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REPORT OF THE MUNICIPAL SOLID WASTE SUBCOMMITTEE OF THE ENVIRONMENTAL ENGINEERING COMMITTEE

REVIEW OF THE OFFICE OF RESEARCH AND DEVELOPMENT'S MUNICIPAL SOLID WASTE RESEARCH PROGRAM

A SCIENCE ADVISORY BOARD REPORT May 1991

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF
THE ADMINISTRATOR

May 16, 1991

Honorable William K. Reilly
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Reilly:

The Science Advisory Board (SAB) has completed its research-in-progress review of the Office of Research and Development's (ORD) Municipal Solid Waste (MSW) Research Agenda (22 Dec 89 draft), and is pleased to submit its final report.

The SAB is pleased that a national R & D initiative is being taken with MSW, because it has been at least a decade since there was such a substantive undertaking. It is gratifying to see the Agency attacking MSW problems by first drafting a comprehensive research agenda. This new planning effort will do much to coordinate future efforts, as well as to build upon on-going disparate efforts both within and outside the Agency. The SAB views this program to be very important to the thousands of operating state and local MSW programs throughout the country.

Although we expect that the ORD will address all the issues presented in this report, we particularly direct your attention to the following suggested priority shifts:

1) Based on national needs, MSW source reduction and landfill disposal research should be top priorities in the draft Research Agenda. Definitions, criteria, and measures of progress that will lead to processes and products that significantly reduce MSW at its source need to be developed, as do technical, economic and institutional incentives. Technology of landfill design and operations, recognizing the potential for the better application of biochemical reactor research, needs to be modernized.

2) Recycling and strategic planning research should receive a medium priority relative to other areas. Recycling research should be coordinated with source reduction research.

3) Thermal destruction research should receive lower research priority because of the level of work already in progress, the high level of knowledge developed from hazardous waste combustion

research, and the anticipation of limited availability of resources.

4) Exposure to toxicants associated with MSW needs to be better characterized and the application of risk assessment methods broadened to include associated welfare and technological risk.

5) In order to effectively use limited resources, the Subcommittee recommends the development of guidelines and contingencies for limiting or deferring project initiatives, should this prove necessary.

These recommendations, along with more detailed comments on the entire draft Research Agenda in our report, are made with the anticipation that ORD's Municipal Solid Waste Research Program will be implemented and, in fact, be greatly increased in the near future.

It is abundantly clear that both current funding and goals are only sufficient to achieve limited success in the foreseeable future. Limiting funding and future resources, both extramural and in-house, will materially constrain the Agency's ability to match knowledge with needs.

The SAB appreciates this opportunity to conduct this scientific review and looks forward to receiving your response to the scientific advice transmitted herein.

Sincerely,

Raymond C. Loehr

Raymond C. Loehr, Chairman
Executive Committee
Science Advisory Board

Richard A. Conway

Richard A. Conway, Chairman
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Science Advisory Board

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ABSTRACT

The Municipal Solid Waste Subcommittee (MSWS) of the Environmental Engineering Committee (EEC) of the EPA Science Advisory Board (SAB) has prepared a Research-In-Progress report on the Agency's Municipal Solid Waste (MSW) research program. The review examined the Agency's strategic planning for integrated waste management, source reduction, recycling, thermal destruction, land disposal and special wastes management (combustion residuals, sewage sludge and medical/infectious wastes).

The Subcommittee suggested priority shifts in the proposed research areas, recommending that source reduction and disposal in landfills should be top research priorities, while thermal destruction and special wastes management should have lower research priorities. It was further recommended that recycling research should be coordinated with source reduction research. Also stressed, was the need for the Agency to serve as a catalyst in dealing with MSW issues. Such activities as information dissemination, sponsoring conferences and workshops, developing decision tools, providing technology evaluation expertise, catalyzing market and product development, conducting fate and effect and treatability studies, developing incentives, providing grants and loans, and related supportive activities were viewed as vital to the Agency's mission for MSW research. The SAB views the MSW research program to be very important to the thousands of operating state and local MSW programs throughout the country.

Key Words: Municipal solid waste, municipal solid waste research, municipal solid waste research programs, integrated waste management.

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1.0 EXECUTIVE SUMMARY

This report presents the EPA Science Advisory Board's (SAB) review of the Office of Research and Development's (ORD) research plan for Municipal Solid Waste (MSW). The SAB's MSW Subcommittee (MSWS, or the Subcommittee) recognizes that a decade or more has elapsed since there was a substantive national research and development (R & D) initiative in support of the thousands of municipal solid waste programs and systems in the country. This new planning effort will do much to coordinate future work as well as to build upon ongoing disparate efforts both within and outside the Agency. The following statements relate to crosscutting issues identified by the Subcommittee:

a) Overview - The new goals and objectives should emphasize contemporary and future research needs, clearly separating new initiatives from past accomplishments. - Recognition of the budget and expertise requirements necessary to conduct the elements of the research plan should be clearly evident and embedded in the research strategy.

b) Current funding is only sufficient to achieve limited success in the foreseeable future. - Unfortunately, the realities of limited and available future resources, both from extramural activity as well as in-house staff and facilities, will materially inhibit the Agency's ability to match knowledge with needs, at least well into the foreseeable future.

c) The proposed program elements overlap. There is a need to assess interrelationships among programs and projects. - The program and projects described within the six research areas have some duplication and should be made joint research efforts. However, this overlap is appropriate, as the result of a given program project can serve more than one research area.

d) The Agency should serve as a catalyst. This is a vital role to be refined and pursued! - The Agency is well suited for information dissemination, sponsoring conferences, providing decision tools, providing technology evaluation, catalyzing market and product development, conducting fate and effect studies, conducting treatability studies, developing incentives, providing grants and loans and similar supportive activities as a catalyst for action at the local and state levels, as well as encouraging private sector initiatives. This role needs to be refined and pursued as part of the overall strategic long-range implementation plan.

e) Consolidation of efforts is preferred as a means to provide national data characterizations. - Consolidation of studies of regional or local wastes and disposal needs would be valuable, rather than pursuing nationwide data surveys and broad

averages or characterizations. Similarly, consolidation of existing technology evaluations and comparative studies of management strategies being developed at the local and state government levels, universities, other institutions and even other countries would be a better focus of limited resources.

f) Striking the right balance is necessary to achieve an effective research agenda. - The Subcommittee identified several aspects of the draft Research Agenda where a shift in research priority may be warranted. Source reduction and MSW disposal in landfills should be the top research priorities in the Research Agenda. Recycling should be coordinated with source reduction research. Recycling and strategic planning should receive medium research priority. Thermal destruction and special wastes management should receive lower research priorities due to the work currently in progress and because of lesser knowledge gaps.

g) Education and training is needed at all levels. - Although there is some recognition of the value of education and training as a crucial element within research areas, this need should be evident throughout the document and should be developed clearly and incisively as an initiative complementing all other components of the research plan. An innovative education program at all levels of need, should be developed in harmony with the other elements of the research plan.

h) Advances in pollution prevention and conservation require developing measures of progress. - Better documentation is needed of the benefits and measures of progress of pollution prevention in terms of materials and energy conservation, preservation of ecological resources, reduced MSW generation and reduced pollution impacts. Research aimed at identification of pollution prevention measures, and incentives/disincentives to promote their implementation, is critically needed. Further, it must be targeted at specific social and economic sectors such as individual consumers and households, government at all levels, business and other institutions.

i) Incentives are needed to facilitate goals. - Management of MSW is an important and growing problem. One way to address this problem is through programs to reduce the quantity of solid waste generated and requiring management either through landfills or, both through source reduction and recycling. Various economic, technical and institutional incentives can help facilitate these goals.

