HAZARDOUS WASTE POLICY MANAGEMENT – INSTITUTIONAL DIMENSIONS

INTRODUCTION and CHAPTER ONE: Hazardous Waste - What Kind of Issue?

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May 1984
WP-84-41

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PREFACE

This paper has been produced as part of IIASA's hazardous waste management work, which is the main component of the Institutional Settings and Environmental Policies project. The overall aim of this work, reflected in this paper, is to systematize our understanding of interactions between institutional and technical factors in policy making and implementation. The influence of institutional processes upon technical knowledge built into policy has been increasingly recognized. However, it has yet to be adequately clarified in comparative research on different regulatory systems. Institutional structures canot be easily transplanted from one culture to another. Nevertheless, through the normal flux of policy, institutional development slowly occurs anyway, in more or less *ad hoc* fashion. Comparative insight may help to direct reflection and adaptation in more deliberate and constructive ways.

This paper forms one draft chapter of an intended book on hazardous waste management. The reader will therefore notice references to other draft chapters in this study which are also being circulated separately, and which are available from IIASA. A full list is given overleaf. At this stage the papers are drafts, and are not intended for publication in present form. They are being circulated for review and revision.

I would like to thank those policy makers and others who have exchanged papers and information with us, and those who generously gave of their time and experience in the many interviews which form a substantial input to this work. A full list of acknowledgements will eventually be published.

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INTRODUCTION

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In 1979, the Dutch waste treatment company UNISER was found to have been illegally disposing of large quantities of hazardous wastes and defrauding its customers, which included most of the Dutch chemicals industry [1]. Yet the only law under which the company could be prosecuted dated from the 1850s, and was originally designed for preventing the sale of contaminated meat. Furthermore the credit for eventual prosecution went to local authorities, who persisted doggedly through years of evasion, lack of support and even informal central intervention to suppress the issue.

This example may be an extreme one, but it is not in kind unique. It symbolizes the gulf evident in most countries, between: on the one hand the rapid growth of sophisticated international industries involving countless specific chemicals, complex mixtures, movements and environmental implications, and on the other the underdevelopment, fragility and frequent impotence of regulatory institutions. Despite outbreaks of policy activity following the diversion of

the Seveso dioxin wastes in Europe, effective international regulation especially lags well behind the growth in scale of the issue. Ironically, lack of implementation of *national* policies in the form of controlled disposal sites, spills over into increased international transport and makes the lack of effective regulatory frameworks and stable agreements at this level all the more costly and vulnerable to major disturbances.

Regulatory bodies are increasingly required not only to perform technical administrative implementation of policies, but also to perform the political function of reconciling conflicting perception and interests in the policy domain, in the *justification* of policies and implementing regulations. They have also to manage this balancing act in an increasingly taut net between international concerns about trade in hazardous wastes, and local concerns (e.g., facility siting opposition) which may nevertheless have international ramifications. In the language of operations research, the feasibility space for effective regulatory solutions appears to be relentlessly diminishing.

Traditionally, two of the few resources of regulatory bodies have been the legislation which has given them formal powers and responsibilities, and scientific knowledge which has often completed gaps in formal authority with the authority of science. Although in some contexts these have been supported by extra-institutional influences such as public opinion, other informal factors have acted to undermine environmental policies. To return to the Dutch case for example, UNISER became involved in a major scandal which led to its dissolution and the jailing of several of the company's directors, including one who sat on a government expert advisory committee. UNISER was initially the only waste treatment operator available to the chemicals industry in the Netherlands, so its demise was a severe shock to the system. Yet despite this major

stimulus to create an effective infrastructure, and despite legislation, no such waste treatment and disposal (T and D) facilities yet exist nor are definitely planned in the Netherlands. In an apparently very different system, Hungary [2], a planned national infrastructure of three incinerators and five controlled landfill facilities could not be implemented, for central and local institutional reasons some of which are similar to those frustrating policy implementation in the Netherlands. Thus although there are differences, in both countries industry could not be persuaded or forced to join investment in the facilities nor to protect the investment once made by guaranteeing that waste be submitted to the facility rather than more cheaply disposed of. Both countries' policies have also been undermined by successful local opposition to facility siting.

Different national systems have had their own experiences, but virtually everywhere, legislation to control hazardous waste disposal has been jerked hurriedly into being by rude shocks to the policy system. Whether hasty or "glacial" [3], movement towards the apparent step of formal legislation does not herald any discontinuous change in the structure of institutionalized interests which constrain the emergence, framing and details of such legislation. The same forces continue to exert themselves through the implementation phase, exercising constraints, diversions, delays and transformations corresponding with their interests, perceptions and other commitments [4]. Thus even where elaborate legislation has been passed, as it has now been in most industrialized countries, technical and institutional factors have combined in different but patterned ways to obstruct implementation, so much so that some authorities in this field fear that the public credibility and viability of regulatory systems is in jeopardy [5]. "Implementation gap" and "enforcement deficit" have become

standard terms in analysis of environmental policies. As we shall argue, for several reasons, hazardous waste regulation is qualitatively more difficult and complex than conventional environmental regulation.

Modern environmental policy making, whether it be primarily about reshaping industrial development or about equitable risk management, is itself expensive and elaborate. Furthermore, it proceeds upon complex and not altogether stable foundations of public attitudes, organizational dynamics and political processes. These can become entangled in intensifying conflict, inefficiency and wastage when expectations embodied in policy goals are repeatedly and even sometimes spectacularly diverted or unfulfilled. Interactions between regulatory styles, institutional settings, uses of science, and public attitudes are central to the success or failure of policy making and implementation.

Hitherto, the allocation of risks and the adaptation of economic production through environmental policies has been treated as a problem at the margins of economic policy making and technological choice. However, the scale of such risk and environmental impacts, their multiplication, (e.g. through organizational ineffectiveness or public attitudes), and the scale of implied capital and resource movements, mean that increasingly disruptive perturbations can be created in economies, social systems and international trade and political arrangements. Policies that are unrealistic as to their implementability, and policy making that does not take account of organizational realities as well as technical ones in evaluating options, are reductionist illusions. They are not only economically wasteful but politically costly too [6].

I. Why Hazardous Waste?

Hazardous waste is one of a family of important environmental– industrial issues such as acid rain, climate change, and toxic chemicals, which exhibit growing international ramifications. However their complex origins, and potential solutions often lie at national or local levels, within formally autonomous or informally divergent social and economic units. For all of these issues, the attempt to relate technical, and economic factors to social factors at international, national and regional levels is beset with conflict and uncertainties.

However because of certain unique properties, hazardous waste may be described as the black sheep issue even in this problem family. At least with acid rain there are some uniformities — there is pretty good agreement for example, at least as to what sulfur is (even if there is disagreement about its causal role in creating damage). There is no such agreement as to what hazardous waste is (and *also* disagreement about its role in creating harm). Furthermore although an essentially valueless material, it is packaged, concentrated and traded — it is passed between human agents and institutions which define it in different ways. Social mechanisms channel its environmental disposition more significantly than, say, acid rain. As described later, these and other factors introduce extra challenges to regulation, and to policy analysis.

New kinds of potential perturbation of policy systems and international arrangements are created by some of the key structural properties of hazardous waste as an issue. In this work these properties are systematically analyzed for their technical and institutional implications. Since international regulation of hazardous waste is widely regarded as urgent, yet in practice is at best in embryonic form, we have attempted to return to first principles, guided by two convictions:

(a) that the field still lacks strategic definition as a policy problem-area; and

(b) that moves to establish effective *international* regulatory regimes should be based upon a better understanding of how characteristic *national* or *regional* institutional factors influence the definition, meanings and uses of the (in principle) universal resource of scientific knowledge, and key technical terms for regulation.

Our attempt to outline a strategic definition first distinguishes between fundamentally different kinds of uncertainty which are frequently confused. Three key insights cause us to reverse the conventional "linear" relationship between uncertainty, technical knowledge and regulatory relationships [6]. The usual model supposes that uncertainty is based on technical imprecision, but this is fenced in to manageable probabilistic uncertainties (risks) which can be processed into standards. The key insights (developed in later chapters) are that:

(i) technical imprecision is subordinate to, and may be amplified or reduced by *behavioral* indeterminacy and social– organizational pluralism creating different definitions of the issues and problems;

(ii) technical divergence in risk analysis is frequently not due to mere imprecision or ignorance, but to different, actively constructed *expert* definitions of what the risk problem is to be analyzed [7]. These may partly reflect different institutional positions;

(iii) there are continuities between the processes of expert and lay risk perception which are usually obliterated by heavy emphasis upon the supposedly categorical differences. Models of decision processes also

tend to define the interest groups, their agendas and perceptions according to "the" issue and "the" decision process, whereas it seems more proper to define "the" decision process and "the" issue according to the full agendas, priorities and perceptions of different groups and organizations, including different experts.

Previous work in the IIASA Risk group has analyzed the role of risk assessment in decision processes in such fields as nuclear energy, liquid energy gas facilities, oil drilling blow-outs, etc. [8] As with most risk analysis, these all involve relatively monolithic technologies, each with fairly uniform risk-characteristics. The effects upon analytical divergence and uncertainty of different *expert* perceptions and definitions of the technological–behavioral system (let alone lay definitions) can be seen even in these cases. However with its extreme heterogeneity, the concentration and transferability of waste, and its great behavioral indeterminacy, hazardous waste management poses the analytical issues more sharply, and poses a correspondingly more complex practical policy challenge. For these reasons, its international importance, and other reasons indicated throughout this work, hazardous waste appeared to be an analytically challenging and practically important topic to pursue within IIASA's risk management tradition. These appearances have not been disappointed.

II. Why This Study?

Previous work and familiarity with the field in general lent several premises to our research questions:

1. Policy implementation requires more thorough analysis as an institutional, nor merely a technical problem; institutional analysis of

implementability needs integration into mainstream policy analysis [9].

Policy making and policy analysis have in the past focussed too heavily upon optimizing policy-making decisions, relegating implementation to a supposedly trivial after-phase. Yet, unrealistic assumptions about implementation have often been built into policy decisions themselves, with subsequent failure to meet policy targets and promises. This not only squanders resources; it also undermines the credibility of the policy system, potentially entering a vicious circle of decreasing implementability. As a leading policy maker in the hazardous waste field has warned [10]:

> the discrepancy between the daily practice of disposal and official political objectives and pretensions is obvious.... In many cases there is an obvious discrepancy between regulatory requirements and the actual means of meeting them. The enforcement gap is not only a permanent threat to the environment, it also affects the credibility of legal provisions in place.

