INTERSTATE TECHNOLOGY & REGULATORY COUNCIL

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A Regulatory Overview of Plasma Technology
Report of the Plasma Technology Subgroup
Interstate Technology and Regulatory Cooperation Work Group

June, 1996

Acknowledgments

This report represents a collaborative effort on the part of state regulators, industry, public representatives, federal agencies, and other professional organization representatives. The time, effort, help, and advise they freely gave made this document possible.

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Plasma Technology Subgroup Report

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EXECUTIVE SUMMARY

When the ITRC undertook the task of developing a report on plasma technology in July, 1995, only a few states had heard of plasma technology. Fewer had experience in reviewing permit applications for the technology. The object was to try to develop a guide for permitting projects using this technology so that states addressing the issues for the first (or second) time could benefit from the collective experience of other states, and not have to "reinvent the wheel" to learn about the technology and its permitting issues. At first only five states had experience or an expectation that they would be involved in a plasma technology permit in the near future. As this report goes to press, seven states are expecting to receive permit applications or work on projects involving plasma technology in 1996. Although we could not have predicted this development a year ago, it seems that this guide is coming out just as the market for the technology is increasing.

Plasma technology used to treat, remediate, or recycle waste materials is still a very new and developing technology that has not settled into a definite market niche. In various design configurations, plasma technology units can be used on a wide variety of wastes, and can either destroy toxicity or produce a product from the treatment of waste materials. Plasma units can be operated in a manner that has fewer impacts on the environment than conventional thermal destruction technologies, such as lower air emissions and a stable vitrified residue. State permit staffs found that although the plasma technology was new to the environmental control area, the waste feed, air management systems, and residue handling systems could be similar to other projects which regulatory agencies have dealt with in the past.

The Plasma Technology Subgroup developed the following findings and policy options for consideration by the Demonstrate Onsite Innovative Technology Committee of the Western Governors' Association at their June, 1996 meeting:

o State regulatory agencies have spent a considerable amount of staff time trying to determine if the units should be regulated under RCRA as an incinerator or as a "miscellaneous unit". Plasma units have considerable differences and advantages over incinerators. The regulations for "miscellaneous units" allow for evaluation of all environmental impacts from the facilities. Plasma units which require a RCRA or state equivalent permit should be classified as "miscellaneous units" and regulated under "Subpart X" regulations unless there is a compelling reason to do otherwise.

o Reliable cost information for environmental applications of plasma technology is not available, but is necessary for comparisons with other technologies. The Subgroup suggests that future projects using the technology should keep cost and performance data in a common format such as that suggested by the Federal Remediation Roundtable document, A Guide to Documenting Cost and Performance Data. The cost and performance data should compare long term or life-cycle costs of a project, not just short term costs. A focus on short term costs only tends to discourage the use of technologies which provide a more permanent solution to waste management.

o The development of performance based regulations with specific goals for cleanup and limits on emissions, rather than regulations designed for a specific technology, will remove some regulatory barriers to plasma technology and other innovative technologies. States should develop performance based environmental standards, not only because it would help bring innovative technologies to market, but also, because it encourages a focus on environmental impacts - the goal, rather than the technology - the means of achieving the goal.

o State regulatory agencies should coordinate permitting activities on new technology projects such as plasma. Coordination and communication between different permitting groups within an agency or between separate state agencies issuing permits on a project makes agency responses to an applicant more consistent and will usually reduce the time spent addressing issues by eliminating duplication of effort. Agency staff and a permit applicant can achieve further efficiency in review time by agreeing up-front on the type and amount of data that needs to be collected on a new technology in order evaluate a permit application.

Further information is needed about the true costs of plasma technology. Documentation of emissions and residue quality of commercial scale units is also needed. However, as individual states go forward with plasma technology projects in 1996, they do so with a greater understanding and confidence in the technology. It is hoped that this report and the network developed among the state regulators will provide a much more efficient and thorough technical review of these projects, as well as resulting in a more consistent approach to the technology across these states.

SECTION I

INTRODUCTION

PLASMA SUBGROUP BACKGROUND

In February, 1995, the Interstate Technology & Regulatory Cooperation Workgroup (ITRC) was formed for the purpose of sharing technical information and regulatory approaches to new technologies among state environmental regulatory agencies. It is a subgroup of the Demonstrate Onsite Innovative Technology committee (DOIT) sponsored by the Western Governor's Association. Twenty-two states are currently participating in the ITRC workgroups. It is hoped that sharing information on new technologies will reduce the time and resources required for states to review new technologies, and that the common base of knowledge developed will lead to more uniform permitting approaches for these new technologies from state to state.

The ITRC's main area of focus is on new technologies for the treatment, remediation, and investigation of solid wastes. Four technologies were selected to be studied and reported on to the Western Governor's Association annual meeting in June, 1996. Plasma technology was chosen for study in March, 1995. The Plasma Technology Subgroup, which includes representatives from the states of California, Colorado, Idaho, New Mexico, Texas, and Washington, first met in July, 1995.

OBJECTIVES OF THE REPORT

This report describes the status of plasma technology as used in environmental applications. The broad range of current and potential environmental applications will be discussed. The experiences and major regulatory issues of individual states in permitting plasma facilities will be presented.

It is not the intention of this report to provide a step-by-step guide to permitting plasma technology units. A permitting road map for thermal technologies is being prepared by the National Technical Workgroup on Thermal Treatment of Mixed Waste (NTW). They have completed a draft description of federal and state regulations which may be applicable to plasma technology projects. We do not feel it necessary to

duplicate their effort. Rather, the important aspects of plasma technology, in particular, which should be considered in a permitting process will be discussed. Regulatory issues which impact this technology will be highlighted.

The Plasma Subgroup cannot make regulatory judgements for individual states, but we hope to provide a discussion of other state experiences that will serve as a guide for those states which are faced with reviewing a plasma technology project for the first time.

SECTION 2

PLASMA TECHNOLOGY OVERVIEW

CURRENT APPLICATIONS

When the prospect of studying plasma technology was brought up before the ITRC, only a handful of states out of the twenty-two participating states had even heard of environmental applications of this technology. Even fewer states had experience in reviewing projects for the technology. Laboratory and pilot scale units have been approved in Idaho, California, and Texas. A commercial scale unit for treatment of medical waste was permitted in San Diego, California, but due to a change in market circumstances it has not been built.

Research on environmental applications of the technology are wide spread. The U.S. Department of Energy (DOE) has funded research at Los Alamos National Laboratory in New Mexico and at the Idaho National Environmental Laboratory in Idaho Falls, Idaho on the treatment of radioactive, mixed and hazardous wastes. The University of Bordeaux I, France, and the Georgia Institute of Technology organized and held a second International Symposium on Environmental Technologies: Plasma Systems and Applications in October, 1995, in Atlanta, Georgia. The symposium highlighted some of the research being done in this area by private companies, government facilities, and by universities around the United States and Europe.