The current draft Research Agenda does not include research on the development and testing of various incentives to achieve the goals of the MSW research plan, despite the observation that these approaches may be among the most cost-effective. Included in this Research Agenda should be an examination of the utility of economic instruments such as deposits and discharge fees (analogous

to tipping fees, but placed upstream in the process) on certain products or other incentives to encourage manufacturers to look for environmentally-friendly designs, production and marketing.

j) Data collection and interpretation requires both statistical tools and heuristic reasoning. - The Subcommittee suggests that the process of information development should entail an examination of mechanisms to collect, use, and recognize the value of statistically valid data, as well as heuristic reasoning. Consideration and use of prior experience and scientific knowledge that by consensus are considered valid and credible within the scientific community, are the foundation of heuristic reasoning. Because the menu of proposed projects cannot be adequately addressed, given the limited level of funds available to the Agency for the purpose of carrying out the proposed research program, heuristic methods may negate the need for detailed statistical studies in all research areas.

k) Core research should be devoted to increasing scientific understanding of the major problems and identity of promising solutions. - Some of the programs and projects seem suitable candidates for the new ORD Core Research Program. Project selection should not be based upon immediate regulatory needs, but on the extent to which the added science can increase understanding of the major problems and point to promising solutions. Candidate projects should be identified.

l) Risk assessment of disposal options should be broadened to include associated welfare risk and technological risk. - The planned Research Agenda's risk assessments of disposal options cover human health and refer to environmental (ecological) risks. These assessments should be broadened to include associated welfare and technological risks. A semiquantitative, or perhaps even a qualitative analysis of all risks associated with the various reuse/disposal options seems to be appropriate. The uncertainties associated with the various risk estimates need to be characterized.

m) Continuing improvement in characterization of exposure is needed for all waste management options. - There is a need to characterize the emission and/or effluent at the point at which people and the environment are exposed for all of the waste management options. At present, such characterizations are very primitive or even lacking for some management options.

n) Source reduction should be strengthened in the research agenda. A major effort by all levels of society is needed to direct and change public perspectives toward source reduction. - A major effort at all levels of society, through voluntary, as well as regulatory means, is required to achieve source reduction goals.

As previously stated, source reduction should be a top research priority in the Research Agenda. The most basic physical science R&D requirement is to get a better understanding of what the various wastes contain (e.g., urban, suburban, commercial, manufacturing, etc.) in order to target ORD projects and to properly characterize such waste sources. Characterizations should be approached in a site-specific manner and should be linked to the technology involved, avoiding the tendency of engaging in generalities or national averages. Finding alternatives to disposal or end uses which are not related to lifetime product use is critical to both source reduction and recycling efforts.

Product research priorities need to be established based upon product impact on wastes (both in terms of quantity and hazard), their susceptibility to redesign or remanufacture, and benefits derived.

o) Recycling research should be coordinated with source reduction research. - The objectives of recycling, as outlined, are appropriate and require no additional comment. An important role for the Agency is information consolidation and dissemination, such as through workshops. For instance, volume reduction is the most immediate and obvious way for local government to reduce waste amounts. There are many communities already engaged in such activities, and this information could be communicated via workshops as proposed in the draft Research Agenda.

Since recycling involves institutional issues relating to habit changes and economics, development of cost reduction strategies is critical to the success of recycling. Research is needed on how to collect, separate and furnish MSW materials to recyclers at minimum cost. Additionally, improvement in the ability of communities to establish or improve recycling programs is needed.

p) Thermal destruction and ash residues research are mature research areas facing important new issues. - Significant advances in combustion technology have been achieved in the last decade. A substantial amount of knowledge about combustion and incineration has been developed by research for hazardous waste disposal. The Subcommittee recognizes that there are overlapping combustion research issues that may be assigned either to the hazardous or to the non-hazardous combustion research programs. Recognizing these facts, the high costs of combustion research and development, and the limited knowledge base for other MSW research areas, the Subcommittee ranks the thermal destruction and ash residues research program needs with a low relative priority. Without contradiction, the MSWS recognizes that important new research issues exist for combustion research.

Generally, the topics in presented on this topic in the draft Research Agenda are appropriate. However, the Subcommittee

believes that revised priorities are needed. Proposed areas of investigation for thermal treatment and residue management should address research to better understand the dynamical behavior of various species of volatile toxic metals. First priority should be given to mercury control and monitoring, and identification of mercury metal speciation in incinerator emissions. The speciation of chromium also deserves additional attention, as the relative amounts of trivalent and hexavalent chromium in emissions dramatically affect the risks posed by chromium emissions. Products of incomplete combustion from organics should continue to be evaluated.

Other important research areas that should be included in the Agency plans are:

1) Investigation and mitigation of potential occupational exposures,

2) Long-term equipment and process performance evaluations, and

3) Development of accelerated rate testing methodologies to predict long-term performance of MSW thermal destruction processes.

Long-term operational maintenance and emissions behavior characteristics of incinerators should be investigated in order to identify and understand the performance of these systems and ensure their reliability through their life cycle. With respect to both combustion and Air Pollution Control (APC) device performance, the goal should be to reliably characterize emissions during the entire life of a facility, accounting for the range of combustion conditions and variability in performance that can reasonably be expected to occur.

In view of the number of large incinerators under construction and planned, as well as intense public interest, funding of research into long-term emission problems should be continued, taking full advantage of knowledge and progress in the private sector.

q) The Agency needs to develop a comprehensive risk assessment methodology for incinerator ash residues. - The Subcommittee is in general agreement with the draft Research Agenda's proposed research plan for ash residues. The Agency could establish an advisory panel to coordinate research efforts on appropriate tests with other groups such as ASTM, ASME, NSF, industrial groups or with colleges and universities. EPA needs to develop a comprehensive "cradle-to-grave" risk assessment methodology for ash residues. Further, the Agency should identify and implement means to ensure that occupational exposures to ash residues, within incineration/combustion facilities, during

transport and at ash disposal sites, are adequately mitigated in all instances.

r) Landfill disposal research deserves top research priority. - The Subcommittee agrees that land disposal research is a top priority. This section needs clear integration of the elements of good science and engineering and their relevance. The Agency's research should identify the advantages and disadvantages of the roll of landfills as dynamic microbiologically-mediated processes in landfill management. Landfill "mining" and methane utilization should also be addressed together with ultimate use requirements.

s) Special wastes management should be integrated with the separate research initiatives. - Special wastes are actually issues which have been around for some time, but have been treated as a relatively new initiative because of current public perception. Combustion residuals, sewage sludge and medical/infectious wastes research areas should be integrated with the other separate research initiatives. In this area, as well as in some of the others, the possibilities of the MITE program for development of innovative technologies should be further explored.

2.0 INTRODUCTION

In response to considerable public interest, the Agency published in early 1989 a position document, prepared by the Municipal Solid Waste Task Force, entitled "The Solid Waste Dilemma: An Agenda for Action." (See Reference #11. NOTE: all references and resource material cited are listed in Appendix D.) The Office of Research and Development's (ORD's) Office of Environmental Engineering and Technology Demonstration (OEETD), acting on the recommended action items in this report, constructed a research plan (See Reference #10) to address identified needs. The plan includes topics on source reduction, recycling, thermal destruction, land disposal and special wastes management (combustion residuals, sewage sludge and medical/infectious wastes). The document includes a strategic plan for integrated waste management, as well as a proposal for a municipal (solid waste) innovative technology evaluation (MITE) program.