2. Implementation constraints are strongly determined by the same institutional and technical factors which influenced policy making (legislation) in the first place.

It is always valuable to trace the historical evolution of policy making concern and the emergence of a dominant public policy problem-definition. With such a historical perspective one may see how legislation on a given issue is shaped by relatively arbitrary factors. Seen this way, formal policy decisions are only one phase and not in any way an end-point in a continuous flux of maneuvering and negotiation between different groups. The technical dimensions of policy are nested in this process. Thus implementation constraints and options have to be examined and understood historically, in the light of the informal processes feeding into, and through legislation and formal policy decisions (e.g., specific regulations) into implemented (or non-implemented) real

consequences. This has to be analyzed carefully at national and local levels, including their interactions.

3. Formal risk assessments and related techniques need to be integrated with an understanding of diverse organizational rationalities and perceptions.

Risk-benefit analyses and other formal decision aid techniques assume that the rationality of optimization determined from some central policy level prevails throughout the policy domain. Yet, the implicit requirements of a given policy may be unrealistic with respect to the constraints and rationalities of other parts of the system, even *within* e.g. a single regulatory bureaucracy.

This rationality may break down on these (and other) counts as a result of diverse local organizational and technical realities. Risk assessment for regulation has yet to progress far enough to take full account of implementation realities. Some have argued that it is only the local transformation and even contradiction of central policy rationales by local actors which (informally) maintains the viability of such policies [11]. This is discussed more in chapter three.

4. Anxiety underlies decision making in this area, and interacts with the misuse of science. The resilience of the policy process as such is an issue.

As already noted, implementation difficulties have given rise, at least in the hazardous waste field, to a feeling that the credibility of decision making is under threat. "A climate of fear now dominates the discussion of environmental issues" [12]. The dynamics of credibility and "legitimation" are complex and tortuous, but the consequences of its lack are highly concrete and vitally important.

Previous work and the present study

Several international organizations have conducted research or held expert meetings on hazardous waste management. It is therefore necessary to address the question: why another study? The reply is to be found by briefly examining the previously established work.

The largest study has been that undertaken by the North Atlantic Treaty Organization, NATO Committee on Challenges to Modern Society (CCMS). This began in 1973, and was organized into working groups each of which tackled a specific aspect of the overall issue. A first phase was completed in 1977, and a subsequent phase in 1981 [13]. Late work has focused on the problems involved in reclaiming contaminated land. As more, uncontrolled landfill sites are found, and as controlled ones fill up and are closed down, the research may become of more and more importance. However the main effort of the broader CCMS work on hazardous waste management was more or less completed before any of the countries then legislating or about to legislate policies for hazardous waste managements had been able to gain any experience of the formidable *implementation* problems which have since become so prominent. Although valuable groundwork was laid in the NATO study, at that stage the general assumption tended to be that if loopholes existed in regulation, these could be closed by making legal definitions of key technical terms more scientifically accurate and precise, and by investing more effort in local enforcement.

The NATO study examined regulatory/technical options, but was not sensitive to the full impact of dimensions of ignorance and uncertainty, nor to the interactions in implementation between different institutional arrangements, risk defining processes, and technical judgments and decisions. A further limitation of any comparative insight from this study was that it was confined to

liberal market economies, and although there are many interesting differences of approach amongst these, the opportunity for comparison with a centrally planned economy did not exist.

One prophetic observation stands out from the 1977 Final Report of the NATO Study, but its prospective insight was not followed up in further research. It was noted that if implementation of hazardous waste legislation was not effective, the public credibility of the legal frameworks would be threatened. We would go further and add that the credibility and viability of the governing institutions themselves is undermined by ineffective and uneven implementation which has been experienced since the NATO CCMS Report and the enactment of most hazardous waste legislation in the mid- to late-1970s.

The UN Environment Program has taken considerable interest in hazardous waste management since 1980. Under the adage that in hazardous waste as elsewhere, "an ounce of prevention is worth a pound of cure," UNEP has attempted to provide a framework for ensuring that less developed countries do not repeat the mistakes of industrialized countries which now find that the economic and political costs of old, uncontrolled waste-dumping far exceed the costs of controlled treatment and disposal from the start [14]. Part of this concern has caused UNEP to attempt to gather reliable data on the production and movements of hazardous wastes, especially across international borders and to poor countries desperate for foreign currency and with no technical resources or infrastructures to deal properly with such wastes. This initiative however is still in its earliest stages, and even national or regional authorities lack effective data on what they are charged with regulating, where it goes, etc.

A major concern of all international bodies has been the lack of an internationally agreed definition of a hazardous waste. Attempts at conventional forms

of regulation, such as registering and controlling all movements and disposals of hazardous waste, fall at this first hurdle because no workable universal definitions of the crucial terms exist. Even so, such bodies continue to seek a formula that would act as a single internationally meaningful framework into which all national and regional definitions and hazard classifications could be fitted. This objective has been the cornerstone of all attempts at regulation; where difficulties of harmonization and implementation of international agreements or directives have been encountered, the blame has been attached to imprecision in the key terms. The assumption has tended to be that this could be eradicated by more careful analysis and technical precision. However more recently, some experts have begun to appreciate that such apparently purely technical terms also inevitably incorporate local, particularistic administrative concerns and institutional factors [15]. This point has not been developed until the present work; yet it has radical policy implications.

International policy initiatives therefore, such as UNEP/WHO's 1983 collaborative document, *Hazardous Waste Management — Policy Guidelines and Code of Practice* [16] offer sound policy principles, which lack consideration of the problems of implementation as they arise in local institutional circumstances. Many of the very severe problems of implementation that hazardous waste policy has encountered have to do with the widely different perceptions, purposes and strategic definitions being used by diverse actors in the hazardous waste field. The European Commission's experience has been that policy directives painstakingly negotiated and on the face of it, sound, are then watered down, and adapted in a variety of different, not always compatible or acceptable ways, by local institutional processes through which they have to pass in order to be implemented [17]. Even common technical definitions can take on widely

different practical meanings when transformed from policy into implemented reality.

OECD's Hazardous Waste Management policy group has been compiling and acting as an information-exchange forum for some years. Again, this is only for market economies This work has mainly been conducted on three fronts — dealing with past dumps; international transfers; and siting of new facilities. In connection with the problems of international movements, the OECD group has been attempting to develop a single cross-referencing chart which would "unify" the different hazard classifications schemes of all the OECD countries plus international conventions such as the London and Oslo sea-dumping conventions [18]. Like the work of other organizations such as EEC, OECD's contributions have been quite properly tied to more closely policy-defined needs, and have also in the case of the hazard classification "dictionary" for example, reached the point where the problems of *implementation* of policy schemes just begin to rear their ugly head.

With the possible exception of the UNEP work, all of the previous international policy analyses of hazardous waste management were conceived and/or conducted at a time of innocence about implementation difficulties yet to come. That innocence has rapidly and in some cases, painfully evaporated. We now know that making policy *reality* rather than myth involves far more than tightening up the crucial terms and definitions with more science. But the complex interactions between technical and institutional factors which make implementation such an important (though still underrecognized) part of policy *making*, have yet to be understood and their implications clarified for policy processes and designs. This is where the IIASA group's experience lies, and where its work is targetted, as a complementary effort to those already in

existence.

One other important point of difference between our research and other internationally oriented work on this topic should be stressed.

International policy and research bodies naturally tend to focus on the international dimensions of the regulatory problem. However it is worth first examining where the international dimensions originate, so as not to take them — and their continued growth — for granted. There are two coinciding strands; (a) national and international companies "trade" many kinds of hazardous wastes to treatment and disposal facilities elsewhere. They wish to ensure free international movements as a general principle, and exert policy pressure accordingly; (b) they are supported by many national policy makers who see that public opposition to siting domestic facilities (or lack of industrial interest in investing in them) makes export of wastes an important outlet to maintain. Yet other political and economic realities mean that restricting cross border movements of most hazardous waste would be an attractive option. If the *domestic* conditions could be created to make this feasible, this would take a lot of pressure off the troubled international regulatory level. In addition, as we argue, technical harmonization needed for regulation at this level is intrinsically limited by national institutional factors. Research on domestic policies and institutions — especially comparative research — *is* research on the international policy options too.

International policy research on hazardous waste has reached the present point, where experience from earlier research and policy initiatives has gradually led to the realization that the roots of the major international problems lie in local factors: international trading in hazardous waste, and perturbations in such systems are affected by domestic difficulties in establishing treatment and

disposal facilities; international standardization of hazardous waste definitions as a means of international regulatory control is made impossible by the incompatible, diverse *local* administrative functions and meanings of such technical frameworks.

It has taken major international efforts and initiatives to work backwards to this point. Entering the field rather later, and with a different background, we have therefore gone straight to inter–national *comparative* research, on those different local roots and what grows from them. Only after this local comparative focus can we then return to the international policy domain with a better understanding of the constraints and potentials of the options for design of effective international policies and institutional arrangements.

III. Science for Public Policy

Underlying this research and previous risk assessment work at IIASA have been a lasting interest in the roles of science in risk management-policy problems in general [19].

As discussed later, there are fundamentally different ways of defining hazardous waste management as a policy problem. The dominant public perception is of a risk management problem, yet from the policy making standpoint it is more a controlled industrial development problem. To policy makers the "hazardous" aspect of hazardous waste is a relatively minor issue, and their main concern in this domain is to convince an uneasy public that this is so [20].

> "Extensive efforts are needed to inform the public better on the technical criteria involved in hazardous waste disposal and on how far precautionary measures are taken to exclude or limit short term and long term risks. It has to be demonstrated to the public that disposal

> facilities are designed and managed properly so that people feel confident that things are done in the right way and in the interest of citizens themselves.... There are experiences well proved and persuasive disposal concepts and technologies existing. What we have to do is to sell them better to the public."