The interest in this potentially very versatile and useful technology is wide spread. The environmental applications of the technology are, however, at an early stage of development. A great deal of learning and information gathering on application of the technology to environmental problems will continue as research proceeds and as commercial units are established. Currently a commercial unit proposed to treat medical waste in New York has received a permit to construct under Part 201 of the New York rules for its air program. A "Research & Development" permit is expected to be in effect in the summer of 1996.. A unit to treat radioactive, mixed, and hazardous waste is being proposed for Hanford, Washington. A unit to treat hazardous waste is being proposed for the Norfolk, Virginia Naval Facility. Another proposed demonstration unit for the treatment of mixed waste at the Idaho National Environmental Laboratory is on hold pending federal funding.

Other types of thermal processes have been proposed or constructed for the purpose of treating wastes. Each of these technologies are applicable for different types of wastes, constituents, and physical states. These processes use different means to achieve thermal treatment, but are similar to plasma technology

in issues relating to waste feed design, gas management systems, monitoring, and regulations. These processes include, but are not limited to, the following technologies:

Resistance (Joule) Heating Processes

Steam Reformation

Induction Heated Molten Metal Processes

Wet Air Oxidation Processes

Molten Salt Processes

Many of these processes have been tested on specific waste types with varying levels of success. These processes are currently in various stages of development, implementation, and operation.

Although environmental applications of plasma technology are at an early stage of development, the use of plasma technology is not new. Plasma was first demonstrated by Sir Humphrey Davy in 1804. The Siemens Company of Germany was using

plasma technology to make metal products in the late 1800's. By the early 1900's, plasma heating was being used to refine nitrogen for fertilizer production. The technology was imported to the United States in 1920. The technology can be found in the electric furnaces of the steel industry in the U.S. and in the arc welding units of the construction industry. Plasma has been used as a source of heat to test reentry vehicle heat shields developed for the National

Aeronautics and Space Administration. The equipment used to produce the plasma is being manufactured today for these and other industrial applications. Companies developing environmental uses can acquire "off the shelf" plasma producing equipment and adapt them to the new applications.

POTENTIAL APPLICATIONS

Plasma technology is a method of producing heat for the breakdown of waste materials. Hydrocarbon fractions in a waste are broken down to carbon monoxide, hydrogen, carbon dioxide, and/or water depending on operating conditions. Metallic waste components settle to the bottom as potentially recyclable scrap metals. Inorganic fractions of the waste may form a slag layer on top of any metallic

layer. The technology has the potential to treat a wide array of waste types and forms. Bench scale or field scale studies have been performed or are being planned on the following waste types:

Contaminated Soils Coal Ash

Solid and Liquid Organic Waste Asbestos Containing Wastes

Chlorinated Solid and Liquid Organic Waste Medical Waste

Hexachlorobenzene Weapons components

Diethylphthalate Thermal Batteries

Illegal Drugs and Pharmaceuticals Small Arms Ammunition

Incinerator Fly Ash Incinerator Bottom Ash Explosives Mixed Wastes

Surrogate Radioactive Wastes

PROCESS DESCRIPTION

Plasma technology involves the creation of a sustained electrical arc by the passage of electrical current through a gas. Because of the high electrical resistivity across the system, significant heat is generated which serves to strip away electrons from the gas molecules, resulting in an ionized gas stream or plasma. At 3600 ^{o}F (2000 ^{o}C) gas molecules dissociate into the atomic state. When the temperature is raised to 5400 ^{o}F (3000 ^{o}C), gas molecules lose electrons and become ionized. In the ionized state, the gas is electrically conducting, can be confined by electromagnetic fields, and has an almost liquid like viscosity. Common examples of plasmas are lightning bolts, the fluorescent gas in light bulbs, and the spark of a spark plug.

The special characteristics of plasmas, including an unrivaled energy density, have intrigued scientists and engineers for decades. An upper practical temperature limit of 3600 ^{o}F (2000 ^{o}C) can be achieved from the burning of fossil fuels while electrically generated plasmas can produce temperatures of

36000 ^{o}F (20000 ^{o}C) or more. This order of magnitude increase in temperature, when controlled in a confined space, can break down contaminants into basic atomic species more readily than fossil-fueled incinerators. In treating hazardous wastes, plasma technology can be used to produce a vitrified slag and a gas stream that is reduced to its basic molecular components.

TECHNICAL CONSIDERATIONS

Plasma treatment units will consist of several components besides the plasma producing unit. Those components are a waste feed system, a processing chamber, a solid residue removal and handling system, a gas management system, and operational controls and monitors. Many of these ancillary systems are similar to designs for other waste treatment and industrial processes. These systems , though not unique to plasma technology, must be engineered to address the specific waste streams and volumes being handled in a proposed unit.

Waste feed systems may need to be engineered to add solids, liquids, sludges, or entire waste drums into the hot treatment vessel. The interior of a plasma vessel is hot, dusty, and turbulent as the waste materials are being dropped into the vessel and dissociated into molecular components. The design of the treatment vessel needs to eliminate, to the extent possible, any fugitive emissions. The air management, waste feed, and residue handling systems also need to address elimination of fugitive emissions. Special conditions for automatic waste feed cutoff and /or shut down of a unit should also be considered in the permit conditions for the unit. Of course, special care should be taken for handling and introducing radioactive and infectious wastes to a reaction vessel, so that material does not escape prior to treatment.

The regulatory authority should set operating conditions which are necessary to ensure protection of public health and the environment. These conditions should include at a minimum: the amounts of waste to be added, method for waste addition, rate of waste addition, temperatures required for treatment of each specified waste, when the automatic waste feed will be cut-off, when the unit will be shut down, how monitors will be connected to the automatic waste feed cut-off, and how to address unexpected operating conditions.

Plasma units have shown an ability to achieve or exceed a Destruction and Removal Efficiency (DRE) of 99.99% for handling organic compounds. A New York State/ U.S. EPA joint plasma arc project demonstrated a minimum of 99.9999% DRE on PCBs in a 1984-85 study under the EPA SITE program. Individual permitting authorities will need to set the specific performance standards based on the types of waste treated and the current regulatory standards. The operation and emissions from the unit will then need to be monitored to ensure that these standards are met.

Monitoring of the process will be similar to other thermal treatment processes. The high temperatures within the plasma may require unusual technology to measure temperatures within the plasma chamber. Off-gas monitoring to assure adequate treatment will likely use conventional off the shelf technology.

The management and treatment of the gas stream will depend on the materials added to the process, but again, will likely use conventional technology. Scrubbers, baghouses, molecular sieves, and HEPA filters may be used alone or in combination, as needed, to address halogens, particulates, volatile metals, volatile organics, and radionuclides which may be found in the air stream.

The residues from the reaction vessel may include a metallic layer and/or a vitrified, glass-like, inorganic slag. The quality of the vitrified plasma unit residue has been shown to resist leaching of toxic components as demonstrated by the Toxicity Characteristic Leachability Test in the research that has been done to date. The material will need to be tested on a reasonable schedule to assure that this indeed is true for the specific waste materials and operating conditions of a particular plasma unit. It may be appropriate to reduce this testing schedule after a sufficient operating history indicates a consistent residue quality.