At the request of OEETD, the SAB was asked to review the Agency's research strategy for municipal solid waste. The SAB's MSW Subcommittee (MSWS) recognized this as a significant event, because a decade or more has elapsed since there was a substantive national research and development initiative undertaken to examine problems associated with municipal solid waste program management. Therefore, it is appropriate that the SAB undertake this MSW research review.

The Municipal Solid Waste Subcommittee (MSWS) was given the following charge: Prioritize the six principal research areas, and answer the following questions: a) Have all the research needs, regulatory as well as state and municipal, been adequately identified, or are there other additional issues that ORD should focus on? Is the plan appropriate considering these needs?; and b) Is there an appropriate balance among the research projects in the engineering, monitoring, effects, and health risk and risk assessment disciplines? This SAB research review report is not organized along the same lines of these questions, since a more useful way to respond was developed as the review progressed. The issues as presented in the charge and the Draft Municipal Solid Waste Research Agenda were reviewed in the SAB's MSW Subcommittee meeting of January 30-31, 1990.

The following Subcommittee findings and recommendations encompass the OEETD Research Plan, the briefings (oral presentations and discussions which ensued at the January 30-31, 1990 meeting) and subsequent deliberations of the Subcommittee.

3.0 CROSSCUTTING ISSUES FOR MSW RESEARCH

The SAB MSWS recognizes that the EPA has a history of productive research and development (R&D) in municipal solid waste (MSW), albeit an interruption of MSW R&D coincident with an increased emphasis on hazardous waste. It is most appropriate to recognize that the focus on MSW R&D must be renewed and that the Agency has started to address the problems by first drafting a comprehensive Municipal Solid Waste Research Agenda. This new planning effort will do much to coordinate future work on the many challenging MSW problems, as well as to build upon ongoing disparate efforts both within and outside the Agency.

The central and unifying concept of integrated waste management should be based on sound science. The application of this concept for planning the Agency's research program, and for implementation of MSW regulations, may resolve environmental concerns of recent years.

3.1 INTRODUCTION AND OVERVIEW

The EPA Municipal Solid Waste Research Agenda provides an important forum for presenting the views of the Agency on the need for rational approaches to solid waste management, and the role that fundamental and applied research can play in promoting this goal. The public perception of issues related to solid waste, and their response to solid waste management efforts and initiatives, often reflect significant fear and misunderstanding. Media reports speak of an impending garbage crisis that must be addressed. However, these same reports often foster a fear of needed facilities, for example, by promoting the belief that environmental damage from landfills is inevitable, or that municipal incinerators always pose a significant health hazard. This public fear is a major component of the "not in my back yard" (NIMBY) attitude which limits the ability to site needed facilities. The EPA Research Agenda should promote a recognition that solid waste management is a public responsibility that must be met in a rational, technically sound manner. Research results obtained by ORD can provide the scientific basis for developing such a technically sound, integrated approach to solid waste management.

The introduction to the draft Research Agenda discusses at length the serious dimensions of the garbage crises, highlighting health and environmental risks from landfills and incinerators. The discussion motivates the need for research to meet these needs, but does so in a manner that suggests an emergency or "fire fighting" approach to the problem. While these issues are important, and should be discussed, more of the emphasis in the introduction should be shifted toward a discussion of the historical evolution of the solid waste problem and management approaches, and the positive role that fundamental and applied research can play in accelerating this evolution. The introduction

should stress the important contribution that research will make toward improving all phases of the solid waste management system, ultimately leading to improved technologies and management approaches that are deserving of public trust and support.

Goals and objectives should emphasize contemporary and future needs, clearly separating new initiatives from past accomplishments. Moreover, recognition of the budget and expertise necessary to conduct the elements of the research plan, and that needed within the user community to receive and apply the results of the R & D efforts, should be clearly evident and embedded in the research strategy. Accordingly, if technology development and its transfer is impeded by personnel or budget needs, then the research plan should acknowledge this and include the implications in the overall strategy or approach.

3.2 PROGRAM FUNDING, RESOURCES AND PRIORITIES

CURRENT FUNDING IS ONLY SUFFICIENT TO ACHIEVE LIMITED SUCCESS IN THE FORESEEABLE FUTURE.

Limited resources will materially inhibit the Agency's ability to match knowledge with needs well into the foreseeable future. This expected shortfall of resources should be clearly stated so that it can be taken into consideration by any reader who expects a large part of the draft Research Agenda to be fulfilled.

In its review of the MSW draft Research Agenda, the Subcommittee realized that resource limitations, both funding and the availability of qualified personnel, would prevent the Agency from undertaking all areas of research. The draft Research Agenda identifies the six research areas in order of priority as viewed by the Agency: 1) strategic planning, 2) source reduction, 3) recycling, 4) thermal destruction, 5) land disposal, and 6) special wastes. The Subcommittee believes that these priorities should be reordered, but did not wish to place rigid numerical rankings to the research areas. It suggests a reordering of research priorities according to a high, medium, or low scale and recommends the following emphasis: High - source reduction and disposal in landfills; Medium - strategic planning and recycling; and Low - thermal destruction and special wastes.

Table 1 compares the research priority ranking of the draft Research Agenda with that of the Subcommittee for the six research areas. This listing and ranking was based upon perceived need (i.e., risk-reduction opportunities associated with knowledge gaps) by the MSW Subcommittee, and not upon relative quality or comprehensiveness of existing and planned programs. Clearly the latter should influence the Agency's decisions as well. For example, land (landfill) disposal was given high priority; research needs are great, but the research plan presented to the SAB needs considerable redirection and development before the Agency

addresses its priority. On the other hand, thermal destruction of municipal solid waste was given a lower priority, in contrast to its central importance to hazardous waste management. However, the Agency may be reluctant to reduce the efforts currently given to this mature research area, which is important to hazardous waste management. Therefore, the Agency is cautioned to temper the Subcommittee's recommendations based upon the desired end points to be achieved, balancing existing, planned or overlapping programs.

There are various reasons for the Subcommittee's research priorities. Source reduction and landfill disposal are considered high priority areas which need new impetus and technology-forcing changes. Strategic planning is reduced in priority because many decisions are already being made by local solid waste planning agencies and undeveloped nationwide strategies cannot make or contribute to the various local needs. Similarly, recycling is an active area of private R&D and less Federal effort is needed.

Special wastes are considered low priority because most solutions depend on various codisposal or codestruction options which have been fairly well developed and have a reasonably high potential for success when these technologies are applied.

ESTABLISHMENT OF PRIORITIES IS ESSENTIAL

The Subcommittee considers that the menu of proposed projects cannot be adequately addressed, given the limited levels of funding available to the Agency. Consequently, the Subcommittee suggests that projects must have clear priorities in order of importance to the Agency. The Agency's perspectives on these priorities should be shared with and reviewed by the technical and scientific community intended to implement the draft Research Agenda. Further, guidelines and contingencies for limiting or deferring project initiatives should be developed, should this prove necessary.

3.3 PROGRAM ANALYSES

THE PROPOSED PROGRAM ELEMENTS OVERLAP. THERE IS A NEED TO ASSESS INTERRELATIONSHIPS AMONG PROGRAMS AND PROJECTS.