Largely as a result of this pressure to justify policy commitments to third parties in several areas, environmental policy and the regulatory use of risk management has assumed the existence of developed scientific underpinnings which are not there. To some extent this has been beneficial in forcing such scientific attention and development in e.g. toxicology, like the strategy of regulatory forcing of pollution control technology development. But frequently the elaboration of statutory regulations (and political pressure behind them) has proceeded as if the science were already developed, and has created enormous pressure to produce the necessary "applied science" very hastily, and within strong constraints as to the scope and depth of such research. The understatement of various kinds of uncertainties and methodological limitations, and even downright falsification [21], has been an inevitable result. This has all been based upon the misconception that the science either was in place, or could be definitively developed to an external mandate, in a given time.

Even if bureaucratic dynamics require a belief in objective, rule-bound knowledge, the full extent of this policy "forcing" of science, and of the ignorance, uncertainty, variability and lack of normal scientific standards which it leaves, is increasingly, if incoherently, recognized in public, leading to loss of credibility. This suggests that a fundamentally different approach may be necessary. Rather than create policy and foster international mechanisms which rely upon or suggest that definitive and elaborate scientific knowledge can be used to meet legal and statutory rules embodied in policy, it may be necessary to devise a more explicitly adaptive, open-ended regulatory process.

This would recognize the *intrinsic, institutionally cultivated* nature of scientific uncertainties, and would therefore explicitly allow in policy design for the evolution of scientific uncertainties and of the negotiation of their interpretation into policies [22]. Some systems approach this adaptive model more than others, though their adaptation may be essentially private to the regulator and regulated party. A main part of our research has been to explore this idea, especially attempting: (i) to characterize more clearly the types of uncertainty which are critical in this issue, and (ii) to understand the crucial dimension of interaction between public attitudes towards regulatory science, and the role for science which regulatory institutions tend to express.

Frequently, hastily produced science has been used as if it were definitive knowledge so as to bolster policy positions on risks, only to have that science later shown up in public as incomplete or shoddy. Often it may be only "incomplete" against unrealistic expectations or criteria laid down, for example, in legal processes; but there is a basic confusion between the use of science to produce *truth* (which in these areas usually only means overwhelming uncertainties and decision-paralyzing sets of qualifications to every statement) and its use (and overuse) in cultivating *public authority*. Many policymakers, not taking the hazard issue too seriously, use science to bolster public authority without appreciating the intrinsic backlash they may be setting up.

Even scientists themselves tend to have underestimated the extent of informal judgements and unspecifiable decision rules within science; these cannot be formally justified, especially not in skeptical settings such as policy or legal arenas. When so tested therefore, they frequently fail the test of credibility [23]. This not only damages specific policies or claims, but the institutions' general credibility because they have pinned their public authority to

simplistic images of science. The frequent response to signs of this diminishing credibility (as in siting paralysis) is to produce *more* science, performed in hasty circumstances, and thus inadvertently to intensify the negative feedback effect.

Comparative research in this field is valuable because it indicates how flexible is the use of the same science, to the same current regulatory purposes, in different institutional settings. Decision rules in science are not fixed and fully specifiable — this is part of the flexibility of science. This creates difficulties in justifying scientific decisions which have policy commitments (e.g., the social allocation of health risks) inextricably embedded in them. Different political cultures distribute the responsibilities for public authority very differently through their institutional networks, with correspondingly different demands upon science, and different implicit claims about the nature of issues.

IV. Organization of Study and Outline of Chapters

The unifying theme of this study is the influence of institutional settings on the ways in which technical knowledge is used and risks are defined for regulation. The following chapters examine different institutional settings and uses of technical knowledge in an attempt to clarify which factors in different settings are essential to the *issue* as it is found in whichever setting, which factors are essential to a given regulatory institutional setting; and how these intersect to influence the implementation of national policies. This was designed as a first necessary phase, before being able more thoroughly to examine the international policy dimensions.

Before outlining the chapters, some brief mention should be made of the way this study was conducted. As indicated, the research was intended as a first necessary phase, to examine national institutional settings, before returning better equipped to address the international dimension more directly.

Without the resources to employ field workers under our control, operating to a common methodological framework on a common, specific decision problem (e.g., a siting issue) in several countries, we have had to be pragmatic and opportunistic, moulding possibilities of external collaboration towards our concerns, and to some extent in return shaping our framework in the light of those possibilities. Our strategy has been to identify a few key themes, then to identify in which countries those theme questions are most sharply drawn amongst the countries in which we have conducted significant research. Thus chapters four to six inclusive are theme chapters, with "lead countries" illustrating those theme issues; though they all contain comparative materials, these are not developed in equal depth. This is an inevitable limitation of our study, but it should be remembered that we are offering a structure to the key policy *questions*, not claiming solid policy *conclusions*.

The next chapter outlines three different possible strategic policy orientations towards hazardous waste, and shows how they often conflict with one another in reality. For hazardous waste management the need for industrial innovation is dominant, more so than for (dispersed) conventional emissions, and conflicts sharply in some dimensions with environmental risk management strategies. Chapter one then goes on to examine the main structural properties of hazardous waste as an issue that are universal and thus potentially cross-cut or underly the imprint of different regulatory cultures in which the issue finds itself being managed. These properties also strongly influence the

ways in which risk assessment could be used in the policy management of hazardous wastes.

Chapter two evaluates this question by reviewing the general state of the art in risk assessment. It also extends the current state of understanding in its treatment of uncertainty and expert problem-perception. This chapter stresses the correspondence between the different structuring of decision rules in science for risk management and different institutional structures of regulation. This underlying framework allows an examination of the tension between standardization of scientific risk criteria and regulations, and variable, situation-specific optimization. Chapter three begins by looking at the more extensive structure of possible regulatory nodes in hazardous waste management, and evaluates the kinds of risk assessment relevant to each point of influence. A key observation of chapter three is that hazardous waste belongs to a class of policy issues whose uncertainties embody multiple, contradictory definitions of the problem, and even widely divergent constructions of apparently straightforward, 'crucial' data such as hazardous waste arisings and movements (or in other fields, deforestation rates and fuel wood consumption). It is shown how this extra dimension of ignorance with heterogeneity makes the standardization–situational optimization dilemma unusually difficult in the hazardous waste case, so much so that a management option of institutional *risk-absorption* becomes more attractive. This strategy has been pursued in some states of the FRG, and Denmark, and is planned in Hungary. It is explained more in chapter three, and examined in greater depth in chapter 5.

Chapter four then examines the institutional origins and processes of construction of the key management tools of *hazard classification* of wastes, in different administrative settings. The main comparison examined is between

the US and FRG. Differences of classification are identified as originating in the different regulatory and political cultures, and specifically, different administrative *purposes* embodied along with technical criteria in the classifications.

Chapter five examines the management schemes of Bavaria and Hesse in the FRG and Denmark which are centralized at the state or lower level, with unusually strong institutional structures of shared responsibility and unitary control, 'absorbing' risk decisions into routine management of the system. The conclusion of our work is that this institutional strategy may well be necessary for adequate regulation and public acceptance and could only work if the market for such central facilities is protected by controlling exports from a region.

Chapter six examines an opposite case in the UK, of decentralized policy with background central advice, and informal but low profile supervision. Here the management of T & D is very fragmented and heterogeneous, with almost totally private-industry responsibility for T & D, and local authority responsibility for all aspects of implementation and important aspects of policy too. The interaction between local authorities with mainly very poor resources, central government regulators with a strong informal network of *collaboration* with industry, and scientific resources for regulation, is the main theme of this chapter.

Chapter seven is an attempt to draw some tentative conclusions. It also draws upon IIASA and other work in the field of risk perception and social attitudes, to offer a framework for interpreting the implications of different regulatory styles for public opposition and thus, broader management viability. Finally, since this was an exploratory first-phase study, this chapter structures and discusses some options for further policy research aimed at better

international policy management of this issue.

Case studies are included which were performed by collaborators in Hungary and the Netherlands. These offer sharp contrasts of economic structure, level of economic turnover, and political–administrative culture. Nevertheless certain common themes emerge, notably in the problems each country is having in even approaching the creation and implementation of an industrial infrastructure for waste treatment and disposal, let alone managing it in an acceptably risk-controlling manner.

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12. See e.g., W.D. Ruckelshaus, "Science, risk and public policy", *Science*, 221, 9/9/1983, pp. 1026-1028.
13. NATO CCMS Pilot Study, Final Report, Brussels, 1978. See also Lehman, op.cit, note 5, which lists (p.3) the twelve reports of the CCMS Study, and which is itself the proceedings of a 1981 symposium under CCMS auspices.
14. See e.g., *Industrial Hazardous Waste Management*, Paris, UNEP, 1983, (joint publication of the International Register of Potentially Toxic Chemicals, and the Industry and Environment Office, Paris, of UNEP).
15. E.g., Wolbeck, op.cit, note 5. E. Finnecy, private communication, and IIASA seminar on "Hazardous waste management — definitions and implementability", IIASA, Laxenburg, March 1984.
16. UNEP-WHO joint study, (editors J.W. Huismans and M.J. Suess), 1983.
17. B. Risch, "The activities of the European Community on hazardous waste", in Lehman (ed.), op.cit, note 5, pp.123-136. The original EEC Directive is Council of the European Communities, "Council Directive of 20th March 1978 on Toxic and Dangerous Waste", *Official Journal of the European Communities*, 31 March 1978, pp.L 84, 43-48.
18. OECD, Environment Directorate, Waste Management Policy Group, "Basis of a cross-reference system for wastes listed as hazardous in OECD member countries", discussion draft, March 1984. Several other papers have been distributed on aspects of hazardous waste management, such as descriptions of legislation, a discussion of siting problems, and estimations of compliance costs. The first documents from OECD show the general point made in chapter one, that early interest in waste management stemmed mainly from concerns about energy and resource conservation, not about hazard. "Waste Management in OECD Member Countries", OECD, Environment Directorate, Paris, 1976. For the evolution of OECD interests, see "Report of the Waste Management Policy Group", OECD Environment Committee, Paris, March 1982, and "Outline of the 1984 Programme Proposals", October 1982.
19. B. Wynne, "Institutional mythologies and dual societies in the management of risk" in E. Ley and H. Kunreuther (eds.) *The Risk Analysis Controversy: An Institutional Approach*, Springer Verlag, 1982; "Uncertainty and ignorance in policy", in the proceedings of the IIASA International Forum on Science for Public Policy, IIASA, Laxenburg, forthcoming 1984.
20. Wolbeck, op.cit, note 5.

