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Title: **Considerations Relating to Mixed Waste Treatment Technologies**

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Considerations Relating to Mixed Waste Treatment Technologies

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ABSTRACT

In order to select the most appropriate mixed waste treatment technology, many factors need to be evaluated. Depending upon individual circumstances, different factors will carry greater weight. Some of these factors must be addressed early on in the selection process. Various factors may also be used as screening criteria thus streamlining the selection process.

New and innovative technologies should also be addressing key, critical factors during the conceptual development phase in order to guide efforts through the construction of production units. This will aid in the development of technologies which are attractive for technology transfer.

This paper discusses considerations relating to the selection of mixed waste treatment technologies. Covered by this paper are applicability, cost, availability/maturity, capacity, safety/reliability, secondary waste generation, liability, regulatory considerations, treatment requirements, and public interactions. Basing selection processes on these factors will help assure that all technologies are evaluated fairly and that the appropriate waste treatment technology is selected for a given situation. Suggestions for selection processes are also covered as well as other important information required for selecting a mixed waste treatment technology.

INTRODUCTION

Many new mixed waste treatment technologies are currently being developed. This is being done for reasons such as a lack of critical, key technologies, or because the public misunderstands certain existing technologies. The engineering aspects of selecting an appropriate waste treatment technology may not always be the most important within the complex sphere of mixed waste treatment. The controlling criteria for the selection of a mixed waste treatment technology are now not always technological or cost based.

Just because a technology is "new" does not always mean that it is superior with regards to critical key factors. Therefore, all of these key factors need to be evaluated in order to gain a comprehensive understanding of waste treatment options. This evaluation needs to be fair and objective so that it can be beneficial to all parties involved.

Some of these factors need to be included in the conceptual development phase of treatment technologies in order to guide efforts through the design of production units. By doing so, this makes new technologies much more attractive for transfer to the private sector since the associated risks and benefits have already been identified and initially evaluated. This will also quickly weed-out technologies that are not necessarily promising, thus saving precious research and development funds.

This report will describe the critical factors relevant to the selection of a mixed waste

treatment technology (or option). It will also briefly cover suggestions for the selection process and other important information required for selecting a mixed waste treatment technology. These factors and the selection process are also applicable to hazardous waste treatment technologies.

FACTORS NEEDING CONSIDERATION

Many factors should be comparatively evaluated to determine which technology is the best for treating a particular mixed waste. Depending upon individual circumstances, and the selection process used, different factors will carry greater weight. Additional factors may exist and must be addressed on a case-by-case basis. Factors may also be broken down further into various elements for easier evaluation and comparison. However, we should consider at least all of the following:

- Applicability
- Availability/Maturity
- Treatment Requirements
- Cost
- Capacity
- Safety/Reliability
- Secondary Waste Generation
- Liability
- Regulatory Considerations
- Public Interactions

These factors can be grouped into screening factors and evaluation factors. The use of these two groups of factors is described below along with an explanation of each factor.

SCREENING FACTORS

A small number of factors can be used to screen potential technologies for more rigorous analysis. This is a proven cost and time saving technique. Factors that may be employed include:

Applicability - The technology must be appropriate for treating the waste in question. This is the most basic requirement. A mixed waste treatment problem can be significantly compounded if the technology used can not effectively treat the waste. Technologies which are applicable to a wide variety of waste types and forms should be considered more favorably than treatment technologies that are not. For the purpose of screening, a simple "pass/fail" criteria can be used.

This factor needs to also be included during more detailed analysis. Quantification can be done by processes such as benchmarking or performance evaluations.

Availability/Maturity - In most instances, there is an existing mixed waste problem with compliance schedules driving treatment. These timing requirements may dictate the use of proven, available, and mature treatment technologies. Emerging technologies have associated with them greater risks and a higher degree of uncertainty. It should be noted here that by treating mixed wastes as soon as possible, the overall risk they pose is reduced. The decision must be made when to stop looking for different solutions and start using an existing technology which can safely and compliantly treat a mixed waste. For the purpose of screening, the categories of "conceptual", "bench/laboratory", "pilot", and "production" can be used with a lower cut-off limit specified. This factor should be revisited in more detail during subsequent evaluations, particularly with regards to the adaptation of technologies and process to handle the radionuclides present in mixed wastes.