The program and projects described within the six research areas have some overlap. Some of this overlap is appropriate, since a given program or project can serve more than one research area. An analysis of the relationship of new programs or projects to current efforts also would be helpful, e.g., the relationship between the project on "Expert Systems for Municipal Solid Waste Management Decisions" to the hard-copy decision-making guides now under revision. In a broader sense, these factors may be better shown if a program

Table 1 - MSW Subcommittee Consensus Ranking of MSW Research Needs*

Research Area	EPA Draft Research Agenda Hierarchy	MSWS Consensus Needs Priorities	Rationale for MSWS Priorities
- Strategic planning for Integrated Waste Management	1	Medium	Methodologies are well along in their development and local and state agencies are already using these techniques.
- Source Reduction	2	High	Likely to have greatest impact over the long term. Limited existing knowledge.
- Recycling	3	Medium	Many new issues. Discovering new problems. Limited existing knowledge.
- Thermal Destruction	4	Low	Mature research area. Technical knowledge base is large, including concomitant research for hazardous waste. However, there are new issues for air emission characterization and control. Need to better understand metal speciation in incinerator emissions, as well as products of incomplete combustion. Ash disposal problems.
- Disposal in Landfills	5	High	Modern landfill designs require higher technologies. Ultimate sink for combustion and other residuals. Limited research effort in last decade.
- Special Waste	6	Low	Redundant with other research areas. Incorporate with other programs.

*NOTE: This relative ranking of priorities is based upon perceived needs, not upon the relative quality or comprehensiveness of existing and planned programs. The agency is cautioned to temper the above recommendations based upon the desired end points to be achieved, balancing existing and planned programs. (Refer to appropriate text for further comment and reasons for application of these rankings to new and existing programs.)

analysis based on a matrix approach is initiated which links program elements and their relative priorities.

3.4 AGENCY AS CATALYST

THE AGENCY SHOULD SERVE AS A CATALYST FOR CHANGE.

Generators look for savings in disposal cost or profit in product or waste marketing. To the extent that the Agency can act as a catalyst to enable the generator and waste manager to develop beneficial solutions, it needs to prioritize its research program and identify its role in the process.

The Agency should serve as a catalyst. This is a vital role which should be refined and pursued. For instance, the Agency is well suited for and has the capacity for information dissemination, sponsoring conferences, providing decision tools, providing technology evaluation expertise, catalyzing market and product development, conducting environmental fate and effects studies, conducting treatability studies, developing incentives, and providing grants and loan support and similar supportive activities as a catalyst for action at the local and state levels, as well as encouraging private sector initiatives. This role needs to be refined and pursued as part of the overall strategic long-range implementation plan. The Agency also needs to be involved in developing information and technology-forcing efforts such as the study of socioeconomic patterns, existing consumer attitudes and how these can be impacted, advantages and disadvantages of landfills designed as bioreactors or dynamic operating systems, and alternatives such as large-scale in-vessel composting and treatment technology of concentrated wastes and recycling operation wastes.

Unless there is an overriding criterion related to protection of the environment and human health, the Agency should not be involved in specific product development (other than incentives or grant support) and should not reinvent ongoing programs. Numerous programs to label products based on their environmental attributes and recycling guides are developing in the U.S. and abroad. The Agency should study these resource programs, assess their strengths and weaknesses, determine what might be learned from them and make information about them available, with an aim toward determining if a government-based program is appropriate in the U.S.

3.5 CONSOLIDATION OF EFFORTS

CONSOLIDATION OF WASTE CHARACTERIZATION EFFORTS IS PREFERRED AS A MEANS TO PROVIDE A NATIONAL DATA BASE.

Basic waste characterization studies are ongoing or have been completed by States, local governments, and industry. These studies are being conducted at the level of detail needed e.g., specific

data for local decision making. Nationwide data and broad averages or characterizations are not needed, but consolidation of on-going studies by regions or regional management would be valuable. Similarly, consolidation of existing technology evaluations and comparative studies of management strategies being developed at the local government levels, universities, and by other countries (e.g., in Canada and Europe) could ensure prudent use of limited resources. This recommendation also applies to endorsement or expansion of existing programs, such as an identification of environmentally friendly products and certification, rather than developing redundant, effort diluting, or competing initiatives.

3.6 OPTIMIZING THE RESEARCH EFFORT

STRIKING THE RIGHT BALANCE IS NECESSARY TO ACHIEVE AN EFFECTIVE RESEARCH AGENDA.

One of the Subcommittee's charges (See Appendix A) was to evaluate the extent to which the Research Agenda provides an appropriate balance among the six major research areas and the various disciplines (engineering, monitoring effects, risk assessment) that are brought to bear on each major area, as reflected in the enumeration and prioritization of specific projects.

Recognizing the constraints imposed by limited resources and competing demands that EPA research programs face in responding to near-term regulatory needs, while attempting to maintain their core research activities, the Subcommittee identified several aspects of the draft Research Agenda where a shift in balance may be warranted. (See Section 3.2 and Table 1).

3.7 EDUCATION AND TRAINING

EDUCATION AND TRAINING IS NEEDED AT ALL LEVELS.

The proper translation and effective dissemination of research results are important. The Agency's personnel resources are insufficient to accomplish the proposed agenda. This will create an impediment to implementation of the proposed research and its timely application. Although there is some recognition of this crucial element within project areas, this need should be evident throughout the document and developed clearly and incisively as an initiative complementing all other components of the research plan.

An innovative education program, at all levels of need, should be developed in consort with the other elements of the research plan. This program should address education and training needs of personnel in local and state government as well as in the private sector. The resources needed to implement an educational program such as grants, fellowships, internships or other support mechanisms should be developed.

3.8 POLLUTION PREVENTION AND CONSERVATION

POLLUTION PREVENTION AND CONSERVATION REQUIRE MEASURES OF PROGRESS.

The draft Research Agenda reflects the Agency's commitment to pollution prevention as a means of addressing a broad array of environmental concerns. Implementing pollution prevention, which manifests itself most directly in the research areas of source reduction and recycling, requires research in and integration of a combination of technological, economic, and social science disciplines.

Better documentation of the benefits and methods of measuring the effects of pollution prevention in terms of materials and energy conservation, preservation of ecological resources, as well as reduced MSW generation and pollution impacts is needed. Heuristic approaches to the examination of the qualitative and quantitative benefits would be a useful activity.

Research on identification of pollution prevention measures and incentives/disincentives to their implementation is needed. Further, it could be targeted at specific social and economic sectors such as individual consumers and households, government at all levels, business and industry, and other institutions.

3.9 INCENTIVES

INCENTIVES ARE NEEDED TO FACILITATE GOALS.

One way to address the problem of MSW management is with programs to reduce the quantity of waste generated through source reduction and by recycling to reduce quantities of waste sent to landfills or incinerators. Various incentives (economic, technical, and institutional) can facilitate these goals. In addition, various incentives could be applied to help solve environmental problems associated with technical approaches. For example, if batteries are a principal source of mercury in thermal destruction emissions from incinerators, economic or other incentives could be employed to find a substitute for mercury in batteries, to reduce the quantity of batteries in solid waste or to facilitate the recovery of batteries from solid waste before they are incinerated.

The current draft Research Agenda does not include research on the development and testing of various incentives to achieve the goals of the MSW research plan (See Reference #10, Appendix D, pages 1-21 to 23), despite the fact that these approaches may be among the most cost-effective. Included in this draft Research Agenda should be mechanisms to develop environmentally friendly regulatory policies which examine the use of economic instruments, such as deposits and discharge fees on certain products, or other

such incentives. The goal is to have manufacturers incorporate these policies into design, production, and marketing strategies.

Research should also seek institutional incentives, such as the inclusion of life cycle costing provisions in procurement procedures. Research could also be encouraged to identify those areas in which human behavior modification would lead to reduced or more environmentally acceptable solid wastes. Household, business and industry, government, and institutional practices should all be targets of such an incentive.

3.10 DATA COLLECTION AND MANAGEMENT

DATA COLLECTION, INTERPRETATION AND THEIR UTILIZATION REQUIRE CONSIDERATION OF BOTH STATISTICAL VALIDITY AND HEURISTIC REASONING.