21. The case of Industrial Biotest involved falsification of toxicology test data used in international regulation.

22. An analogous case is made in G.A. Daneke, "An adaptive-learning approach to environmental regulation" *Policy Studies Review*, 3(1), 1983, 7-12.

23. See e.g., S.B. Barnes and D.O. Edge (eds.), *Science in Context*, London, Open University Press, 1982, especially the papers by Collins and Oteri et al. See also B. Wynne, "Science and law as conflict resolving institutions; informality and discretion in the construction of policy authority", IIASA working paper, November 1983; forthcoming in *Environment International*, 1984.

CHAPTER ONE:
HAZARDOUS WASTE — WHAT KIND OF ISSUE?

Brian Wynne

I. THE SOCIAL CONSTRUCTION OF NATURAL PROBLEMS

Like other policy issues, hazardous waste is not a "given" problem, with a natural internal structure and boundaries. These are *socially* defined, for a variety of reasons, often conflicting. This fact is not altered by the prominent technical dimensions of such issues. It is always worth digging into the historical emergence and current limits of such problems as formally defined, to see how *unnatural* and even arbitrary such boundaries may be, and to understand their flexibility towards social influences.

The purpose of this is not to suggest that the problems are therefore unmanageable (though the possible redefinition of social and natural factors entailed by the exercize may invite a redefinition of "policy management"). The purpose is to better understand the interaction and scope of local variables and universal dimensions in the issues under management. Let us look at just

some of the boundaries:

1. Like squeezing a balloon in one place causing it to inflate in another, hazardous waste as a problem for treatment and disposal is inflated by disallowing atmospheric or aqueous dispersal of pollutants; and vice-versa.

2. "Hazardous" waste should include municipal, household waste, because the toxicity of leachates from municipal landfills is often at least as bad as that from controlled "hazardous" waste landfills [1]. Yet municipal waste is excluded, not on technical risk grounds, but on pragmatic logistic and political grounds. To control municipal wastes as hazardous would not only swamp organizational and financial resources, but probably create enormous political reaction too.

3. Radioactive waste disposal falls under entirely separate legislation interest groups and institutions. Although there are analogies some technical parallels, and strong overlaps in terms of siting difficulties, hazardous waste management normally excludes radioactive wastes [2].

4. Hazardous waste should include all domestic sewage, which is usually itself toxic in organic matter and often mixed with e.g. heavy metals. The US EPA's standard test for toxicity of wastes to define them as hazardous was relaxed by a factor of 10 in concentration limits of certain compounds in leachates, because the original criterion would have meant the inclusion of most domestic sewage, again swamping the system. So the fence is socially defined to exclude sewage [3].

5. Most systems exclude mill and mine tailings just because they are so colossally voluminous and thus logistically impossible. It also seems to offend common sense that something should be neutral when in the ground, but when

extracted, even if a toxic component (e.g., a metal) has been removed, it is regarded as toxic waste. This kind of issue caused a major controversy in the US, where oil drilling muds and brines were initially defined as hazardous wastes, only eventually to be excluded because the implications for the oil exploration industry were so horrendous. Dow Chemical also (in the end successfully) argued against having brine from which they had extracted Bromine being defined as hazardous waste when they pumped the less toxic brine back where they had extracted it from [4].

6. Many common natural substances would be defined as hazardous waste if the definitions used in regulations were strictly enacted. We have mentioned the examples of "phenolic substances" (wood) and "biocides" (salt) elsewhere. Again, some regulatory definitions of hazardous waste by "reactivity" include emission of methane and hydrogen sulfide. Without discretionary freedom to ignore this criterion when pragmatically necessary, all domestic wastes would have to be regulated as hazardous.

7. Many hazardous wastes are exempted from certain national regulatory systems because they are dealt with in-house by their producer. This excluded proportion of all hazardous waste is estimated to be as high as 60-70% in several countries. It is thus a major factor in social narrowing of the official problem definition.

In order to gain further perspective on the extent of this selective regulatory attention, it is useful to remind ourselves of some figures of the following kind [5]:

1. There are about 7,000,000 known chemicals

2. Approximately 80,000 are in commercial circulation
3. Approximately 1,000 new chemicals enter commercial use each year
4. In total world laboratory resources, about 500 per year could be testable for toxicity (at colossal expense)
5. One test, for carcinogenicity alone, can involve 800 test animals, and 40 different tissue specimens per animal for pathology examinations; that is, 32,000 specimens, needing $500,000 and 3 1/2 years
6. Approximately 14,000 food additives and contaminants
7. US EPA hazardous substances list contains approximately 500 substances
8. UK and EEC hazardous substances list contains about 30 items
9. The US EPA's EP test for hazardous wastes covers only 14 chemicals
10. In the US, OSHA has regulated no new chemical for 6 years.

Even this rough indexing indicates just how severely any hazardous waste management framework reduces the full scope of the potential 'natural' issue* to proportions with which it can cope. This reduction creates artificial boundaries and internal structures such as volume and concentration cut-offs, which have little to do with objective natural dictates, and much to do with social factors, pragmatic necessities and administrative purposes. This leaves many central aspects of the problem — even apparently technical matters — open to varying, even contradictory definition and ambiguity. As we shall see, neither "hazard," "waste," nor "management" have intrinsic natural meanings free of variable social-institutional determination. This is true *between*

* 'Natural' here is a deliberately ambiguous term, since although the overall problem is from the regulatory level often perceived as natural, it is of course created by social processes at another level (i.e., industrial production).

different national or state systems, and between different groups *within the same system.*

Historically the developing framework of environmental regulation has followed relatively self-evident empirical categories--specific media such as public hygiene, food, water, air, soil; or specific agents such as pesticides. Different interest groups, different economic and other constraints, different legislative initiatives and implementing institutions, and different technical specialist inputs have tended to compartmentalize policies, regulations, and practices into these separate fields. Each has developed its own momentum and traditions, often leading to arbitrary discontinuities, division of labor or attention, lack of coordination of standards and approaches, inconsistencies, loopholes, and an overall wastage of scarce regulatory resources. Yet actions and approaches in one field may have strong effects upon neighboring areas.

Thus, for example, the hazardous waste problem is exacerbated by the fact that it eventually came to regulatory attention largely through the problem of ordinary waste management. Since this was always a low priority issue compared to air, water or food pollution, it was only subjected to explicit attempts at control through legislation later than all the other environmental areas. This has meant that cleaning dispersive emissions to air and water to meet tightening regulations for those media has left increased volumes of contaminated residues of more concentrated hazardous materials such as filter sludges, dry-precipitated dusts, slags and so on. Indeed it was the dramatic impact of previous regulation in the conventional areas upon volumes of toxic sludges, concentrated liquids, etc., which eventually stimulated industrial and regulatory concern about hazardous (packaged or concentrated) wastes. These inter-media switches are the product of unsystematic sectoral decisions

Waddell refers to the syndrome of "solving one environmental media problem at the expense of another medium," and in particular, "a tendency to generate solid/hazardous waste problems [by] solving air and water discharge problems"[6]. A sense of their potential scale is given by noting that a typical medium scale coal fired power station burning medium grade sulfur coal, would yield hazardous solid waste of one square mile of elemental sulfur one foot deep, if all the sulfur were electrostatically precipitated out from the normal annual aerial emissions [7].

The issues and processes are basically continuous across the socially constructed and established boundaries of legislative framing, administrative competence, technical specialization and political-economic interest. There is no guarantee that such boundaries bear any relationship to some optimal overall environmental or economic norm, indeed there are many reasons to suppose the opposite. Yet, for better or for worse, these labyrinthine socially institutionalized boundaries and divisions, often contradictory, have developed and evolved as the concrete reality which policy making and implementation has to understand and live with. They have substantial, objective* causal effect on events, just like physical reality. Of course, some of these institutional processes and structures may be significant obstacles to better practice, and some may be more adaptable at less cost and less disruption than others. Some will be more resistant to change than may appear, because they are connected with and imply the support of other commitments not immediately evident by studying only the issue as conventionally defined.

* By "objective" here we do not mean unbiassed in some ultimate sense, but that there are intrinsic dynamics that have a certain pattern and stability which takes over independent of specific interests and choices.

The arbitrariness of the institutional patterns carving up natural systems is sharpened by conflicting pressures: (i) on the one hand the logic of inter-media connections and movements of pollutants coincides with the political pressure towards centralization of pollution management, (ii) on the other hand the logic of fragmentation within regulatory bureaucracies analyzed as an expression of rational organizational response to their environment. Bureaucratic regulatory fragmentation corresponds with issue fragmentation as internal groups specialize towards particular problems, expertises and external interests, and define separate boundaries round their fields of attempted control [8].

There is no preordained formula resolving such conflicting institutional tendencies — compromises evolve *ad-hoc*. The point only adds emphasis to the previous observation that there is nothing given or natural about the shape and character of hazardous waste management as an issue. The area contains shifting, multiple and even somewhat contradictory definitions and boundaries, not just as academic abstractions but as live vehicles of policy interaction manipulated by policy actors themselves.

II. THREE STRATEGIC ORIENTATIONS

Thus, even from a central policy standpoint, there are at least three different but interacting primary definitions of hazardous waste management as a policy problem:

1. **As an extension of conventional fields of pollution abatement, risk management and environmental protection.**

Hazardous waste in the form of concentrated solid or aqueous wastes, being historically the last area to be regulated, has encountered not only greater volumes of such "packaged" wastes due to earlier tightening in air, water emissions, etc., but also less room left in which to maneuver over different possible options for proper treatment and disposal. Thus physical prohibition (e.g. discharge limits) or ambient performance standards as regulatory instruments for air, water, etc., left some room for autonomous choice by an industry or set of industries as to how to meet such standards. Hazardous waste management, however, is being more or less forced to become more positively interventionist and to *direct* industrial practices and choices--as Wolbeck has put it [9]:

> A sound policy should not confine itself to saying what should not be done, but should, above all, indicate what should be done.

This naturally leads to more potential conflict between industry and regulatory bodies, and implies more of a "political" burden on science as technical justification for interventionist directives, as will be discussed in chapter two.

A further implication of the risk management perspective is that the problem area should be capable of definition in terms of risks to human health and valued environmental entities, and in comparative terms where possible. Yet, the hazardous waste issue is in important respects simply under-ripe as a policy issue amenable to conventional risk management processes--it may be dominated by dimensions of *ignorance* rather than definable risks. This important difference may be obscured by the social process wherein organisations gradually redefine such radical uncertainties as manageable probability functions [10].