Since the process equipment is engineered according to the materials and constituents which will be introduced into a unit, it is essential for an operator to have a waste evaluation plan. The plan should enable the operator to avoid adding those materials which the unit was not designed for, and which may be detrimental to the operation and materials of construction of the unit. Regulatorily mandated waste evaluation and characterization plans can be controversial due to worker exposure during sampling and the expense of laboratory analysis. New technologies which are non-intrusive and which continuously monitor air emissions are being developed which may replace some front end mandated analyses. The NTW is currently studying this issue in depth and is expected to have a report completed by September, 1996.

COST "ANALYSIS"

There are few estimations of the cost for treatment by a plasma arc unit. Cost estimates have covered a broad range between $50 and $1000s per ton. These cost estimates at early stages of development of a technology tend to be highly inaccurate. The ultimate success of a technology will be determined not only by performance, but also by its cost. The waste remediation and treatment market place will ultimately determine its opportunity for application. For this, as well as other new technologies, it is therefore important to begin to collect accurate cost data in a way that can be compared to other technologies and other applications of the same technology. It is hoped that future demonstrations and applications of this technology will use a standard format to collect cost data, such as the Federal Remediation Roundtable - A Guide to Cost and Performance Data.

TECHNOLOGY ADVANTAGES

Plasma technology provides another means of producing and transferring heat to waste materials. Unlike combustion, no oxygen is required to produce the heat. The gas stream produced is much smaller than with combustion technology and, therefore, can be easier and less expensive to manage. Plasma technology can be controlled to achieve higher temperatures in the melted materials. Depending on the waste materials and supplemental feeds, metals and inorganics may form separate layers, allowing the recovery of metals. In some operating modes, the metal and inorganic fractions of materials are vitrified together. Test data is very encouraging as to the relative stability of vitrified materials produced from plasma units. Vitrified slag produced from a variety of waste materials have been shown to be non-leachable by the Toxicity Characteristic Leaching Procedure. Solid residues may meet the Land Disposal Restriction criteria and be acceptable for landfill. In the case of low level radioactive materials or mixed waste the radio nuclides which are trapped in the solid residue are also in a stable, non-leachable form.

TECHNOLOGY DISADVANTAGES

As with other thermal treatment technologies, volatile metals will vaporize and be carried out of the unit with the air stream. Halogens will also be entrained in the air steam. The materials of construction of the unit and the air management system will have to be designed to handle these materials if they are introduced into the unit. Waste feed systems may be similar to feed systems for other types of units. They need to be able to form a seal between the inside and outside of the unit to prevent air emissions of gases leaving the plasma unit as the plasma arc melts the waste materials.

The graphite electrodes used to produce an arc and the lining of the treatment vessel or chamber are degraded and/or consumed gradually during the waste melting cycle. Maintenance to repair or replace unit components requires a well thought out plan to protect workers, to avoid spreading contamination and to appropriately handle materials removed from the unit. This is of particular concern if the waste materials handled in the unit are radioactive.

SECTION 3

PERMITTING OPTIONS

SUBPART "X" VS. SUBPART "O"

State permit writers have had difficulty applying EPA's definition of incineration to alternative thermal treatment systems such as molten salt, plasma, or molten metal where oxidation is sometimes occurring. The difficulty centers on the definition of "flame". Some regulators argue that a flame occurs when hydrocarbons are oxidized even if the heat source is indirect such as electrical resistance. Others argue that EPA intended that "flame" be limited to the classic fuel/oxidizer propagating a flame front found in afterburners. Still another case is catalytic oxidation. Another is surface catalytic effects from ceramic thermal masses. There are other examples as well.

There is a source of regulatory confusion as to whether to regulate these units under 40 CFR 264, Subpart O (Incinerators), or Subpart X (Miscellaneous Treatment Units). In addition, some states actually have explicit or de facto moratoriums on incineration. Applicants and investors are concerned about the public perception/acceptance issues of incineration as well. All of these delay permitting. The regulatory confusion lies in ambiguities in the definitions of incinerator and plasma arc furnace. The requirements of both Subpart O and Subpart X are adequate to address the health and environmental impacts of plasma units. However, a clarification of these definitions by the U.S. EPA would eliminate the time state regulatory staffs spend with each application for these and other alternative thermal treatment units to determine which rules apply. The NTW is working on a permitting road map for thermal technologies. It is hoped that the group will be able to clarify EPA's intent on this issue.

Ultimately, permitting authorities should concentrate on evaluating impacts to the environment and public health from a unit. These issues must be addressed regardless of how a unit is defined.

RESEARCH, DEVELOPMENT AND DEMONSTRATION APPROVALS

Regulations under the Resource Conservation and Recovery Act (RCRA) allow the issuance of a research, development, or demonstration permits for a one year duration. The applicant must provide financial assurance for the proposed activity and the permitting process must include notification to the community of the proposed activity. The permitting authority has the discretion to determine which other items addressed in a full RCRA permit must be covered for a particular research, development, and demonstration permit in order to protect human health and the environment. These permits may be renewed for three additional one year increments.

Many states, especially those with authorization from the U.S. EPA to implement RCRA, are able to issue these permits. The flexibility in these permits was to allow permits for small scale, temporary tests or demonstrations to be issued in a timely manner, with a review appropriately detailed for the scale and potential risk of the activity.

States report that Research, Development, and Demonstration (RD&D) permits are not a frequently used option. Texas has issued only one of these permits in the last 10 years. Washington has issued only two of these permits, and California has issued three since 1990, two of them to the same test unit.

One of the reasons for the infrequent use of the RD&D permitting option is that the process may not be substantially faster than for a full scale RCRA permit. When a regulatory authority is presented with an entirely new technology, and that technology is to be used to treat high risk materials, the length and depth of the review may take as long as a full scale permit. Agency staff must ask the same questions regarding emission sources regardless of the size of a project. This time could be reduced if the state permitting authority can learn from the experiences of other states that may have already dealt with the technology.

ALTERNATIVE PERMITTING STRATEGIES

Permits for air emissions from research, development, or demonstration projects may also be required under the Clean Air Act. States may have authority to implement the federal program and/or may have their own permitting authority for air emissions. Some states have exemptions for air emissions from research facilities based on a low potential to emit air contaminants. Texas has a standard exemption from an air permit which is applicable to research facilities and pilot units. It is designed for low impact sources and places a limit on all emissions from a unit, including fugitive emissions. Specific toxic compounds have individual limits as well. A standard exemption is obtained from the Texas Natural Resource Conservation Commission by submitting a brief application form, facility description, and emission calculations for review and approval. Review of an exemption application is typically much faster than a full scale air permit.

Treatability studies may be done without triggering the need for a RCRA permit under federal regulations. Up to 10,000 kilograms of a hazardous waste material may be sent to a facility to have tests done to determine the feasibility of a treatment or remediation method. There are notification and reporting requirements, but a permit is not required. Many states have adopted this regulation and report that it is used frequently to verify the effectiveness of a chosen remediation method prior to implementation of a remedy.