Treatment Requirements - This is a determination of whether a technology can meet the applicable waste treatment requirements (basically destruction and removal efficiencies and emission requirements). This is a subset of Regulatory Considerations discussed below. It should be noted that different treatment technologies may have different treatment requirements. For the purpose of screening, a simple "pass/fail" criteria can be used.

EVALUATION FACTORS

Once the preliminary screening of applicable technologies has been accomplished, then a more detailed evaluation can proceed. This evaluation needs to be fair, objective, and based on the most current information and projections available. The following factors should be part of this evaluation (including applicability and availability/maturity discussed above) as a minimum.

Cost - Cost effective technologies are becoming more important due to decreasing budgets available for waste treatment and environmental restoration operations. All aspects of cost need to be evaluated. Capital costs, operating costs, and the opportunity costs associated with proceeding with a specific technology should be considered. Return-on-investment, life-cycle costs, payback time, etc. are good methods for quantifying the costs associated with various alternatives. The selected method may need to be appropriately modified to take into account the cost avoidance motive of mixed waste treatment as apposed to profit generation which is the basis for some of these quantification methods.

Capacity - A viable mixed waste treatment system must have the capacity to treat appropriate quantities of wastes in a timely fashion. The capacity of a treatment facility employing a certain technology directly impacts the costs associated with that particular option. Utilization or expansion of existing treatment facilities for certain mixed waste types should not be discounted. There is no real necessity to quantify capacity for evaluation purposes since this factor should be an integral part of cost considerations. Yearly throughput or waste work-off time can be used to quantify this factor. Include estimated process availability in the calculations if they are done.

Safety/Reliability - The relative risks that a technology poses to workers, the general public, and the environment must be addressed. There are risks associated with all technologies and these need to be comparatively weighed along with other considerations. Addressing this factor early on in the development phase of a technology can expedite completion of various DOE requirements such as safety analysis reports and operational readiness reviews.

Quantifying safety/reliability is difficult to do especially for new technologies. Quantification can be done to some degree by employing a high level failure modes and effects analysis or other similar analysis.

Secondary Waste Generation - Effluents associated with treating mixed wastes must be minimized in order to comply with current waste-reduction strategies. Minimization is particularly important when treating mixed wastes containing listed hazardous components since the secondary waste streams will be considered listed under the "derived from" rule and thus will be difficult and expensive to dispose of. Secondary wastes can therefore greatly impact final disposal costs and regulatory compliance issues. Greater emphasis should be given to alternatives which produce stable waste forms that meet applicable disposal requirements. Alternatives which have undefined secondary waste streams should be approached with caution and must be further reviewed before they can be used as production technologies.

Secondary waste generation can be quantified by the ratio of total waste inputs to total secondary waste outputs. All outputs from an alternative should be included (used HEPAs, blowdown streams, spent activated carbon, empty drums, etc.).

Liability - Mixed waste problems belong to a wide variety of individuals and groups who have the legal responsibility to address the problems as specified by applicable regulations and agreements (such as the Federal Facility Compliance Agreement). These individuals and groups must deal with these problems in a way that minimizes their liabilities during and after waste treatment. This issue must be considered by all parties during any evaluation process. Technologies that result in waste forms that meet disposal requirements and pose the smallest risk possible to workers, the public, and the environment will minimize liability to responsible parties.

Liability factors are extremely hard to quantify. Consulting with legal council that has experience with environmental law may be prudent.