2. As a problem of establishing a new industrial-organizational infrastructure.

Although conventional pollution control needs technological development (e.g. in filter systems), the concentration, trade, treatment and disposal of hazardous wastes requires a whole new industrial infrastructure to be created. When most industrial countries enacted legislation on hazardous or "special" wastes in the 1970's, few of them had much existing industrial facilities for collection, transport, treatment and disposal of hazardous industrial wastes, beyond what was available for ordinary garbage. An urgent problem was, therefore, to develop such a industrial infrastructure; indeed the U.S. EPA's aim in implementing the 1976 Resources Conservation and Recovery Act (RCRA) was to stimulate the growth of such an industry via private investment in relatively well known technological processes. The purpose of the regulations was to create a large, attractive market of hazardous wastes legally requiring licensed treatment; free enterprise would do the rest. As Kragg describes it [4], this failed to happen for a complex set of reasons. One of these has undoubtedly been the unusually direct connection between the details of regulations being drafted but whose final shape was uncertain, and not only the scale of the potential market of wastes thus defined, but also of the degree of regulatory intervention in the choice, design and operation of the industrial plant felt necessary to fulfill the regulation [11]. Other countries, such as the Netherlands and U.K., adopted similar approaches to the U.S. The Netherlands, for example, enacted legislation to regulate chemical wastes by identification, registration and prohibition of lax landfill, before developing an industrial treatment and disposal infrastructure. It was persuaded by industry that such an infrastructure already existed, but of the three central elements, one

developed serious technical difficulties, one was closed down after a scandal and court case jailed its directors, and the other was export. Any opportunity to plan and develop adequate treatment and disposal facilities ahead of legislation which would supposedly create the demand for them was always severely restricted, especially by freedom to use cheaper export options. Other regions or countries, such as Bavaria and Hesse in the F.R.G., built upon systems of public facilities previously established at state or local levels, including measures to protect their industrial waste catchment.

From this perspective there is less of a perceived problem over the scientific basis of different risks, treatment and disposal methods, etc. These tend to be regarded as well established and unproblematic compared to the organizational problems of (a) evolving an infrastructure, then (b) making it work effectively as an organizational problem, channelling the right wastes to the right treatment and disposal route. The burden of regulation and risk management falls more in the area of controlling the emergence of a technically competent, professionally responsible organizational network in the form of some mix of private and public industrial operators. However, there is strong interaction between technical definitions of hazard as embodied in statutory lists and scheduled tests, and industrial freedom to operate within decision margins that give a reasonable chance of economic viability.

3. As a problem in recycling wastes, or reducing their volumes and specific toxicities by changing industrial production techniques.

In this perspective there are some overlaps with 2., but the focus is very different. Despite the prominence given to resource recovery, recycle and waste reduction in the public language and aims of hazardous waste

management policies, the reality is that rates of recycling have languished, even fallen back in recent years [12]. Undoubtedly a critical problem is the apparently inevitable general lack of security concerning the instability of the input "raw materials"--someone else's wastes--to recovery plants which may be highly sensitive to input composition. It is generally agreed that here, technical possibilities are again severely undermined by institutional factors including contradictory perceptions of the materials in question.

Recovery and recycling would be continuous with treatment and disposal, except for a critical, yet problematic, regulatory boundary which divides them. Recovery and recycling imply that the materials are goods, whereas treatment and disposal imply that they are wastes. If they are defined as the former they are exempt from regulation, yet the discrimination is ambiguous, slippery and dependent upon who is defining it. A galvanic sludge containing copper, for example, might be "stored" uncontrolled against speculation on the future price of copper!

Recovery and recycle also overlaps with, but is different from innovation in waste reducing production technologies, since the latter is self-evidently in-house to the waste generator, whereas recovery and recycle may well be through transfer to some other operator(s).

The production–innovation approach has found its sharpest conceptual expression in proposals to integrate notions of 'true' waste costings in strategic planning and choice of new processes and products in industry. To some extent this is happening in a few places. A major problem of any waste-reducing strategy is that it directly conflicts with the treatment and disposal infrastructure development or maintenance, because it undermines the market, thus viability, of the latter.

These different perspectives on the policy management definition imply different needs in terms of: areas of regulatory competence and recruitment; instruments to control or stimulate industrial activity; investments in plant and processes as well as underlying R and D; organizational arrangements within regulatory bodies; interest group configurations; tensions with surrounding economic and administrative practices; and decision making techniques and related resources. In other words, they imply wholly different policy arrangements even though they intersect in a large ill-defined arena.

Thus, even within this environmental policy area there are conflicting tendencies, on the one hand, towards integration, not only with other environmental fields, but also with broader industrial development and technology policies; and on the other hand, fragmentation into coherent, discrete and manageable decision making units.

Several other policy currents and historical patterns thread the hazardous waste management field. Again, their properties and the conflicts between some of these help define some basic constraints which affect optimal management.

III. HISTORICAL DEVELOPMENT OF THE ISSUE

One important conflict is the evolution of regulatory concern for hazardous wastes from ordinary local authority garbage collection, treatment and disposal. Regardless of toxic chemical hazard, this was already a problem for which legislation was being developed in the early 1970's; "special" waste arrangements received only minor attention. The point is that institutional infrastructures existed and attention--albeit fragmented--was already focussed at local level on solid wastes. The management of hazardous or "special" wastes

was seen at first as a relatively routine extrapolation of arrangements at this level. This has important implications discussed in Chapter two.

Two events and one other growing influence upset this tradition and imposed upon it a strong pressure towards centralization:

1. The 1974 energy crisis created an intensive concern with energy and other resources recovery from waste materials generally. Many technical and industrial aspects of such recovery needed research and development and thus the impetus of central governments to advance them. Also central governments needed to respond to a general sense of crisis by being seen to do something centrally to overcome the problems. The concern for the ***hazardous*** dimensions of waste management developed only after waste management had become a policy issue for resource and energy conservation reasons [13].

2. The major shocks like discoveries of past toxic dumps at Lekkerkerk in the Netherlands and Love Canal in the US created such political reverberation and economic implications of cleaning up that only central governments could marshal the necessary resources and authority to respond [14]. Erupting public disquiet and insecurity was reflected in frantic regulatory and legislative responses which suddenly brought hazardous wastes from relative obscurity to the forefront of attention even in pre-existing Acts like RCRA [12]. Despite this sudden advance to central policy attention (or perhaps ***because*** it was also so rapid), the legislation being developed proved inadequate to deal with the issue of unanticipated toxic dumps from the past, and separate legislation had to be hurriedly enacted to deal with this issue in the U.S.A. and the Netherlands. Also, although this history rapidly created a public definition of the issue as one of ***hazardous*** waste control, the authorities in many countries still tended to see it more as a problem of industrial development.

3. It is significant that early regulatory attempts for hazardous waste were diverse local initiatives. thus another major impetus towards integrated hazardous waste management has been the desire on the part of industry for consistency and predictability between diverse decentralized control initiatives, and for equal terms of trade and competition in respect of extra production costs due to compliance with standards. In this sense, hazardous waste management has followed national and international concern about hazardous goods regulations, where definitions and registrations of hazardous materials, and acceptable toxic testing standards, have been the main concern. The OECD's program on toxic chemicals regulation, for example, has explicitly incorporated adequate disposal of wastes as part of an integrated, anticipatory control framework covering the entire life-cycle of a chemical, from inception (as a good or a waste, regardless) to grave [15].

There is a growing amount of hazardous waste being transported across national frontiers. Elaborate and expensive research on toxicology is more directly associated with toxic goods (where the value of the materials justifies the expense of research for risk assessment purposes) and passes on to hazardous waste only indirectly, as the latter are derivatives of the former. Uniform international standards and test protocols are important to industries, who fear that artificially tight standards might be used by a country as a concealed import restriction to protect a domestic industry. However, viewed another way, industry is not averse to lax standards elsewhere when they allow it to export hazardous goods or wastes. Lax standards in one country may drain the domestic business needed in another country to support a viable treatment and disposal infrastructure.

The pressure, therefore, towards international coordination of hazardous waste, as well as hazardous goods, policies has grown beyond even the centralization at national level of originally local arrangements. The appropriate reach of such international coordination, specific agreements, or legislation (in the EEC case) alongside national, provincial and local responsibilities is a problem [16] which still needs clarification. Thus the European Commission, for example, has issued Directives on hazardous waste management [17] which have had to adopt a realistic respect for member countries' jealous adherence to cherished policies and procedures. Directives thus allow the necessary flexibility of approach and talk in terms of the same policy goals being achieved, the means being up to each member country. The problem with this has been that flexibility on the means of implementing a policy is in reality tantamount to fragmenting the original policy itself, so the temptation has been to try to restrict national discretion by issuing central, more elaborately and strictly defined implementing regulations.

A fine balance has to be maintained between central dictation and local discretion, but this is easily unhinged by surprises. An example was the requirement, created overnight by the political hue-and-cry all over Europe about the 41 lost Seveso barrels. This created the suddent demand for tight regulations about cross-border transport of hazardous wastes, to a very rapid deadline, when a Directive embodying a painstakingly negotiated compromise between the Commission and member states had been drafted and was about to be enacted [18].

In summary, therefore, there would seem to be a few fundamental questions underlying analysis of this policy area:

1. Is it possible practically to reconcile what are, even from a single central standpoint, different definitions of the core policy problem, and the central policy goals?

2. How do the different institutional patterns in different national systems emphasize different profiles of these three strategic orientations?

3. How do these definitions proliferate, with what practical implications, when one identifies diverse other actors and interests in this policy field, even within a given regulatory setting?

4. What are the key kinds of ignorance and uncertainty undermining better policy management, and how might they be brought within a managerial frame? Does emergent public concern demand a conventional risk management policy definition even if the issue and the science are not appropriate at least as yet, for such a definition?

IV. COMPARATIVE POLICY SYSTEMS AND UNIVERSAL TECHNOLOGY — Significant Structural Properties of Hazardous Waste as an Issue

One of the common problems encountered in attempting to implement hazardous waste management policies has been incompatibility of approaches in different jurisdictions which, because they are connected by trade, economic and other legal patterns and overlaps, imply the need for some consistency and continuity of practice across those boundaries, whether these are inter-province, inter-state, or inter-nation. These differences of approach straddle all levels:

(i) political philosophy and constitutional traditions;

(ii) legal systems;

(iii) administrative traditions and practices;

(iv) technical policy evaluations and choices; and

(v) detailed technical classifications, criteria standards and definitions.