The state of California has the ability to issue variances from permitting for management activities that involve wastes that do not meet the federal definition of a hazardous waste. This option has been frequently used to allow research and pilot projects to proceed.

California Certification Program

Two barriers to acceptance of new technologies are redundant technical reviews required by independent or overlapping regulatory jurisdictions and market fragmentation. The California Department of Toxic Substance Control (DTSC) Environmental Technology Certification Program is designed to provide a onetime scientific and engineering evaluation of the efficacy and efficiency of an environmental remediation, waste treatment or pollution prevention technology. This evaluation could be used by regulators in California or other states in making permitting and cleanup decisions and by technology developers in marketing their technology. The evaluation is given for specific waste streams, media types, and conditions as negotiated between the vendor and DTSC.

California has certified 15 technologies in the two years since the pilot program began. Among those technologies being evaluated is the Airco Coating Technology, a cold gas plasma system for surface cleaning or treatment of plastic parts.

Recycling Determinations

The resulting end product of destruction of organics in a controlled and limited oxygen atmosphere is carbon monoxide and hydrogen. Other constituents from the original waste material will also be present such as volatile metals, halogens, and possibly products of incomplete destruction. Several vendors of plasma technologies, as well as other alternative thermal technologies, have demonstrated the ability to produce a carbon monoxide / hydrogen mixture, also known as synthesis gas or "syngas", of sufficient quality and purity to meet current industrial specifications for that product, and to make sufficient quantity to run the units as syngas production units. Although there are no known units currently operating in this mode, several projects have resulted in regulatory decisions.

Plasma Energy Applied Technology applied for and received permits to operate a plasma technology unit in San Diego, California. The unit was to treat medical wastes from a hospital and produce a syngas that was to provide fuel for a generator. Due to market changes, the unit was never constructed.

Molten Metal Technology, Inc. is proposing to produce syngas from industrial wastes and sell the syngas to an adjacent chemical plant. The Texas Natural Resource Conservation Commission (TNRCC) issued a letter on February 27, 1996, concurring that the thermal destruction of industrial wastes to produce a commercial specification syngas is recycling. The TNRCC will require the facility to apply for permits to store any hazardous wastes prior to recycling. The company will have to report and maintain records to demonstrate that they actually are producing commercial grade products and do have a market for them. Please see Section 4 for more information.

Additional information on these case studies, as well as Quantum Tech, Inc. and Quantum Chemical/ USI, are given in Section 4.

SECTION 4

STATE REGULATIONS

A plasma arc unit may require waste treatment or waste water treatment permits, as well as air permits. The most difficult regulatory issues surrounding these units are usually related to the waste treatment permits issued under RCRA or a state equivalent. Often state statutes and/or regulations are derived or adopted from existing federal authorities. Also, some Federal Agencies (i.e., the U.S. Environmental Protection Agency and the Nuclear Regulatory Commission) are allowed to authorize states to implement the federal program. However, oversight of the state's implementation continues by the federal agency. States must demonstrate their ability, through statutes, implementing regulations and experience, to "regulate" equally as well as the federal agency. They must have as stringent regulations as the federal agency, however, they may pass laws, and in some states, promulgate regulations, making the state environmental program more stringent than their federal counterpart. In cases where a state does not have authorization for the federal program there may be dual authority overseeing health and safety or environmental protection; both federal and state.

States may regionalize their regulatory responsibilities to enforce state laws and regulations or they may authorize a local authority to enforce state laws and regulations or promulgate their own authorities as a local governing body.

States also have regulatory programs for the control of air emissions and to prevent the pollution of water. Any remediation or waste treatment activity employing plasma arc technology will need to be permitted or approved by one or more state regulatory authorities. The rules and procedures may vary greatly from state to state. An applicant must check with the regulatory authority in each state to determine the regulatory requirements for a specific project.

States which had expressed an interest in plasma technology were sent questions regarding permitting. The responses are summarized in Appendix B.

SECTION 5

REGULATORY EXPERIENCES

This section presents case studies of regulatory experiences with plasma technology projects. Each case has a lesson or example to be followed or avoided in future projects. Only a brief description of the projects are provided here. Further details may be obtained from the appropriate state contacts given in Appendix C.

PAST AND CURRENT PROJECTS

National Technical Working Group

The National Technical Workgroup on Thermal Treatment of Mixed Waste (NTW) was established in 1991 through an interagency agreement between the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA). NTW is composed of representatives of DOE headquarters, sites, and contractors; EPA headquarters, regional permit writers, and researchers; the Nuclear Regulatory Commission; Regulating States; and Citizens Advisory Groups.

The NTW, MWWG, and ITRC have different emphases with respect to the mixed waste problem. The NTW focuses on resolving technical issues related to permitting mixed waste thermal treatment processes. The MWWG focuses on stakeholder involvement to improve demonstration, evaluation, and implementation of innovative technologies for mixed waste management. The ITRC focuses on removing state barriers to implementing technologies for all hazardous waste management, including mixed waste. It is important that the groups continue to coordinate with each other to ensure that resources are used efficiently, consistent products are developed, and all concerns addressed.

The mission of the NTW is to support the development of coordinated, consistent, and environmentally protective national permit procedures for thermal treatment of mixed waste. The main goals of the NTW are to develop technical data and to provide a communication forum for federal permitting procedures for mixed waste facilities.

Current activities that the NTW is focusing on are a federal permit roadmap and providing for an exchange of information by EPA and state permit staff. The permit roadmap will identify the major elements of the permit process. The "state permit writer involvement" project will encourage consistent application of federal programs by the states.

California Permit Process for Medical Waste Treatment

The California Department of Health Services (DHS) determined that the Plasma Energy Applied Technologies (PEAT) plasma-arc unit was not an incinerator for purposes of permitting under the Medical Waste Management Act. The PEAT unit was being considered at a hospital in San Diego, California. The reason the unit was not considered an incinerator was because the Medical Waste Management Act defines incineration to take place in a controlled-air, multi-chambered incinerator, and plasma-arc as approved by DHS takes place in the absence of oxygen. This is an example of a state making a determination that a plasma arc unit is something other than an incinerator. This particular unit was never constructed, although air permits were issued. Market changes were given as the reason.