The Agency considers it an important objective that regulations should be developed from credible and reliable technical information. One means to ensure that this objective can be realized is for technical information to be based upon statistically valid data. However, in view of the extensive menu of proposed research projects and limited financial resources, the MSW Subcommittee does not perceive that, taken as a whole, the realization of this objective can be ensured.

Therefore, the Subcommittee suggests that the process of information development should entail not only an evaluation based on statistically valid data, but should also include heuristic reasoning, that is, mental rules of thumb which have been established from a consideration of prior experience and knowledge of a scientific nature which, by consensus, are considered valid and credible within the scientific community. Substitution of "rule of thumb" analyses for technical and scientific studies is not being proposed.

It is not necessary to gather new data to answer every question. One may frequently be able to use prior scientific knowledge and reasoning. In developing this expanded base of information upon which regulatory initiatives are founded, it is considered important to harmonize opinions by first clearly agreeing upon a consensus regarding the meaning (semantics) of available information. Absent such agreement, conclusions used to validate and defend regulations may remain unclear.

3.11 CORE RESEARCH

CORE RESEARCH SHOULD BE DEVOTED TO INCREASING SCIENTIFIC UNDERSTANDING OF THE MAJOR PROBLEMS AND IDENTITY OF PROMISING SOLUTIONS.

Some of the programs and projects seem suitable candidates for

the ORD Core Research Program as a new effort by the Agency to develop the resources and technology needed to address today's environmental problems. Project selection should be made not by immediate regulatory needs, but rather by the extent to which the added science can increase understanding of major problems and point to promising solutions. Candidate core research projects should be identified.

3.12 RISK ASSESSMENT

RISK ASSESSMENT OF DISPOSAL OPTIONS SHOULD BE BROADENED TO INCLUDE CONSIDERATION OF ASSOCIATED WELFARE AND TECHNOLOGICAL RISKS.

Currently, planned risk assessments of disposal options address human health and environmental (ecological) risks. However, they should be broadened to include associated welfare risk and perhaps technological risk. Welfare risks include property devaluation, physical and mental discomfort, loss of a resource such as groundwater and liability. Technological risks include the probability and consequences of failure by various modes. Some indication of the uncertainty associated with the various estimates should be given, and the basis for the uncertainty estimate should be indicated.

3.13 COMPOSITION OF POLLUTANTS

CHARACTERIZATION OF EMISSIONS AND COMPOSITION OF POLLUTANTS IN RELATION TO POINTS OF EXPOSURE FROM MSW ACTIVITIES IS NEEDED FOR ALL WASTE MANAGEMENT OPTIONS.

There is a need for continuing improvement in characterizing emissions and/or effluents at the points at which people and the environment are exposed for all of the waste management options. At present, such characterizations are primitive or lacking for some management options. Without this information, it is difficult to assess the potential risks/effects associated with the technical options or to determine the need for these technologies.

It is important that expertise be sought when identifying substances in liquid effluents and gaseous emissions from MSW activities which represent significant potential human health and environmental risks. Monitoring of regulated chemicals may not be sufficient and may result in failure to detect the presence of some substances which can significantly contribute to risk. It is realized that effluents are complex mixtures which cannot be completely characterized and which will vary not only with management options, but also with location and over time. Given this complexity, analyses based on partial characterization of effluents are limited, and the Agency should consider ways to help understand and overcome the limitations of current character-

izations, including the extent and degree to which models are used to estimate environmental levels.

Attention to various levels of measurement should be provided. In terms of the consequences related to public perception, and in the absence of compelling risk-oriented evidence, one may question the need to strive for or promote measurements at or below current analytical limits. (See References #13, 14, 19 & 21, Appendix D).

4.0 DIRECTED COMMENTS ON THE DRAFT RESEARCH AGENDA

The following comments refer to the six research areas in the draft Research Agenda. Reordering of priorities for research programs is suggested within each of the six areas.

4.1 SOURCE REDUCTION

SOURCE REDUCTION SHOULD BE A TOP RESEARCH PRIORITY IN THE RESEARCH AGENDA.

Research priorities should include the development of social science materials for an educational outreach program to begin to change manufacturing and consumer habits and government procurement policies at all levels. Within the context of setting priorities, Objective 2 of the Strategic Planning Section of the draft Research Agenda (Reference #10, Appendix D, page 2-6) probably should be the first priority, as it relates to education of the public and waste management planners.

As it relates to the six overall research areas, source reduction should be a top priority in the draft Research Agenda. A basic physical science R&D requirement, however, is to understand what is in various types of wastes (e.g. urban, suburban, commercial, manufacturing, etc.). This involves the development of better waste characterization techniques. Characterization studies should be approached in a site-specific manner and should be linked to the technology involved, avoiding the tendency of engaging in generalities or national averages.

The Subcommittee recognizes that the industry itself is, and should be, engaged in the development of waste composition data. There is a large amount of data in existence at the state and local levels and numerous household, commercial, existing landfill, and industrial waste studies are being conducted. Existing data need consolidation and evaluation to be useful for management decisions. The Agency can play an important role in the development, interpretation, and dissemination of the data. It is important that the data reflect state-of-the-art techniques and understanding.

Product priorities need to be established based upon their contribution to the waste stream (both in waste quantity and

hazard), their susceptibility to redesign or remanufacture, and the benefit derived, be it in reduction of hazard or quantity. Once such product priorities are established, then the broad objectives of the draft Research Agenda can become more viable. This should include the development of economic incentive options for promising source reduction and/or recycling techniques. Market factors are important here. If it is cheaper to produce/dispose of a waste than it is to repair, redesign or recycle, these may be impediments to materials conservation.

The Subcommittee believes that source reduction research is high priority because it is likely to have the greatest impact for MSW management over the long term. Because this is a new approach to the reduction of MSW, the Subcommittee advises that the Agency should use care in clearly defining source reduction, in setting goals and criteria, and establishing measures of performance for this work.

4.1.1 Source Reduction Objective 1 - To establish models for assessing environmentally preferable products. (page 2-14)*

Establishing standardized definitions, criteria for judging and methods and models for conducting cost-benefit analyses to develop preferable products would provide useful tools especially if industry groups can be cooperatively involved in this work--again focusing on the larger solid waste contributors.

4.1.2 Source Reduction Objective 2 - To identify and evaluate the pollution generation characteristics of both existing and new products and of changing-use patterns. (page 2-14)*

There is a large body of information on major industrial processes, (including material balances), both as developed by EPA (effluent guidelines and previous ORD studies in the 1970's) and by individual industries. The compilation of these data, as they affect the solid wastes, would be an opportunity to identify wasteful and/or waste saving practices.

4.1.3 Source Reduction Objective 3 - To develop a methodology for measuring the impact and benefits of source reduction. (page 2-15)*

The impact and benefits of management or technology changes can be realized at the plant level and are constrained by such factors as competitiveness between plants, between companies and between countries. ORD may be able to enhance voluntary or regulatory changes by developing general procedures, for management and society, which may be used in establishing the impacts and costs for change.

4.1.4 Source Reduction Objective 4 - To identify opportunities for source reduction and to conduct source reduction opportunity assessments for a variety of waste streams. (page 2-15)*

As noted elsewhere in this document, the Subcommittee believes that identification of opportunities for source reduction and the conduct of source reduction opportunity assessments for a variety of waste streams should be a first priority for R&D in order to best focus on the resources that will be applied to meet the other three objectives of Source Reduction. This objective should be expanded to include source reduction in packaging.

In specific research projects, the area to "Conduct Plastic Degradability Studies To Determine The Effects That Plastics Have On The Environment" should be expanded to include recycling.