Research on regulation of risks and environmental pollution has shown how different political and administrative cultures influence the style of regulatory decision making, and produce different outcomes in regulatory decisions on the same issue [19]. Even with the same scientific base available, technical judgements, implicit burdens of proof and standards of acceptable risk vary systematically according to the institutional context in which they evolve. Furthermore, even the same regulatory technical term may be given different practical meanings in different regulatory cultures.

The pressure towards consistency arising from international or interregional equity, planning and free trade considerations is tempered by the sovereignty of different countries' legal and administrative traditions. Technical harmonization is feasible to some extent, but ultimately limited by this factor.

Thus cross-cultural comparative research on regulation of specific issues has helped to elucidate practically, how far it is realistic to push international technical harmonization programs before one begins to imply cutting into the sovereignty and internal consistency of administrative styles, and thus risking purely symbolic, non-implementable gestures rather than policies. For example, the attempt to establish precise concentration threshold values of hazardous chemicals to define legally regulable wastes uniformly across countries in a trade area such as the EEC would encounter opposition from countries which *as a general decision making style*, not only on the single issue in question,

have institutionalized scientific advice so as to give selected scientists large areas of informal discretionary judgement in policy decision making. To change the regulatory method or style on one issue to make it *internationally* consistent on that issue would not only threaten established institutional arrangements for that issue; it would also undermine the more general requirement of *domestic* consistency of decision making style across different issues within the same political-legal culture.

As Wilson's collection of essays analyzing several regulatory bodies in the U.S. has shown, however, the uniform imprint of a given political culture upon all issues under its domain is qualified and differentiated by the specific characteristics of each issue and the unique history of legislation, interest-group interaction, etc., in each case [20]. Despite some common features relating to their common political-constitutional setting, therefore, the EPA, for example, operates in a very different style from, say, the Federal Trade Commission; and even within the EPA, decision making styles may vary significantly (with implicit inconsistencies of standards*) between, say, Drinking Water Control and Solid Waste Management.

In order to clarify the extent of different regulatory options and constraints, it is therefore necessary to delineate the significant *intrinsic* technical and intitutional features of the issue which will have to be accommodated by whichever regulatory culture confronts the issue. This section therefore identifies the important universal characteristics of the hazardous waste issue which shape the local and international possibilities for design of optimal regulation:

* Thomas and Roberts [15] relate the story of the pesticide standard being promulgated for RCRA, which would have meant that an apple could be sold and eaten, but not disposed of on a municipal garbage dump. The anomaly in this case was noticed and rectified.

1. **Heterogeneity**

Potentially hazardous chemical wastes arise in almost every kind of industrial, and many non-industrial activities. Chemicals are used in almost every human activity, and inevitably eventually become regarded as waste. Most, if not all hazardous waste legislation expressly excludes not only domestic and other non-industrial wastes which may contain hazardous chemicals—it also specifically exempts small waste generators (typically <10 te per year) and many other wastes such as oil drilling sludges, various refining slags and mining tailings, etc. Even so, with the framework so whittled down that some estimate it to legally exclude more than 65% of all hazardous wastes, the U.S. RCRA, for example, is still supposed to regulate the activities of some 270,000 separate waste generators [15], involving thousands of widely different chemicals in different consignments and unknown mixtures, and approximately 50,000 waste transporters performing an estimated 200,000 million ton-miles per year of waste haulage in about 1.5 million vehicles [21]. The regulated actors range from international giants such as DuPont, to tiny family businesses with one operation. The movements, transfers, mixing, storage and treatment of those wastes is all performed by countless uncoordinated decisions and arrangements operating under normal decentralized market principles. Even the treatment and disposal industry in the U.S., let alone waste generators and transporters, involves an estimated 25,000 facilities of many different types. There are also many new industries emerging rapidly in areas like microelectronics and biotechnology which are small but numerous, and use small quantities of highly toxic materials. It indicates the extreme differentiation of the field to note that one hazardous waste treatment and disposal company, Safety Kleen, which grew to be a major enterprise, began as a solvent collector from small dry cleaning

firms with an average pick-up of 7 gallons [22]. This also indicates why frequently a key expertise in the hazardous waste T and D field has been in transport and collection systems. A similar portrait of extreme heterogeneity, albeit on a correspondingly smaller scale, can be painted for other countries. It is not only a matter of sheer numbers and diversity of activities and materials being handled. When there are countless industries creating chemical wastes with less than 100 employees, yet 30% of all chemicals sales (in market economies) are achieved by only 25 giant companies, differential size is also a significant matter for regulatory strategies.

Thus both hazardous wastes themselves, *and* their generating industries, are extremely dispersed, heterogeneous and ill-defined. All this offers a striking contrast to the structure of the nuclear waste problem with which chemical waste is often compared. Nuclear wastes involve a very narrow range of well-known radionuclides in relatively narrow bands of composition. Furthermore, they arise in a very limited number of well-known sites, are transported in a small number of consignments to very few treatment or storage facilities. It is easy to keep tabs on the arisings and movements, and those arisings are in chemical and hazard terms rather uniform, and easily supervised. Furthermore, the industry itself, even where there are a few dozen utilities, as in the U.S., is rather monolithic, with few centers of decision, control and responsibility [23].

Thus, whereas nuclear waste or spent fuel regulators at least know what is produced and moving where, chemical waste regulators are very far from this position. In important respects the regulatory problem for chemical wastes is more akin to nuclear proliferation safeguards regulation than nuclear wastes, since there is a strong element of the detection and control of unknown,

perhaps deliberately clandestine activity. This problem of heterogeneity, and regulatory ignorance of basic elements of what they are supposed to regulate, is highlighted by the indications that contaminated groundwater problems are arising from the rapid growth of microelectronics led by the mushrooming of many small firms. These discard small volumes of new, highly toxic chemicals, for example as surface cleaning or etching agents, but are too small to carry in-house chemical expertise for recycle or proper treatment; and they produce batches of waste possibly too small and variable to be worth another agent collecting them for recycle [24].

The question of industrial structure is central because without knowledge of this it is difficult to evaluate the belief that exemptions for small generators, exclude a vast number of generators but a tiny proportion of wastes from the regulatory system. OECD and EPA data [25] suggest that this is strongly the case, but other policymakers have indicated that the countless unknown small generators are the greater source of regulatory anxiety. In this regard it may also be relevant that some countries or states, such as Denmark and Bavaria, are making strenuous efforts to establish effective regulated collection and treatment even of domestic hazardous wastes, which begin at each household as small volumes of highly toxic materials but end up on municipal sites in large volumes. In Britain it is now estimated that the worst cases of soil pollution of mercury and cadmium (amongst other things) come from domestic waste sites, not from industrial wastes [26]. It is necessary to remember that the reassurance of small volumes *per se* in aggregated figures may be beside the point if legally uncontrolled small volumes of highly toxic waste are locally concentrated in human exposures.

A question raised by the extreme heterogeneity of the field is whether there is, in fact, a unitary regulatory field anyway. Can standardised regulatory approaches based on that assumption realistically tackle the issue? For example, small firms by definition tend to have less control over their economic and social environment, and are likely to be less concerned with calculations of long term pay off or side effects of present decisions. They will have a short-term time horizon for decision making. Large companies, on the other hand, more secure, with greater forward commitments at risk, and more control over their immediate environment, perhaps a national image and international trade to nurture and protect, are likely to have a longer term decision making horizon. These cultural aspects of decision making, and various specific organizational matters, such as how internal accounting and responsibilities are allocated, how rapid turnover is, etc., will affect hazardous waste attitudes and practices in companies as much as they will affect other areas. As a general point, small firms will tend to have a different attitude towards regulation than large firms which may have had direct influence on the regulations anyway.

Whether there is a unitary regulatory field is always an implicit problem as regulatory bureaucracies responsible for a large area of policy like environmental policy tend towards fragmentation into necessary specialist competences and approaches dictated partly by the innate characteristics of a given issue. Pollak has described this and underlying processes whereby administrative segments have to gain expertise and credibility with separate, outside, regulated constituencies [27]. In hazardous waste these same tendencies appear to be more extreme than in other areas, because there are so many different industrial sectors and processes to be regulated and each one has its own characteristics relevant to the evaluation of effects of different regulatory

options and tactics. These tendencies towards fragmentation are exacerbated both by a structural need for more positive interference with the industries being regulated (discussed below) and the historical origins of hazardous waste regulatory attempts in fragmented local institutions.

2. Professionalism

The contrast with nuclear waste throws into relief another significant aspect of the chemical waste issue, namely the historical lack of professionalism in the field, which strongly affects the social structure and potential effectiveness of different regulatory strategies and arrangements. In the nuclear case, whether we are talking about radiation protection or engineering safety of nuclear plants, there has always been, from the outset of the industry, a well-developed professional cadre of experts, highly funded and with a strong basis in fundamental research as well as more applied analysis. As Serwer has shown in the case of radiation protection [28], these cadres evolved early on, a strong sense of professional self-regulation, akin to normal scientific fields even where this regulation was extending into industrial areas. This affected standards of vigilance, expertise, and quality control which helped to maintain public credibility and acceptable regulatory standards, even when the "regulatory" experts were formally part of the industry. Ensuing institutional structures of regulation were at least well-developed and financed, highly professionalized, with a strong ethos of enlightened self-interest (self-protection via preemption of public hostility by protecting public health). Furthermore, there was a continuous bridge--even an identity--between the government regulators and the regulated industry. The regulators were recruited from the industry, and shared a common professional background and identity, somewhat aloof from

either government or industry context. This arrangement has drawbacks, but also important benefits. There is no doubt that this "self-regulation" was far better than no regulation at all, which was the case for a long time with hazardous waste.