Quantum Tech, Inc. RD&D Permit

Quantum Tech, Inc. applied to the Texas Natural Resource Conservation Commission for a Research, Development and Demonstration (RD&D) permit for the operation of a waste processing system consisting of a thermal desorption unit, a plasma arc treatment unit, and off-gas management units. The permit was issued in March, 1990 and was renewed in February, 1993. The facility was located in Houston, Texas. The facility was authorized to test the plasma arc system on various hazardous wastes, including organic liquids, halogenated organic liquids and other wastes. Quantum Tech, Inc. conducted several tests on the system, and was able to demonstrate 99.99% Destruction and Removal Efficiency on a feed of benzene. The company requested designation as a recycling unit, as the company represented that the process could produce a synthesis gas. Little data was available on the quality of syngas which could be produced using this process. The applicant never settled on the list of waste materials that he was proposing to receive into the unit. The TNRCC staff issued a letter on September 29, 1994, that set out when the unit could be considered a recycling process, and when the system could not be a recycling process. The letter also specified certain additional information that would be required to evaluate a full scale permit for the unit. The RD&D permit was terminated by consensual revocation on August 15, 1995. The Houston facility has closed. No application for a hazardous waste recycling or treatment facility has been submitted to date. However, an application for an air permit for a plasma unit to treat non-hazardous wastes has been submitted to TNRCC and is under review.

The RD&D permit for this facility gave broad authority for testing a wide range of materials in the facility. In hindsight, it is clear that this particular RD&D project was done to collect data for a commercial facility. There was no initial agreement (and possibly no discussion) between the applicant and the TNRCC staff on the type and quantity of data that would have to be collected for a full scale permit application. The scope of the RD&D and full scale projects changed several times during the course of discussions. At the end of the RD&D process, data necessary for an air permit had been gathered, but sufficient information was not available to evaluate a RCRA permit or a recycling determination. It may not always be possible for an applicant and a regulatory agency to agree on data needs at the beginning of an RD&D effort. The staff may be unfamiliar with a new technology, and only discover the issues as the RD&D effort progresses. Regulatory requirements may change during the project. An applicant may change the scope or focus of the project during the RD&D effort. It is also frequently difficult for a vendor to identify and focus on a waste market segment, for fear that will limit the application and viability of the technology. However, a vendor must gather treatability data on particular waste types, so that the technology may be demonstrated to be effective and able to achieve consistent results in dealing with those wastes. Given these difficulties, it is still to the advantage of both applicant and regulatory agency if an agreement on type and quantity of data to be collected can be agreed upon early in the process. Changes in scope should be kept to a minimum.

California Certification of Plasma Technology for Vapor Phase Treatment of VOC's from Surface Cleaning Operations

Airco Coating Technology manufactures cold gas plasma systems for surface cleaning of various plastic and metallic parts, and altering the surface chemistry of various plastic parts. These systems are used to replace solvent based systems for surface cleaning or treatment of parts thereby reducing or eliminating the generation of hazardous wastes and/or toxic emissions associated with the use of solvents. The Airco Coating Technology system has been certified as a pollution prevention technology by the California Department of Toxic Substances Control.

This technology is very different from other plasma units which have been reviewed by this committee. It does not use high temperatures to break apart contaminant molecules. It does, however, use a plasma system. The experience of California in reviewing this technology demonstrates the willingness of the California EPA Certification Program to evaluate plasma technologies.

New York Experience

The New York State project to develop plasma technology was conceived to address the non-aqueous phase liquids (NAPL) (i.e.: oils) which were continuously produced from pump and treat operations at the Love Canal site. At that time several hundred gallons of NAPL were produced each month and transferred for storage to 10,000 gallon steel tanks on site. In the early 1980s there was no technology that was permitted to treat dioxin wastes and regulatory requirements at that time forbid their transport offsite. Because of a concern for the growing inventory of NAPL in tank storage, the lack of a permitted treatment technology, and the uncertainty of the federal regulatory process to provide a timely resolution of the problem, New "York State embarked on the development of a treatment process. The advantages of high destructive power, small size relative to other processes at the time, and ability to be made mobile led us to select plasma technology. EPA, in partnership with NYSDEC, provided partial funding, contractor support, and conducted the stack testing throughout the demonstration period. NYSDEC provided funds to design, build, and own the mobile unit. Pilot tests on the unit took place in Canada, where the unit was manufactured. Tests indicated that the technology was effective in treating several waste streams. A"destruction removal efficiency" of 99.9999% or greater was demonstrated for PCBs.

The project officially started in 1982. Upon completion of the test program in Canada, the unit was transferred to the Love Canal site in 1986. The NYSDEC projects staff continued to pursue a permit to operate from the permitting branch of the same agency. Over the course of years, the project faced constant changes and increasing stringency in regulatory requirements. Regulatory required changes to hardware items in the process and monitoring equipment for the unit resulted in several costly changes to the contract. Contract amendments took almost six months. It was the severe time delays incurred under the permitting effort, during which little field work could be conducted, that caused the project to struggle. With constant changes from the regulatory side in the last two years of the project (1986-88), and with no final agreement on permitting conditions in sight, the project was terminated.

Washington Demonstration of "Tunable Hybrid Plasma"

A Tunable Hybrid Plasma unit was demonstrated at the Hanford Reservation Site in Washington. This variation on plasma technology is patented by the Massachusetts Institute of Technology and is used for the treatment of volatile organic compounds in air. The test unit was used to breakdown carbon tetrachloride removed from the vadose zone at Hanford. The unit required a moderate energy electron beam to produce chlorine, carbon dioxide, and carbon monoxide. Water vapor present in the air stream reacts with the chloride to produce hydrochloric acid, which is then neutralized by treating it with a base solution.

The accomplishments of the test were that carbon tetrachloride was treated in the air stream from an inlet concentration of 150-300 ppm to an outlet concentration of less than 1 ppm. The air stream was scrubbed. No detectable levels of VOC's were found in the scrubber solution. Approximately 10% of the chlorine in the gas phase prior to scrubbing was found to be free chlorine. The test demonstrated the durability of the critical equipment components, such as the electron beam foil and filament. Automatic control of the unit was also demonstrated using a PC-based system to eliminate operators for long duration operation.

Phase 2 of the demonstration is being planned to carry out additional evaluations.

FUTURE PROJECTS

Plasma Arc Furnace Operation, Hanford Site, Washington

The United States Department of Energy (USDOE) has submitted a Notice of Construction to the Washington State Department of Ecology regarding the installation and operation of a plasma arc furnace on the Hanford Site. The Notice of Construction application is pursuant to the requirements of Washington Administrative Code 173-400, "General Regulation for Air Pollution Sources," and 173-460, "Controls for New Sources of Toxic Air Pollutants."

The plasma arc furnace is a thermal treatment system being developed to treat buried waste from across the USDOE complex. The technology is targeted for wastes containing both inorganic and organic materials. A large walk-in fume hood containing a direct current plasma arc furnace and its associated off-gas treatment and feed systems is planned for installation. The furnace will be utilized to provide engineering data to evaluate technology performance. Treatability studies will also be performed in the system following the simulated waste tests.

The furnace is a graphite crucible that is refractory lined with a graphite electrode entering the top of the furnace. A direct current potential is applied between the crucible and the electrode, resulting in a stable arc between the crucible contents and the electrode. This arc provides the thermal energy to melt and pyrolize feed materials that are fed in to the furnace chamber via two methods. Containerized materials are fed via an airlock-ram system located on the upper wall of the furnace, granular materials are fed via an auger feed system through the furnace lid. Granular materials are loaded into a hopper feed system in a fume hood located on the floor above the furnace. An auger moves the material through a sealed pipe from the hopper into the furnace. The processing rate of the furnace is approximately 45.4 kg/hour. During operation of the furnace, the furnace chamber will be maintained at a negative pressure vacuum to collect the off-gas generated during system operation. The off-gas will be passed through a scrubbing system to remove any contaminants.