Regulatory Considerations - There are many regulations that apply to the treatment of the hazardous component of mixed wastes. Some are more stringent than others. Some require public comment, while others do not. Some require the use of certain technologies. Some apply to research and development testing while others apply to production facilities. However, for any technology, permitting and associated regulatory compliance is a major process that takes knowledge, time, and money. This is further complicated by the issue of

mixed waste in general since the regulation of this type of waste is in its infancy with requirements and jurisdictions not always defined. By early involvement and by considering all relevant factors, this process can be expedited.

All regulatory aspects must be considered - Resource Conservation and Recovery Act (RCRA), Clean Air Act (CAA), Clean Water Act (CWA), National Environmental Policy Act (NEPA), Radioactive National Emission Standards for Hazardous Air Pollutants (Rad NESHAPs), Comprehensive Environmental Response Compensation and Liability Act (CERCLA), etc. All applicable state requirements must be evaluated also.

Establishing an equitable method of comparison may be difficult since various treatment technology options may have greatly diverse regulatory requirements. In some circumstances public interactions may impact this factor also. By drawing on regulatory experts or even on the applicable regulatory agencies, a side by side comparison of treatment options can be performed resulting in a relative ranking for consideration.

Public Interactions - Public interactions are becoming an important, yet complex issue in the decision making process for determining what mixed waste treatment option should be used. Technical excellence and total openness are paramount due to distrust built on past activities. The presentation of treatment options to the public must be objective and unbiased. Ethics are critical and condescending attitudes are intolerable.

Those involved in the decision making process must be understanding to public concerns relating specifically to waste treatment, yet not allowing unfounded or unrelated concerns and issues to overshadow other important factors. This can be accomplished by involving the public early in the decision process or by inviting them to participate in determining the selection process.

Quantification of public interactions is probably the hardest of all mixed waste consideration factors. The impact of the public on regulatory and other requirements is difficult to determine, dependent upon the location, and is subject to change at any time. Use the judgement of individuals with experience in this area.

SELECTION PROCESS SUGGESTIONS

There are many processes that can be used to evaluate the above factors. It is understood that selection processes will vary from site-to-site and facility-to-facility due to numerous reasons. Common sense and good engineering judgement should be used at all times no matter which selection process is used.

Most selection processes rely on the preliminary screening of alternatives as outlined above. A detailed analysis of the remaining options can proceed once this screening is completed. This is accomplished in most cases by:

1. Reaching a consensus with regards to the selection factors and their associated elements;

2. Determine weighting factors for each factor or element; and

3. Determine the evaluation methods or the figures of merit assigned to each factor or element.

An important note should be made at this time. The inclusion of all impacted parties in determining the selection process will result in public involvement at an early stage and can inform key groups of the additional factors that need to be evaluated when solving mixed waste problems. It is highly recommended that this be done.

Backup or contingency options need to be retained due to the uncertainties (regulatory complications, public opposition, funding) that surround mixed waste treatment. Secondary options should be pursued if possible until such time that the primary option is assured. Evaluate "show stoppers" under the appropriate factors above, not in the final analysis.

Various selection processes have been proposed by many DOE related organizations including Los Alamos National Laboratory, Oak Ridge National Laboratory, Pacific Northwest Laboratory, and others. These have been evaluated by the US Department of Energy, Mixed Waste Integrated Program, Office of Technology Development. The important elements of each of the evaluated methods were included in a proposed process that should be applicable to most situations.

ADDITIONAL REQUIRED INFORMATION

Additional information is required for a selection process to be successful. Detailed information is needed in order to effectively and efficiently address a mixed waste treatment problem. The most important is a detailed waste characterization and volume projection. Other information that is also useful includes future budget projections, proposed new regulations, and information pertaining to DOE and other internal requirements that must be met.

SUMMARY

There are many factors that need to be considered with regards to mixed waste treatment options. These include applicability, availability/maturity, treatment requirements, cost, capacity, safety/reliability, secondary waste generation, liability, regulatory considerations, and public interactions. These factors can be grouped into screening factors and evaluation factors to aid in the selection of a technology or option for a particular mixed waste problem. Various selection processes can be pursued, however it is important to include all impacted parties in the determination of the process used.

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