The research area "Conduct Field Studies To Identify Opportunities For Source Reduction" should place greater emphasis on supporting research to find substitutes or alternatives to the toxic components identified and traced to their source.

4.2 RECYCLING

THE RECYCLING RESEARCH PROGRAM SHOULD BE COORDINATED WITH THE SOURCE REDUCTION RESEARCH PROGRAM.

In specific research areas, assessment of data on health and environmental risks of various recycling operations is insufficient. Where major toxic components are identified, research on treatment alternatives should be conducted when recycling or recovery options are not possible or likely.

The most immediate and obvious way for a local government to reduce the volume of wastes that either have to be buried or burned is through a recycling program. However, a recycling program without proper market development is counterproductive.

Many communities are already engaged in recycling activities and, therefore, lessons to be learned through the workshops proposed in the draft Research Agenda could be beneficial with respect to technology transfer to all who are responsible for MSW. However, in order to develop a market for recycled materials, large quantities of these materials must be separated and accumulated. Accumulation of large quantities of materials for recycle without links to viable markets will result in a disposal problem.

There are problems with marketability of wastes such as paper. In some instances, localities (governments and school systems) that

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NOTE: Asterisked items (*) refer to Reference #10, Appendix D with an appropriate page citation.

are attempting to encourage recycling are not routinely purchasing the recycled materials. This is an institutional problem, involving costs and habit changes. Recycling opportunities should be developed near the recycling center in order to maximize its market and cost efficiencies. EPA and ORD educational materials might be developed in order to examine the problems and possible solutions.

The recycling research area should be coordinated with the source reduction research area. Specifically, coordination of recycling strategies with other strategies such as product redesign are important, because product changes may affect their recycling potential. For example, development of degradable plastics (bio or photo) directly interferes with plastic recycling because inadvertent incorporation of degradable plastics could endanger the recycled product. Increased pressure would thus be placed on waste separation efforts which have already been identified as expensive and hazardous to workers.

In the proposed project, entitled "Workshop on Wastestream Components" (which is not research as it is typically defined by the SAB), the Agency can expect to have an impact. This is an important role for the Agency, especially since the Agency is just beginning some of its proposed areas of research. Information consolidation and dissemination is important, and the Agency is ideally situated to contribute in this area. One area where the workshops could be expanded into research is to provide financial support for municipalities to identify the larger components of their wastes and target them for recycling or other waste management strategies. The program suggested for yard wastes (See Reference #10, Appendix D, page 2-22) has similar needs for information transfer.

The Agency should extend its perception of the composting alternative, by fostering consideration of a regionalized concept including integration with existing management options. Landfill area, for example, could be dedicated to continuous composing (aerobic or anaerobic), with recovery and beneficial use of the compost at the landfill or elsewhere, including the rehabilitation and recovery of marginal lands.

Waste separation studies (See Reference #10, Appendix D, page 2-22) and the development of innovative technologies should build on past and present experiences not only in the U.S., but elsewhere. Development of cost reduction strategies can be critical to the success of innovative recycling methods which may reduce health risks to workers and should receive major research attention. Reduction in the number of pickups per week, the consequences of volume-based disposal rates, as well as identification of waste type for improved segregation needs more investigation. In addition, research is needed on better techniques for segregation and pick-up at households and commercial

establishments, supported by the development of community awareness education materials. The proposals associated with assessing health and environmental risks are good ideas, but if significant risks are found, then research should be continued to solve the problems.

With respect to the proposal to compare recycled products with those made from virgin materials, there is a question as to how one would go about selecting the products to be compared.

The suggestion to assist communities with respect to alternative recycling options is appropriate. Separation methods at the household and small group level need research. For example, high-rise apartments and commercial enterprises have different problems than a single-floor building. Any improvement in the ability of communities to establish or improve recycling programs can have large beneficial results.

4.3 THERMAL DESTRUCTION AND ASH RESIDUES

THERMAL DESTRUCTION AND ASH RESIDUES RESEARCH ARE MATURE RESEARCH AREAS FACING IMPORTANT NEW ISSUES.

Significant advances in combustion technology have been achieved in the last decade. A substantial amount of knowledge about combustion and incineration has been developed by research for hazardous waste management. Recognizing these facts, the high costs of combustion research and development, and the limited knowledge base for other MSW research areas, the Subcommittee ranks the thermal destruction and ash residues research program needs with a lower relative priority. Nonetheless, the MSWS recognizes that important new research issues exist for combustion research.

Generally, the topics in this section are appropriate. However, the Subcommittee believes that revised priorities are needed. Proposed areas of investigation for thermal treatment and residue management should address volatile toxic metals; first priority should be given to mercury control and monitoring, and identification of mercury metal speciation in incinerator emissions. The speciation of chromium also deserves special attention, as the relative amounts of trivalent and hexavalent chromium in emissions dramatically affect the risks posed by chromium emissions. Products of incomplete combustion from organics should continue to be evaluated. (See Reference #19, Appendix D).

Noticeably absent, but nevertheless important, research areas that should be included in the Agency plans, are:

a) coordination of EPA's efforts on investigation and mitigation of potential occupational exposures with

other agencies such as NIOSH and OSHA,

b) long-term performance evaluations of equipment and processes; and,

c) development of accelerated rate testing methodologies to predict long-term performance of thermal destruction processes and coordination with other testing activities such as ASTM and the National Institute for Standards and Technology (NIST)*.

Although the topics covered in this section are appropriate, the Subcommittee believes that some reordering with respect to priority is needed. High priority should be given to identifying and developing effective methods for monitoring and capture of metals, such as mercury and cadmium in MSW, in order to service development of strategies for its removal and containment.

As an example, recent testing at several state-of-the-art MSW incinerators has revealed low or even zero mercury capture efficiency, despite the fact that they employed pollution control technology and operating conditions intended to achieve efficient capture. These findings, coupled with the fact that MSW incinerators represent a major localized point source of mercury emissions to the environment, argue for the importance of this topic to thermal destruction research in the draft Research Agenda.

Further examination of the mechanisms of metal speciation in incinerator emissions should also be a high-priority research area. This should include research on a better understanding of the dynamical behavior of various species, as influenced by combustion and other operating conditions. There is some question whether or not the requirements to carry out this objective go beyond the current capability of the Agency. The speciation of chromium in particular deserves additional attention, as the relative amounts of trivalent and hexavalent chromium in emissions dramatically affect the risks posed by chromium emissions.

Proper operation and maintenance of MSW incineration are necessary. Long-term operational, maintenance and emissions behavior characteristics of incinerators should be investigated in order to identify and understand these systems and ensure their reliability through their life cycle. The Subcommittee considers this to be a high-priority area of research. With a view toward mitigating any undesirable performance, investigations should include efforts to further characterize emissions during excursions from optimal combustion conditions, such as those which can typically occur during start-up and shut-down, as well as upset conditions.

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*NOTE: Formerly known as the National Bureau of Standards.

Similarly, data are needed concerning the long-term performance of air pollution control (APC) equipment, and the development of better methods for continuously monitoring such performance. With respect to both combustion and APC performance, reliable estimates are needed for the effects on emissions of facility or equipment "aging" and variability in the frequency and quality of equipment maintenance. The goal should be to have a reliable understanding of probable emissions during the entire life of a facility, accounting for the range of combustion conditions and variability in performance that can reasonably be expected to occur.

