be required and will be more demanding than that required for eyeballing a bottle or an auto hulk. This will be true whenever the system has to deal with containerized materials that may not be what the label asserts.

The above cautions are not meant to suggest that DR systems should be relegated to the scrap heap, if the expression will be pardoned. Rather, the lesson seems to be that, as in every policy issue, the closer we examine the facts, the more complicated the task becomes. Thus, when examining any particular disposal problem, it will be helpful to bear in mind the following questions:

1. What do we want to achieve:
   — Reduction in use, as we might for a pesticide;
   — Recycling and recovery of (nearly) all of what is used, as we might for a solvent, lubricant, or refrigerant;
   — Relatively safe disposal, as we might for a compound that breaks down but does not dissipate in use?
2. What are the "characteristics" of the use of the hazardous material:
   — Inevitably dissipative, as for herbicides and pesticides that have been introduced into the environment;
   — Naturally conservative, as for a refrigeration unit?
3. What are the characteristics of the source:
   — Fixed, as are classical point sources of air and water pollution;
   — Moveable, if not actually moving, as in small volumes of liquids generated in ways that make capture and containerization feasible?

4. How hard is it to identify the waste stream?
   — Will simple inspection suffice, as it does for car hulks and bottles?
   — Will it be necessary to perform simple tests, such as a weight check, or a straightforward qualitative analysis to see if the material is, for example, an acid?
   — Will a difficult quantitative analysis be required to determine composition and contamination levels?
5. What is the origin of the waste:
   — Contaminated residue of something toxic introduced into a process, such as chromium in the plating industry;
   — A product of the process itself such as dioxin;
   — A product that once used becomes a toxic discharge, such as a pesticide or herbicide?

The application of these questions to specific design problems may be illustrated with a few examples:

- If the hazardous material is inevitably dissipated in use, society cannot reasonably have as a goal its recovery. But the goal of decreased use is reasonable. As a general rule, orders to reduce use will involve enforcement difficulties. But a tax on the material itself has the decentralized effect of encouraging each user to decrease use. The size of the tax can be tailored to produce the desired decrease in use if the appropriate demand relation(s) is(are) known.
- If recycling is the desired goal, a reward for turning in the recyclable material sounds promising. As suggested above, the easier it is to be sure of the identity and suitability of what is returned, the easier it will be to administer the reward.
- If the waste is generated in large volumes in a production process (spent pickling acid from a steel mill, for example) the problem begins to look a lot like a standard point source problem. The sources' options for evading regulations and thus avoiding negative incentives will be limited. The definition of waste as hazardous need not determine the approach to achieving a goal of safe disposal.

Beyond this common sense sort of analysis, what can be said about the potential impact of economic incentives in toxic waste control? For example, what about static economic efficiency, a major concern of commentators exploring such incentives in other environmental pollution contexts? The answer to this apparently straightforward question is a complicated one: whether economic efficiency is even a well-defined concept, let alone a benchmark we can conceivably approach, depends on answers to the above questions. Thus, for example, if society wants to achieve 99 percent recycling of spent auto lubricating oil, regardless of source (service station or backyard), then, a deposit-refund system has promise, and the size of the refund need not vary with location of the source (though it might vary depending on the type of source—whether private person or repair shop). Therefore, trial and error could conceivably be used to establish the appropriate refund, which would be that refund resulting in exactly the desired percentage of recycling. The cost of achieving the goal would, at least in theory, be minimized by applying this deposit-refund level.

If, on the other hand, the goal were to keep groundwater contamination below some upper limit in a particular aquifer, source location would matter because the relation of discharge point to the flow of water in the aquifer would determine the contribution of any particular source to contamination at any "downstream" point. The relationships between specific source discharges and observed downstream contamination are difficult to determine for aquifers with more than one or two sources of contamination or with complicated flow patterns. Because source location matters to relative contribution to the problem, the size of the optimal refund per gallon for each source would in principle have to vary to achieve economic efficiency. But finding a set of location-specific deposit-refund levels would be very hard to do given the current state of knowledge of most aquifers, as just discussed. Further, trying to determine the efficient (cost-minimizing) deposit-refund levels by trial and error would be costly to undertake and probably doomed to failure in any case.[36]

36. The extra expense of trial and error policymaking lies in the combination of lags in response by the sources to changes in the refund level and in the irreversible commitments of investment capital they make when they do respond. The first imply extra damages to society and the latter imply extra disposal costs—where "extra" is measured relative to a situation in which the correct refund level can be calculated in advance from knowledge of source costs and natural world (here aquifer) behavior. The effort would probably fail because even if the agency found a set of refunds that seemed to encourage the right level of waste recovery or destruction, it would be essentially impossible to determine merely by further trials whether this was the cost-minimizing set.

CONCLUSION

The bottom line amounts to this. Economic incentives seem to have some unique promise in the hazardous waste field. This promise grows out of the chance to change the terms of the monitoring and enforcement problem of the environment watchdog, not out of the promotion of economic efficiency. It is potentially greatest where the wastes involved are segregated and generated in small volume, precisely those situations in which the threat of improper disposal is most serious.

Although positive reward systems are not required to reap these benefits, they are most likely to be the systems of choice. A taxation system requires knowledge of raw waste generation so that the difference between amounts generated and amounts properly disposed of may be taxed. Deposit-refund systems have the advantages of being self-financing and of promoting decentralized actions to correct improper disposal. But they are effective only where the waste is in the form of an appropriate deposit vehicle. It must be remembered that even a reward system leaves the agency with a monitoring problem. How difficult this problem is depends on how hard it is to ensure that what is submitted for the reward is what it purports to be.