The installation is scheduled to be completed by March 1996; operation will commence upon receipt of regulatory approvals. The furnace is planned for use in conducting at least 10 distinct tests over the next 3 years. The plasma arc furnace has the potential to operate 24 hours per day.

Idaho Plasma Hearth RD&D Permitting Process

The Plasma Hearth Process Demonstration project is one of the key technology projects in the DOE Office of Technology Development Mixed Waste Focus Area. The Plasma Hearth Process being developed by Science Applications International Corporation is a high temperature vitrification process using a plasma arc torch installed in a stationary, refractory-lined chamber. The heat from the plasma destroys organics and stabilizes the remaining residuals in a non-leaching vitrified waste form.

The project is structured using a phased demonstration approach to promote successful implementation of the Plasma Hearth Process for use in treating mixed wastes. The Plasma process will be adapted to mixed waste treatment through a sequence of tests on several units which are divided into two categories: nonradioactive and radioactive. The first of the nonradioactive Plasma Hearth units, referred to as the Proof-of-Principle unit, was constructed at Retech, Inc. Of Ukiah, California. The most recent tests were designed to show feasibility of the Plasma Hearth process for a wide variety of nonradioactive surrogate materials formulated to represent various DOE mixed waste forms.

The Proof-of-Principle test is paralleled by bench-scale testing, at the Idaho National Engineering Lab in Idaho, using radioactive materials to confirm that the radioactive surrogate studies properly model the behavior of radionuclides during treatment. This bench scale unit has received air permits and will operate under the RCRA treatability variance.

As the final step, a prototype PHP system may be constructed for full-scale radioactive waste treatment demonstrations. The radioactive field-scale system will require a Permit to Construct from the Idaho Division for Environmental Quality (DEQ) Air Regulations and NESHAPS approval from EPA. It will also be permitted as a RCRA RD&D unit by the State of Idaho DEQ. The application was submitted to the State of Idaho in June 1995. Idaho DEQ has issued an eligibility determination for the RD&D permit application. These permits and approvals are being negotiated simultaneously at the request of the State of Idaho so that the reviews can be done together. The expected completion date of the RD&D permit is on hold pending DOE approval to proceed with the project.

Virginia Plasma Hazardous Waste Treatment RD&D Facility

The Department of the Navy plans to site a plasma technology unit at the Naval Base in Norfolk, Virginia, for the treatment of hazardous wastes generated at that facility. A Notice of Intent to prepare and Environmental Impact Statement was published in the Federal Register on March 19, 1996. The first public hearing is scheduled in the Norfolk community in mid-April. Permit applications are expected to be filed in four to five months. Initially, a Research, Development, and Demonstration Permit will be sought for a limited waste feed throughput for the first 12 to 18 months of the project. Later, a full scale RCRA permit application will be submitted for the same unit.

Washington Mixed Waste Treatment Application

The Washington State Department of Ecology's Nuclear Waste Program was approached in late 1995 regarding a potential mixed waste treatment facility just south of the Hanford Reservation in Washington State. Allied Technologies Group (ATG) is proposing a facility using three technologies: abrasion cleaning, solidification/stabilization, and plasma. ATG contacted the state program regarding the possibility of obtaining a RCRA Part B permit for a facility using these three technologies. The subcontractor for the plasma unit would be Plasma Energy Applied Technologies (PEAT).

The Nuclear Waste Program staff have made the determination that the plasma unit would be permitted as a "miscellaneous unit"(Subpart X) under the state and federal RCRA rules. They have determined that the unit does not use a controlled flame. It does not meet the definition of an incinerator or a plasma arc incinerator. The unit does not meet the definition of a plasma arc incinerator because it does not have and afterburner, but rather, uses catalytic technology for the vapor phase destruction. The agency plans to go through the Notice of Deficiency (NOD) cycle only once for this application, instead of the many cycles which are typical. A series of face to face meetings over an eight month period have been proposed to resolve any technical differences between the agency and permittee. A 28 month schedule is proposed for the permitting process. Discussions with public interest groups and other stakeholders will begin even before the application is submitted to ensure that public concerns are met.

Massachusetts Third Party Assessment

The Massachusetts Department of Environmental Quality (MDEQ) is currently working with a company that is developing a plasma technology to deal with medical waste. The project is in the early stages of review under their STEP program and may eventually use a brownfield site for locating a demonstration project. The MDEQ program for encouraging innovative technologies helps technology companies find demonstration sites and financing, but also has a unique feature from other state programs. The MDEQ program requires a company to undergo a business review prior to being accepted for the program. A company must have a business plan with a viable market identified for the technology. This feature encourages a higher rate of success for projects undertaken in this program. It helps avoid spending state resources on projects that have substantial barriers to success other than regulatory barriers.

LESSONS FROM SIMILAR TECHNOLOGIES

The following two cases represent state decisions regarding the regulatory status of the process units and the synthesis gas product produced from hazardous wastes. Although the technologies are different, similar conclusions may be drawn on synthesis gas produced from a plasma unit using hazardous wastes as feed.

Quantum Chemicals Company Recycling Determination

Quantum Chemicals Company in LaPorte, Texas and Galveston Environmental Services (GES) proposed to receive hazardous wastes as raw materials in the production of synthesis gas (syngas). A letter was issued by the Texas Natural Resource Conservation Commission on April 28, 1995, which specified the following requirements: Quantum has established a specification for secondary materials to be fed to the syngas unit. GES may accept secondary materials for storage and bulking that, at generation, meet the specification established by Quantum. GES will accept these materials on a bill of lading. The syngas shall meet the plant specification, and shall be placed directly into a plant syngas header. The syngas shall be used as a feedstock by the chemical manufacturing facility to produce commercial products. Quantum will not directly burn the syngas for energy recovery, or the syngas unit and the combustion unit(s) used shall be subject to the permitting requirements of 40 Code of Federal Regulations (CFR) 264, 266 and 270, and 30 Texas Administrative Code (TAC) 305 and 335. In this scenario, dedicated storage for the secondary materials at GES would not require a permit, since the materials would be exempted from the definition of a hazardous waste by meeting Quantum specifications at generation.