With regard to the necessity to mitigate any potential worker exposures, "properly designed, operated, and maintained" must mean inclusively that emissions, such as from fugitive dusts from an incinerator facility, shall be held to levels that are not of regulatory concern. It appears that means are available to ensure that unacceptable exposures do not occur. The Subcommittee believes that research to understand and characterize the present risks from worker exposure is very important, and that such research should identify means to ensure that current and future worker exposures will be mitigated. For instance, within the present universe of incinerators, there is some concern that unacceptable on-site occupational exposures of workers to adverse conditions may have occurred, such as fumes at the tipping dock and fugitive emissions of ash residues.

4.4 ASH RESIDUES

THE AGENCY NEEDS TO DEVELOP A COMPREHENSIVE RISK ASSESSMENT METHODOLOGY FOR ASH RESIDUES.

The Subcommittee is in general agreement with the draft Research Agenda's proposed research areas and their relative priority for ash residues. As discussed above with respect to air emissions, speciation of metals in incinerator ash deserves greater attention, given the importance of such information in predicting the potential for long-term releases of metals from the ash under various environmental conditions. It is anticipated that the development of reliable accelerated rate tests for characterizing such releases can enhance the predictive capabilities of ash characterization methods. The Subcommittee recognizes that it is well known that the development of accelerated rate tests is an area of investigation that is difficult to pursue among most areas of materials science, not just with regard to incinerator ash residues. Given that accelerated rate tests are difficult to develop, the Agency could establish an advisory panel to coordinate research efforts with other groups, such as with the ASTM, ASME, NSF, industry or with colleges and universities.

Two additional areas deserve attention in the draft Research Agenda. First, EPA needs to develop a comprehensive risk

assessment methodology for ash residues. While the Agency has proposed such a methodology for incinerator air emissions (See references #19 and #20, Appendix D), it has yet to complete its development or to extend it to ash residues. Such a methodology should account for the multiple pathways of exposure that may arise during all stages of ash management, and for the full range of health effects associated with ash-borne pollutants. Ash management should recognize different ash types, for example fly ash, bottom ash, and the mixture of both ashes.

Second, the Subcommittee takes the view that through a program of research, the Agency must identify and implement means to ensure that occupational exposures to ash residues, both within incineration facilities and at ash disposal sites, are adequately mitigated in all instances. In addition, as there is strong interest to identify and implement means to reutilize some ash residues, the Agency should conduct research, and coordinate work with the coal, and other industry groups and EPRI, to establish criteria to ensure that unacceptable occupational or general population exposures will not occur in instances in which ash residues are reutilized. Any unexplored areas of concern must be addressed, such as criteria to protect masonry workers and road construction crews.

4.5 DISPOSAL IN LANDFILLS

LANDFILL DISPOSAL RESEARCH DESERVES TOP PRIORITY.

The fundamental difficulty with this section of the draft Research Agenda is that it appears to have been prepared from an assortment of ideas, perceptions and favored projects rather than a coordinated inspection of conditions, needs and proposed solutions based upon state-of-the-art understanding and its implementation and future refinements. It is a somewhat traditional discourse which lacks clear integration of the elements of good science and engineering and their relevance.

The section on land disposal referencing landfills should be rewritten, eliminating the elements of casual commentary, and providing clear and more comprehensive descriptions of the perceived problems and proposed solutions. (The section on **Thermal Destruction** could be used as an appropriate guide.) The text is often vague, misleading, may be taken out of context, does not reflect cognizance of ongoing activities, and usually cannot stand alone without questioning its meaning and significance. This then has led to some proposed projects which, again, lack a cohesive description of problems, research plans, purpose and expected utility. Inconsistencies tend to make scientific and technical credibility suspect, yet the priority of land (landfill) disposal issues is as great as, if not greater than, all other elements of the overall ORD draft Research Agenda. Therefore, they deserve a

corresponding focus, development and integration with the other research initiatives.

In rewriting this section, the Agency should focus on an examination of the advantages and disadvantages of landfills as dynamic microbially-mediated processes which can be managed to diminish them as generator sources of potential adverse health and environmental impacts. At present, this is absent in the draft Research Agenda. Further, the research protocol overemphasizes mechanical issues associated with containment systems, design, "mining", closure and overall construction techniques. The section emerges as an assortment of statements without a convincing synthesis of problem-oriented research and its justification. Despite these shortcomings, the Subcommittee agrees that landfill research is a top priority, since landfills will continue to be the principal disposal technique for many more years.

It should be noted that the public perception that future landfills can be eliminated by other initiatives in MSW management is unrealistic. Basic research in landfill design is weak or missing. Research is needed in technology-forcing or developing areas rather than additional review of past practices. Moreover, codisposal of municipal sewage sludge in landfills with MSW is widely practiced today. Its merits and limitations should be more clearly identified. (This is also a topic addressed in Special Wastes Management.)

The new Clean Air Act draws attention to the characterization of hazardous air pollutants (HAPs) and suggests that these emissions from landfills be investigated.

4.6 SPECIAL WASTES MANAGEMENT

SPECIAL WASTES MANAGEMENT SHOULD BE INTEGRATED WITH THE SEPARATE RESEARCH INITIATIVES.

The section on special wastes management, including combustion residuals, sewage sludge and medical/infectious wastes is recognized in the ORD draft Research Agenda as a relatively new initiative which has received some priority treatment because of current public perception. Yet the issue is a relatively old one, and the section has been written to acknowledge this fact as well as its relevance to other waste management procedures, such as landfills and thermal combustion. In this sense, it is well organized, but should be integrated with the separate research initiatives. For example, since most of the identified special wastes are incinerated, it may be productive to link these research needs to other incineration initiatives.

An appealing aspect of the special waste management section is the incorporation of scientific principles into the research strategy, thereby reinforcing its technical merit. The already

in-place medical/infectious waste management initiative is appropriate and could benefit by a closer coordination with developments in other areas of the draft Research Agenda. In this area, and in some of the others, the possibilities of the MITE program for development of innovative technologies should be further explored. The discussion of the problems and opportunities regarding sewage sludge management sets the stage very well for the following research programs. The programs themselves are focused on knowledge gaps and show innovation. Land application information gaps for sewage sludge, such as plant uptake of certain metals, and possibly certain organics, and pathogen die-off (high priority), should be considered.

Table 2 summarizes the Subcommittee's shift of priorities from a technological viewpoint for the special waste management research topics. The Subcommittee acknowledges that regulatory and policy needs may dictate otherwise.

Table 2 - Summary of Recommended Changes in Priorities for Special Wastes Management Research Topics

Research Topic	MSWS Recommendations	Rationale for MSWS Recommendations
- Co-incineration and co-disposal in landfills	Increase priority	Uncertainties about environmental impacts need to be resolved; significant and promising disposal options.
- Sludge as soil conditioner	Increase priority	An apparently acceptable disposal option; may be beneficial to recovery of marginal lands.
- Risk Assessment	Increase priority	Broaden to include ecological, welfare, and technological risks; evaluate qualitatively; do not limit to quantitative assessment of health risks.
- Co-composting with MSW	Accept EPA priority	Agree with rationale given in Draft.
- Co-treatment and co-disposal with MSW	Accept EPA priority	Agree with rationale given in Draft. Consider as topic for ORD's core research program.
- Analysis of organic emissions from incineration	Reduce priority	Methods are under development for hazardous waste incineration.
- Continuous monitoring of incineration process	Reduce priority	Technology is under development for hazardous waste incineration.
- Thermophilic anaerobic digestion	Reduce priority	Information available from full-scale operations in Europe.
- Conversion to liquid fuel	Reduce priority	Process likely to lead to processing, handling, and marketing problems due to expected toxicity of liquid fuel products. (Published information available from US DOE studies.)
- Vertical reactor wet oxidation for sludge	Keep low priority	Agree with rationale given in Draft.
- Sludge thickening and dewatering	Keep low priority	Technology developed and is being refined.