Similar kinds of regulatory arrangements have developed in other fields. There is a significant connection with the heterogeneity factor, because it is the relatively unitary nature of the nuclear industry as a risk generating activity which has allowed its regulatory cadres to be drawn from relatively unitary technical disciplines (radiation biology and physics; nuclear engineering) and so enhance a strong and somewhat aloof and neutral professional identity. Typical recruitment to hazardous waste regulatory positions appears to vary widely. In Britain the government regulatory body is proud of the large industrial man-years experience of its staff. In others it seems to be mainly engineers, or ecologists, or chemists, with no industrial experience [29]. The hazards of nuclear processes and materials focus only upon radiation damage. This in itself involves an extensive differentiation of specialist topics within the field, but it is nevertheless, under a singular professional discipline, whose relative social coherence has meant that many questions about uncertainties and alternative techniques of analysis, etc. could be retained largely within the specialist community, away from the public regulatory agenda. In the case of hazardous wastes, with a more fragmentary array of technical issues and relevant specialties (even within toxicology alone) this has been more difficult. Because of this lack of a coherent social containment insulating the public regulatory arena from esoteric specialist concerns, many technical uncertainties have been more easily drawn into the public policy/regulatory domain, leading to the greater confusion of standards-setting and implementation.

Biotechnology provides an interesting comparison because the emergence of regulation bears some hallmarks of the development of professional self-regulation of radiologists in the 1920's and 1930's (the precursor of radiation protection around the nuclear industry), and its institutionalization in government regulatory arrangements. Thus molecular biologists effectively themselves alerted public concern to the risk associated with their work in the famous Asilomar declaration of 1974 [30]. Although there was later a lot of regret and retreat from this position, the government National Institutes of Health committee set up to "regulate" activities in this field was not only not an executive agency, but was staffed by largely the same corpus of experts who had first expressed the need for systematic risk assessment and regulation. Thus the same kind of bridging highly expert cadre structured regulatory developments here as in the nuclear case. Now, interestingly, the field which started with scientists organizing self-regulation has industrialized very rapidly under essentially the same regulatory arrangements, and in a diffuse decentralized way very different from the nuclear case, so that this area of regulation bears some characteristics of both the nuclear and (in its industrial structure) the chemical waste regulation cases.

The central feature of hazardous chemical wastes is that, especially in government and most of industry (though not in some larger chemical companies), it emerged from and was thus shaped by the ethos of ordinary waste arrangements and perceptions. There was no professional status attached to dealing with garbage, and no systematic attention or resources given to dealing with them. Thus, for example, many hazardous waste arrangements and regulatory personnel, in governments and in industries, were of relatively low qualification and status, with no cohering sense of professional identity or

reputation to defend, with sound standards. They were usually organized, if at all, only at diffuse and uncoordinated local plant and municipality levels. One of the repeated comments about the early days of the EPA Office of Solid Waste's dealing with RCRA, for example, was of their lack of qualification for dealing with the complex problems of risk management and regulation which swept through and transformed their established more mundane concerns about ordinary garbage [31]. Whereas the source of regulatory recruitment in the nuclear and biotechnology fields has been clear-cut and highly trained, recruitment to regulatory bodies for hazardous waste management seems to have been far more disparate and fragmentary*, with corresponding difficulties in establishing an effective professional identity bridging regulators and all reaches of the industry out to its smallest most esoteric corners.

This history of low status, institutional and technical fragmentation, lack of technical expertise and professionalism, and neglect of hazardous waste combined with the extreme heterogeneity of the area has meant a very different institutional structure of regulation. Although there has existed the requisite professional expertise, resources and awareness for self-regulation in the specialist chemical companies, and despite attempts by trade associations to increase the levels of professionalism, the ethos and implementation of hazardous waste regulation is deeply influenced by this very different history of institutional development. The most important structural consequences are:

(i) extremely uneven levels of technical competence in both industry and local governments, where most of the burden lies, of understanding and transforming regulations into effective action;

*A senior regulator in the U.K., for example, could think of less than twelve people in the whole country who would be qualified for the post of Chief Inspector in the recently created Hazardous Wastes Inspectorate. There are no degrees or Chairs in Waste Management.

(ii) alienation between regulators and regulated, who may have widely different backgrounds and perceptions of issues and how they should be dealt with;

(iii) institutional complications brought about by the origins of regulatory activity and responsibility at low status, non-expert local authority level, followed by rapid adoption of the issue by central authorities due to political crisis in some countries, followed by redistribution, for practical reasons, of responsibility to the same local authorities, but under transformed circumstances including far heavier technical *and* political demands than previously;

(iv) therefore social structural difficulties in trying to establish collaborative regulatory cultures which are nevertheless open and accountable to third parties such as trades unions or other public interest groups.

3. Hazardous Waste is P a c k a g e d Waste

A defining characteristic of hazardous waste is that it is either solid, semi-solid, or, if liquid, packaged. It is *concentrated*, and needs handling and treatment before eventual dispersal, destruction or containment. The immediate sense of the significance of this is given in Figure 1.

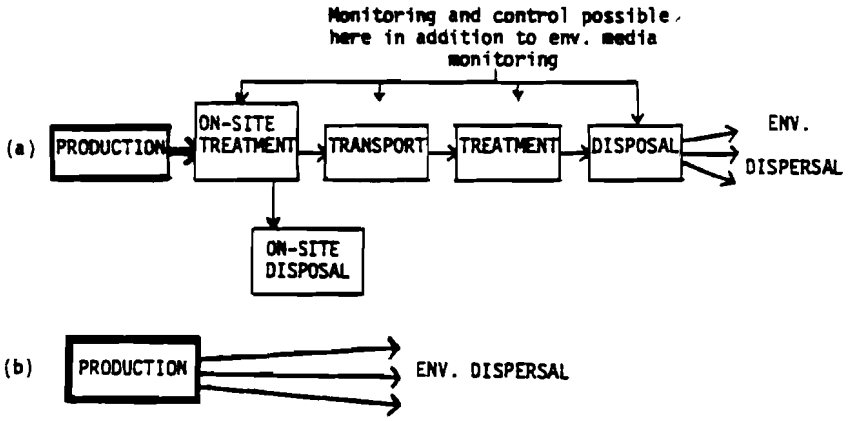

Figure 1: Differences in terms of potential emissions and risks between (packaged) hazardous wastes as in (a) and conventional pollution as in (b)

In order to give a sense of the contrasts between hazardous waste and conventional environmental regulation, we can outline the possible stages in the life-cycle of any single 'packaged' waste:

1. In-plant process-generation
2. Mixing with other in-plant process streams
3. factory-gate "arisings," packaged into transport consignments
4. Collection and transport
5. "Interim" storage (notorious as *defacto* deposition sites)
6. Mixing, repackaging, reloading
7. Treatment and transformation (deliberate or inadvertent) — new by-product wastes
8. Further collection and transport
9. "Final" treatment or preparation for disposal (e.g., for incineration or landfill)
10. "Final" disposal — abandonment; monitored but irretrievable deposition; retrievable deposition (e.g., ex salt-mine).

Through these stages a single waste may also change several times, not only in composition, form and value, but also in ownership or control; and it may thus have its defined nature and status change as it moves from one agent to another, especially between different regulatory systems.

When combined with the aspects of heterogeneity and diffuseness already outlined, this complex *institutional* life-cycle has several important consequences, especially relating to the interaction of technical and institutional factors:

Conventional environmental regulation such as air quality has dealt with disperson of potentially hazardous materials into the relevant medium direct from the source plant. Assessment has thus been to do with relevant *natural* transport and transformation mechanisms back into damage to people or significant media, and control has been usually via specifying ambient environmental standards which industry has to meet by its own means. But hazardous waste is packaged, in consignments defined by the waste generator, is passed on to transport operators who may mix it with other wastes for convenient and economic transport, and pass it on to other transport, storage or new transport means, etc.; and so on, until final disposal, destruction, containment and dispersal eventually occur. These final dispositions, incineration, landfill, or whatever, even if licensed and controlled, still involve conventional environmental dispersal (e.g. flue gases from incineration) and possible natural reconcentration (e.g. in ground water from landfill leaching). All the associated uncertainties of natural mechanisms are therefore still involved.

However, the important *extra* dimension of uncertainty for hazardous waste is the complex behavioral dimension between source plant and final disposition. It is, for example, because it is not dispersed, but packaged and therefore retrievable, that the ambiguity as to whether hazardous waste is a waste or a (recyclable) resource is still open, and a major loophole in regulation. This cannot possibly be defined by central authorities because it is a legitimate and necessary factor of enterprise, innovation, and thus trade between industrial actors. Thus autonomous industrial actors in their own unfathomably diverse economic, technical and social situations, not regulators, have to be given some latitude to define a "waste" as a "good" from their point of view, even if this self-controlled definition automatically exempts their material

from regulation. This intrinsic ambiguity is analyzed further in Chapter two.

Even if the more direct form of behavioral regulation in this area does not create damaging unanticipated effects upon patterns of enterprise, it inevitably implies more conflict between industry and regulator, because being packaged, the waste being transformed and transferred is in principle, at least, more traceable to its source. If it is found to be in the wrong hands or wrong place at the wrong time, the original waste producer is liable even if he has acted in good faith but been let down by an incompetent or illegal operator down the chain of transfer. Unlike, say, 10^{10} anonymous molecules of sulfuric acid found to be acidifying a Scandinavian lake, a container of acid residues with Punters Chemicals Ltd. printed on it being carelessly stored when it is supposed to have been neutralized and carefully disposed of, will get Punters into trouble. Specific cases like this have been experienced, and have caused sharp reaction [32].

The fact of packaging creates a continuity of potential specific traceable responsibility across a *social* network not just a physical system, and thus creates strong pressure to positively control specific behavior within that network as well as the emission levels at final disposal points as in normal environmental legislation. The issue of the dioxin contaminated wastes from Seveso can be interpreted in this perspective [33].

The potential ability of the regulator to scrutinize and control the discrete, identifiable extensions (i.e. packaged wastes) of industrial processes thus implies more interference with industrial production itself. If every consignment is supposed to be declared and its contents described, monitoring here involves testing these descriptions and declarations against direct analysis and there is not only more direct attribution of responsibility than with much of

ambient environmental monitoring, but there is perhaps less room for interpreting false declarations as honest mistakes. Therefore, an element of prosecutional tension and suspicion may pervade the regulatory situation, in the very area where arguably, voluntary compliance and trust are intrinsically most needed to have a viable system.