GES can process and blend materials that do not initially meet the Quantum specification, to meet the Quantum specification, however, a hazardous waste permit for storage and processing of off-site generated hazardous wastes would be required for the units that receive, process and store those materials at GES. This is because those materials requiring processing or blending to meet the Quantum specification do not constitute legitimate substitutes for an ordinary raw material, and thus meet the definition of a solid waste as set out at 30 TAC 335.1, and possibly meet the definition of a hazardous waste at generation. GES must receive hazardous and Class 1 industrial wastes under proper manifests, with all attendant documentation pursuant to 30 TAC 335.12(a). GES would be responsible for demonstrating that the Land Disposal Restriction requirements are met for wastes generated during processing. Once these secondary materials blended from off-specification ingredients, i.e., wastes, meet the Quantum specification, Quantum may process the materials as ingredients, without requiring a permit. Since the materials are no longer wastes, Quantum may receive the process ingredients under a bill of lading. We note that both facilities must keep records of shipments of materials shipped from GES to Quantum, and that Quantum must verify that only materials that meet the Quantum specification are received.

In addition, the TNRCC agreed with Quantum that the syngas production unit is not subject to 40 CFR 266 and 30 TAC 335.221 - 335. 229 (the Boiler and Industrial Furnace rules). Based on information provided to the TNRCC by Quantum and its agents, the TNRCC does not believe that the unit meets neither the definition of a Boiler or an Industrial Furnace as those units are currently defined at 40 CFR 260.10 and 30 TAC 335.1.

Molten Metal Technology Recycling Facility

On February 27, 1996, the Executive director of the Texas Natural Resource Conservation commission (TNRCC) approved a recycling determination for Molten Metals Technology, Inc. (MMT) facility to be located adjacent to a Hoechst Celanese Corporation facility in Bay City, Texas. MMT has proposed to process RCRA wastes into a synthesis gas (syngas) to meet a strict HCC syngas specification. Additional MMT products are proposed to be hydrochloric acid, metals, and a "ceramic". MMT proposes to produce these products from wastes including chlorinated hydrocarbons, refining and petrochemical wastes, and waste solids. The TNRCC required that MMT have a storage permit for receipt of hazardous wastes, keep records and provide proof of product quality and sales, and must document the amounts of off-specification products disposed. MMT must provide this data every six months. If the facility is not able to perform as described in MMT's proposal, the TNRCC reserved the right to reevaluate its recycling determination.

SECTION 6

FINDINGS AND POLICY OPTION RECOMMENDATIONS TO

THE DEMONSTRATE ONSITE INNOVATIVE TECHNOLOGY (DOIT)

COMMITTEE

A variety of environmental treatment and remediation applications are being developed for plasma technology. These applications show promise as useful tools for solving environmental problems with potentially fewer impact to human health and the environment than some conventional technologies. Plasma technology is one of several types of technologies which use heat to dissociate waste into basic molecular components. This group of technologies, which we call alternative thermal technologies, is similar to incineration in that it uses heat to break apart constituent molecules. They are also different from incineration in many ways. They may use temperatures much higher than incineration. They typically do not use an open flame to produce heat, and therefore do not require the high volumes of oxygen or air required by incinerators. Air management systems can be smaller. Air impacts are reduced. Solid residues of these units typically are non-leachable and do not release toxic constituents into the environment. Plasma technology offers a useful tool for environmental remediation, waste management and recycling.

The Plasma Technology Subgroup developed findings and recommendations for consideration by the Demonstrate Onsite Innovative Technology (DOIT) Committee sponsored by WGA. It is hoped that these findings and policy options will point the way toward removing regulatory barriers to the use of this technology.

Finding: Despite differences and advantages over incineration technology, frequently there is confusion over whether to regulate these units under 40 Code of Federal Regulations (CFR), Subpart O, the incineration regulations, or under 40 CFR, Subpart X, for miscellaneous units. There is a need for clarification of the definition of incineration by the U.S. EPA so that state regulatory agencies do not have to spend additional time and resources studying the issue each time an application for an alternative thermal treatment technology is received. The current definition of an incinerator from 40 CFR 260.10 is as follows: "any enclosed device that: (1) uses controlled flame combustion and neither meets the criteria for classification as a boiler, sludge dryer, or carbon regeneration unit, not is listed as an industrial furnace; or (2) meets the definition of infrared incinerator or plasma arc incinerator". A plasma arc is defined in the same citation as " any enclosed device using a high intensity electrical discharge or arc as a source of heat followed by an afterburner using controlled flame combustion and which is not listed as an industrial furnace". The term "controlled flame" is sometimes interpreted as any source of heat to break down wastes, and is other times interpreted more strictly as meaning only a conventional open flame. Tying the inclusion of plasma arc units into the definition of incineration based on the design of a secondary or air pollution control device is confusing and unnecessary. Several states have determined that they should be regulated under 40 CFR, Subpart X. Subpart X regulations still require the states to review and address all technical aspects of a waste treatment unit.

Policy Option: State regulatory agencies should regulate flameless alternative thermal treatment technologies which require the state equivalent of a RCRA permit under Subpart X regulations. EPA should revise the definition of incineration to make it clear that it refers to open flame combustion and to eliminate references to plasma arc incineration. The reference in 40 CFR 260.10 should be changed to read " Incineration means any enclosed device which uses a stationary open diffusion flame in the primary combustion chamber and neither meets the criteria for classification as a boiler, sludge dryer, or carbon regeneration unit, nor is listed as an industrial furnace." This change would still provide for regulation of all thermal treatment units that is protective of human health and the environment, but would eliminate the expenditure of significant state resources and staff time used to determine which citation applies to these units.

Finding: Few commercial plasma technology waste treatment units are in operation, there is little reliable data on the economic viability of the technology for many possible environmental applications.

Policy Option: Reliable cost information on the technology would provide a basis for evaluating its use in commercial applications. The Subgroup recommends that all future demonstrations and applications keep cost and performance data in a common format to encourage fair comparisons in the market place. The ITRC recommends that this information be kept according to the Federal Remediation Roundtable document, A Guide to Documenting Cost and Performance Data.

Finding: Regulations which proscribe technology specific operation and management standards, rather than performance based standards, are a barrier to the use of new technologies in general, and plasma technologies specifically.

Policy Option: State and federal regulations should be revised to reflect performance based standards rather than proscriptive technology specific operation and management standards wherever appropriate and possible. That is, they should set clear goals for clean up or waste treatment, and clear and appropriate limits on air, water, and residual contaminant levels.

Finding: The use of plasma technology may eliminate or reduce long term impacts of a waste due to the destruction or immobilization of that waste and its toxic constituents. Although the technology may have higher costs over the short term, the use of the technology may eliminate or reduce the need for future monitoring, handling, and storage of treatment residues and products. The use of short term costs, rather than life cycle costs, in comparing project options can cause plasma technology to seem less economically viable that less permanent alternatives, when in reality, it is more economically attractive when complete long term costs are evaluated.

Policy Option: All cost analysis for the comparison of this technology with others as a remedy selection should take into account life-cycle analysis and the reduction of future liability and environmental impacts. Life-cycle costs for containment of wastes should consider the total cost of containment over the time frame for which the wastes continue to remain toxic or hazardous to the environment. These time frames may range from hundreds to thousands of years.