APPENDIX A - THE CHARGE TO THE SUBCOMMITTEE

When considering a consolidated, multidisciplinary Municipal Solid Waste Research Program, what should the priorities among the six principal research areas be?

Have all research needs, regulatory, as well as State and municipal, been adequately identified, or are there other additional issues that ORD should focus on? Is the plan appropriate considering these needs?

Is there an appropriate balance among the research projects in the engineering, monitoring, effects, and health risk and risk assessment disciplines?

APPENDIX B - ACRONYMS AND GLOSSARY OF TERMS

AEERL ------ AIR AND ENERGY ENGINEERING RESEARCH LABORATORY, RTP, US EPA
APC -------- AIR POLLUTION CONTROL
ASME ------- AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM ------- AMERICAN SOCIETY OF TESTING MATERIALS
ECAO ------- ENVIRONMENTAL CRITERIA AND ASSESSMENT OFFICE, US EPA, ORD
EEC -------- ENVIRONMENTAL ENGINEERING COMMITTEE of the US EPA, SCIENCE ADVISORY BOARD
EPA -------- U.S. ENVIRONMENTAL PROTECTION AGENCY (also US EPA, and the AGENCY)
EPRI ------- ELECTRIC POWER RESEARCH INSTITUTE
FDA -------- FOOD AND DRUG ADMINISTRATION
HAPs ------- HAZARDOUS AIR POLLUTANTS
HQ --------- HEADQUARTERS OFFICE OF EPA IN WASHINGTON, D.C.
LCA -------- LIFE CYCLE ASSESSMENT
MITE ------- MUNICIPAL (SOLID WASTE) INNOVATIVE TECHNOLOGY EVALUATION PROGRAM
MSW -------- MUNICIPAL SOLID WASTE
MSWS ------- MUNICIPAL SOLID WASTE SUBCOMMITTEE (also referred to as the SUBCOMMITTEE)
MWC -------- MUNICIPAL WASTE COMBUSTION
NSF -------- NATIONAL SCIENCE FOUNDATION
NICAD ------ NICKEL-CADMIUM BATTERIES
NIOSH ------ NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
NIMBY ------ NOT IN MY BACK YARD
NIST ------- NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY (Formerly known as the National Bureau of Standards)
OAQPS ------ OFFICE OF AIR QUALITY PLANNING AND STANDARDS, US EPA
OEETD ------ OFFICE OF ENVIRONMENTAL ENGINEERING AND TECHNOLOGY DEMONSTRATION OF THE OFFICE OF RESEARCH AND DEVELOPMENT, US EPA
ORD -------- OFFICE OF RESEARCH AND DEVELOPMENT OF THE US EPA
OSHA ------- OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
OSW -------- OFFICE OF SOLID WASTE OF THE US EPA
OSWER------- OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE OF THE US EPA
OTA -------- OFFICE OF TECHNOLOGY ASSESSMENT OF THE US CONGRESS
PIC -------- PRODUCTS OF INCOMPLETE COMBUSTION
POTW ------- PUBLICLY-OWNED WASTEWATER TREATMENT WORKS
RESEARCH AGENDA------ US EPA, ORD, OEETD, Municipal Solid Waste Research Agenda, Draft, December 22, 1989 (also referred to as draft Research Agenda and EPA draft report.)
R&D -------- RESEARCH AND DEVELOPMENT
RREL ------- RISK REDUCTION ENGINEERING LABORATORY, US EPA, ORD
RTP -------- RESEARCH TRIANGLE PARK, US EPA, ORD, NORTH CAROLINA LABORATORY

SAB -------- SCIENCE ADVISORY BOARD OF THE US EPA
WMDDRD ----- WASTE MINIMIZATION, DESTRUCTION AND DISPOSAL
RESEARCH DIVISION, US EPA, ORD LABORATORY

APPENDIX C: BRIEFINGS AND HANDOUTS PRESENTED TO THE SAB's MSWS ON JANUARY 30, 1990

1) Active Tasks for Municipal Solid Waste Research (DO19/L/45/77), January 30, 1990 - A presentation by Robert Landreth, US EPA, Cincinnati, Ohio

2) Advisory Committee (A Briefing on Medical Waste) - A presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

3) C.C. Lee, George L. Huffman and Richard P. Nalesnik, Summary of Current Medical Waste Management Knowledge, US EPA, ORD, OEETD, RREL, WMDDRD, Thermal Destruction Branch, Thermal Processes Section, Cincinnati, Ohio 45268 - A presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

4) Council of Governments (COG), State Infections Waste Regulatory Programs, 1988 - A presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

5) EPA's Medical Waste Program - A presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

6) Issues in Medical Waste Management, Background Paper, Congress of the United States, Office of Technology Assessment, Washington, D.C. 20510-8025, Excerpts and presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

7) Medical and Infectious Waste Management Research, Hazardous Waste and Superfund Research Committee, FY 1991 Initiative - A presentation by Dr. Richard Nalesnik, EPA HQ, OEETD

8) Municipal and Medical Waste Program Activities, Office of Air Quality Planning and Standards (OAQPS), Science Advisory Board Review of Municipal Waste Program, Washington, D.C., January 30-31, 1990 - A presentation by James Kilgroe, US EPA, RPT for OAQPS, MWC Emission Limits

9) MSW Research Agenda Health Effects Research Program - A Presentation by H. Robert Dyer, EPA, RPT

10) Municipal Solid Waste Risk Assessment, Program History - A presentation by Randy Bruins, ECAO, Cincinnati, Ohio

11) Municipal Solid Waste Research, Recycling, FY90 - A presentation by Jim Bridges, EPA Cincinnati, Ohio

12) Municipal Solid Waste Research Agenda, ORD - A presentation by Steve Lingle

13) MWC Emission Limits

14) Municipal Waste Combustion Program (Thermal Destruction), Science Advisory Board Review of Municipal Waste Program, Washington, D.C., January 30-31, 1990 - a presentation by James D. Kilgroe, Air and Energy Engineering Research Laboratory (AEERL)

15) Office of Air Quality Planning and Standards, Municipal and Medical Waste Program Activities

16) Office of Solid Waste, Municipal Solid Waste Program

17) Office of Solid Waste, Municipal Solid Waste Program, January 30-31, 1990, Comments for the SAB - A presentation by Steve Levy, OSW

18) ORD Municipal Solid Waste Research Agenda, Municipal Waste Combustion Residues, January 30-31, 1990 - A presentation by Carlton Wiles, EPA, Cincinnati, OH

19) Science Advisory Board Review, ORD Municipal Solid Waste Research Agenda, Integrated Waste Management, January 30-31, 1990 - A presentation by Carlton Wiles, RREL, Cincinnati, OH

20) Science Advisory Board Review, ORD Municipal Solid Waste Research Agenda, Municipal Solid Waste, January 30-31, 1990 - A presentation by Robert Landreth, US EPA/Cincinnati,

21) Science Advisory Board Review, ORD Municipal Solid Waste Research Agenda, Municipal Solid Waste, January 30-31, 1990

22) Sewage Sludge Research FY90 - A presentation by Carl Brunner, US EPA, Cincinnati

APPENDIX D - RESOURCE MATERIAL AND REFERENCES CITED

1) Briefings and Handouts to the SAB (See Appendix C)

2) Fries, George F. and Dennis J. Paustenbach, "Evaluation of Potential Transmission of 2,3,7-8-Tetrachloro-Dibenzo-p-Dioxin-Contaminated Incinerator Emissions to Humans Via Foods, Journal of Toxicology and Environmental Health, Vol 29, pages 1-43, 1990.

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