In any case, the fact that hazardous waste is packaged in principle provides the regulator with more direct information about industrial activities which the industry may not wish to fully display. Paradoxically the regulator needs more information in order to be in a position to *obtain* that information. Because the waste is packaged the regulator needs more knowledge in a new domain, namely about the whole behavioral field of what is produced, where, in what volumes and mixes, where does it go and how is it treated. As analyzed in Chapter two, this creates a new kind of strategic conflict over regulatory information which is fundamentally different from that over "natural" facts.

An extra twist to the existence of a complex institutional dimension in the movement of packaged waste is in the cross-border nature of many hazardous waste flows. The conventional cross-border pollution issues all involve diffuse, mainly atmospheric, natural processes. There is thus relatively uniform deposition of pollutants over very large areas, via natural processes. The issue has been gradually rising to policy status for some time, and whilst its public recognition may have been triggered by specific local observations, its general growth as an issue has been evident for several years.

Hazardous waste is different in that being concentrated and transported by human agents, the local intensity and wider political reverbertions of specific incidents of lack of control may be much more volatile, as it was for the Seveso barrels, or the Belgian banning of Dutch wastes in 1983. Furthermore, the

perception of the *severity* of such events may be multiplied by the fact that they are *directly* under human responsibility, hence perhaps more threatening, whereas e.g. sulfur deposition is indirect, in that the source coal plant operator did not actually direct its emitted sulfur to a given deposition point, (even if the transport connection were actually known). Thus the political/regulatory impact of one incident in the case of hazardous waste, especially if it is a transborder incident, is likely to be more severe and unpredictable than in conventional transborder pollution. Furthermore, sanctions are more concrete. Transborder traffic in air pollution is difficult to stop by the importing nation, but far less so for trucks or freight cars importing hazardous waste. As a policy issue therefore, the amplitudes of unpredictability of hazardous waste are likely to be greater than those of otherwise parallel issues.

A far greater volume of toxic material passes across borders in human hands, by design, in the form of traded goods, raw materials, and wastes, than by natural processes. Toxic goods transfers have been subject to well organized attempts at coordinated regulation, but toxic wastes have been less well regulated [34]. Not being part of consumer products (as are many toxic chemical goods), they are likely to be more prone to neglect, and sudden fluctuations of political mood amid demands or real moves to close frontiers to hazardous wastes. This instability may invite paralysis of cross-border hazardous waste transfers, economic disruption and environmental mismanagement unless better understood.

4. Inverse Materials — Cash Exchange Relations

In order to define some important differences, it is useful to start by viewing hazardous waste T & D as just any other complex industry, regulated by

conventional operating emission standards to air, water, and soil. The industry has resources inputs — other industries' wastes — for whose industrial 'conversion' it makes (or hopes to make) a profit. The only difference — and it is crucial — is that its resources inputs are of negative value. The T & D industry does not pay for its "resources'; it is paid specifically for taking them away and dealing with them and it is paid before it converts its 'resources' into final 'products.' This means that the T & D industry receives the money as well as the inputs, yet — unlike a conventional industry which *pays* for its inputs — it is only really concerned to receive the former. The relationships are represented in Figure 2.

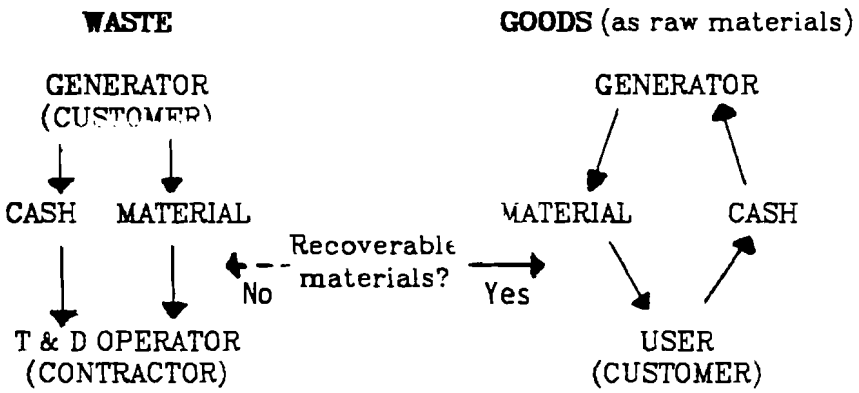

FIGURE 2 Materials-cash exchange relationships: hazardous waste and conventional materials. For waste, (a) the ***cash buys a service, not materials*** and (b) the ***service is invisible to its buyer.*** ***(I am grateful to E. Finnecy for the original point from which this is developed.)***

The regulatory situation is fundamentally affected by this structural property. Four points arise from this:

(a) for waste, the cash buys a *service*, not materials;

(b) the service is invisible to its buyer, who therefore does not know if it has been fully performed. Therefore the servicer (T & D operator),

who has *already* been paid, has no incentive to carry out the service (i.e., receive the hazardous waste, or treat them properly once received) because this costs the servicer;

(c) because of the lack of value in the waste from the generator's point of view, it is not subject to any kind of "quality control"; thus its chemical composition, mixing and even physical form may vary more or less uncontrollably. Yet this radically affects the feasibility of treatment, in which somebody has to invest resources. Such uncontrolled variation is a major problem for T & D operation and thus a key obstacle to more investment in T & D;

(d) for wastes containing valuable resources that could be extracted, the same variability problem arises. But in principle there may come a point where the value of extractable materials makes the "waste" worth paying for by the T & D industry rather than being paid to take it away. However this not only makes more incentive for quality control ("no quality, no pay" clauses), it also converts the "waste" into "not-waste," and thus automatically exempts it from hazardous waste regulation in most systems. This is a major loophole because there are so many wastes, and the transition for each one is open to diverse and fluctuating definition way beyond the single perspective and control of a regulatory body.

5. Ignorance and Under-Ripeness for Risk Management

As indicated before, the hazardous waste problem is in important respects underripe for systematic risk management approaches because the area is

characterized by ignorance of basic, elementary properties and parameters more than definable uncertainties in known damage generating processes and substances. Thus, for example, although he felt it to be a flawed Act, the Dutch Secretary of State for Environment in 1979, L. Ginjaar, decided to go ahead with the Chemical Waste Act because there were at least registration requirements which would eventually produce information, at the time initially completely lacking, about the volumes and compositions of the large variety of wastes produced by industry [35]. In his view, only when this was compiled and analyzed could a better Act be designed and proper research carried out to define risks and help choose better regulatory instruments and standards. Perhaps indicating the extent and intractability of this ignorance, although Ginjaar thought such revisions could be made in three years, these are not in sight after 5 years of implementation.

The concrete objective of hazardous waste regulation is to differentiate wastes into streams, which can be channelled towards different kinds of treatment and disposal appropriate to each class of waste. Despite the scientific uncertainties in the environmental behavior and health effects of different chemicals and mixes, this form of regulation implies an adequate degree of knowledge about health risks (perhaps built upon supposedly wide margins for error by assumptions e.g. about containment). It focuses instead upon the effective organization of this industrial and trading activity into the appropriate treatment and disposal option. It is, therefore, as noted, inevitably more *directive* than conventional environmental regulation. Thus, for example, regulations may specify not only that PCB's must be incinerated, but they may further specify how they must be collected, how they may or may not be mixed, and under what conditions of design and operation their incineration must take

place. The same kind of constraints may be exercised for a very long list of scheduled chemicals or waste streams.

Such regulation of the T & D industry is part of the waste management system for hazardous waste, but does not exist for conventional emissions. The dilemma is that public attention requires formal risk management frameworks; this requires detailed regulation; but this stifles an embryonic T & D industry which is simultaneously part of the problem and part of the solution.

The heterogeneity factor also enters in here. The kind of regulation described above is inevitably highly interventionist, which is a major reason for the difficulties experienced in implementation. But it is intervention in a wide variety of different industries, plants, processes, and conditions. It implies a need for a very wide range of specific expertises. Not surprisingly, compared to the experts in any given industry, the experts in a regulatory body will be non-experts, and conflict is highly likely, not just on specific points but more corrosively, over competence and credibility in general.

Compare this situation with the nuclear case again. Here there is usually only one central decision making frame*, and the institutional structure of regulation outlined before means that the regulators are an integrated part of the industrial design, planning and decision making process anyway. Nuclear plant design, for example, is carried out in detailed consultation with regulatory experts to assess design features of requisite safety standards. Waste processing and transport are likewise designed and conducted with regulators part of the decision making process. The dividing line between regulation and industrial planning is nearly broken down altogether. Thus the "interference" of

* Private initiatives in U.S. nuclear waste processing have virtually collapsed.

regulators due to the fact that nuclear waste is also packaged, is a non-issue because they are already integrated in decision making anyway, and in a state run monopoly industry there is not the same cutting edge of competition and ever-vulnerable profit margins to keep regulators and their impact as distant as possible.

Another side-effect of the same structural property is that, because the nuclear industry is essentially only one industry, there is no real ambiguity as to the "wastes-resources" boundary. There is, of course, one such conflict cleaving the whole area, namely the proper role of plutonium created in and extracted from spent thermal reactor fuels, and there are others, such as the role of otherwise useless natural uranium as breeder fuel if that option is chosen. However, the point is that these are conflicting options and definitions dealt with by whole policy systems, and uniformly applied without ambiguity within a given system once decided. Unlike hazardous chemicals, they are not subject to regular definition and dynamic choice by a polycentric interacting network of autonomous enterprises with diverse interests and perceptions. Thus one major source of *intrinsic* confusion and limitation to effective implementation in hazardous waste regulation is essentially absent from the nuclear case.

Conclusions

These observations of the underripeness of hazardous waste policy for risk assessment may be *structurally* valid, but that fact is that public reactions and pessure is creating an inevitable demand for the issue to be defined more elaborately and formally in terms of risk assessment. Whether this will be an exercise in public reassurance or a genuine decision aid remains to be determined.

The keys to this will be:

(i) The way in which regulatory bodies treat intrinsic ignorance and uncertainty which, in this field, encompass any attempt to formulate a risk management approach.

(ii) The responses of policy to the conflict between the need to create and maintain a new industry as part of regulation, and the increasing need to subject it to formal regulatory controls before its *existence* is even secured. Thus the risk management dimensions interconnect with basic institutional questions of industrial investment, public financing and management, etc.

The next two chapters review different existing approaches to formal risk analysis and analyze their relevance to the hazardous waste problem area, before going on in Chapter 4 to analyze the variable institutional roots of the apparently purely technical endeavour of hazard classification.

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