Finding: The potential for worker exposure and the high cost of laboratory analysis has created pressure for alternative monitoring controls. Continuous air and water monitoring devices are under development. They may replace the need for up-front waste analysis in part or in total as they are perfected. The National Technical Workgroup (NTW) is studying the issue of regulatory mandates for waste characterization versus process and emissions monitoring for a treatment facility to determine if continuous monitors are effective and appropriate alternatives to other types of process monitoring and waste characterization.

Policy Option: The ITRC should not duplicate the NTW study. Once the study is complete , the ITRC should evaluate the applicability of the NTW report and make appropriate recommendations and take appropriate actions to further resolution of this issue.

Finding: Demonstrations of a new technology, such as plasma technology, are done for several purposes. They may be done to develop the technology, or they may be done to demonstrate the effectiveness of the technology for a particular waste stream. Sometimes the demonstrations are done via a treatability study or an R&D permit to collect the information necessary for a regulatory agency to issue a permit for a commercial facility.

It is not always possible for a regulatory agency to know all the questions and information that will be needed to evaluate a new technology. However, a clear understanding of the type and quantity of data

that will be needed later to evaluate a permit application at the beginning of this process by both the applicant and the regulatory agency will save time and resources for both parties.

For new technologies, in particular, permitting issues can be resolved and reviewed in a much more timely manner if there is coordination between programs within a permitting agency and with other state agencies which may also issue permits or approvals for a project and if there is meaningful, ongoing communication with an applicant or technology vendor. Communication and agreement between a regulatory agency and an applicant or technology developer on the information required and pertinent issues to be resolved can result in permit applications which address all potential environmental and public health impacts for the new technology and which require fewer state resources for evaluation.

Policy Option: If a demonstration is done to obtain a state approval or permit for a larger project, then the issuing agency should come to an agreement with the applicant on what type and what quantity of data is necessary to evaluate the approval or permit application wherever possible. This agreement should be reached at the beginning of the demonstration, treatability study, or R&D permit application review.

Policy Option: The review time can be reduced and the quality of the review can be enhanced for new or innovative technology permits if the various program divisions of an agency and separate state agencies which may be issuing permits for different aspects of a project will work cooperatively to communicate, share information, and agree on consistent permit requirements. Governors should direct their agencies to coordinate review of applications for new or innovative technologies.

Finding: The Plasma Technology Subgroup found this exercise of learning about and considering regulatory issues for a new technology very useful. The ability to discuss and resolve issues with peers from several states has a value beyond that of merely reading a report of the Subgroup's activities. A greater knowledge and comfort level with the technology was gained. Sharing the solutions that several states have used allowed the group to evaluate the merits of each and benchmark their own state's policies and procedures against the results of other state activities. Each participant felt that the review of future applications for this technology will proceed more quickly, requiring fewer state resources and staff time than they would have if they had not participated in this group.

Policy Option: The ITRC Plasma Subgroup should follow and support the technology demonstrations and permit applications which are scheduled for review in 1996 by the states of Washington, Idaho, and

Virginia. They should work to educate the regulatory agencies in non-participating states on the past year's work by the Subgroup. They should develop and carry out a communication plan to inform other ITRC states about the regulatory issues regarding this technology and to distribute the report.

Finding: Overcoming regulatory barriers to implementing an innovative technology does not guarantee acceptance by a local community where it is to be used. Stakeholders have identified the need to become involved early in the decision process for choosing technologies for a site so they can influence the process rather than have to work to change a decision. It is clear that development and deployment of new environmental technologies can create anxiety and uncertainty in some local communities. This could possibly cancel-out any permitting efficiencies states may gain by working with the ITRC. Stakeholders in the ITRC process have pointed out that "early involvement promotes (technology and vendor) credibility" and tends to reduce delays in demonstration or treatment projects.

A technology vendor, or applicant for a site, has the most complete information on the technology and, therefore, has the best opportunity to involve a community early in a permitting process. The applicant is responsible for presenting the benefits of a technology over conventional methods of treatment to a community. An effort to involve the local community should start very early in the project, preferably prior to the submission of a development plan or permit application to a state regulatory agency.

Policy Option: The Plasma Technology Subgroup felt that applications of this technology would attract community attention. States with controversial permit activities should ensure that they have public notification procedures which allow for early notification and involvement of an affected community. A document entitled A Guide to Tribal and Community Involvement in Innovative Technology Assessment was produced by the Stakeholder Subcommittee of DOIT, and may provide a useful guide in these activities to both regulatory agencies, permit applicants, and technology vendors.

Appendix A
Vendor Information

Seven plasma technology vendors were identified and sent questionnaires concerning their technology. The attached responses were submitted by the following four companies. The completed questionnaires are not available in electronic form. For information regarding the respones to the questionnaires please contact Terry Escarda of the California EPA at (916) 322-7287.

1. Plasma Energy Applied Technology

2. Science Applications International Company

3. Electro-Pyrolysis, Inc.

4. Massachusetts Institute of Technology - Tunable Hybrid Plasma

Appendix B

Regulatory Survey Summary

Appendix C

Contact List 1

Contact List 2

Appendix D

Suggested Reading List

Peter Crowx, J. Goodwill; "Industrial Plasma Applications in North America"; Center for Materials Production, Carnegie Mellon Research Institute, Pittsburgh, Pennsylvania, 1993.

T. L. Eddy, B. D. Ravio, N. R. Soelberg, O. Wiersholm; "Advanced Mixed Waste Treatment Project Melter System Preliminary Design Technical Review Meeting"; Lockheed Idaho Technologies Company; INEL-95/0054.

T. L. Eddy, J. W. Sears, J. D. Grandy, P. C. Kong, A. D. Watkins; "Modified IRC Bench Scale Arc Melter for Waste Processing"; EG&G INEL, EGG-MS-10941, June 1994.

T. L. Eddy, J. W. Sears, J. D. Grandy, D. V. Milley, A. W. Erickson, R. N. Farnsworth, E. D. Larson; "Properties of Vitrified Rocky Flats TRUW with Different Waste Loadings"; EG&G INEL, EGG-MS-11420, July, 1994.

R. L. Gillins, S. D. Poling; "Plasma Hearth Waste Treatment Demonstration for Radioactive Mixed Waste"; SAIC, Presented at the 1994 Incineration Conference, Houston, Texas.

J. D. Grandy, T. L. Eddy, G. L. Anderson; "TSA Waste Stream and Final Waste Form Composition"; EG&G INEL, EGG-MS-10617, January 1993.

G. R. Hassel, J. A. Batdorf, R. M. Geimer, G. L. Leatherman, J. M. Wilson, W. P. Wolf; "Evaluation of the Test Results from the Plasma Hearth Process Mixed Waste Treatment Applications Demonstration"; SAIC through Martin Marietta Energy Systems, Inc., October, 1994.

G. R. Hassel, R. M. Geimer, J. A. Batdorf, G. L. Leatherman; "Evaluation of the Plasma Hearth Process for Mixed Waste Treatment Applications"; Presented at the 1994 Incineration Conference, Houston, Texas.

P. C. Kong, J. D. Grandy, A. D. Watkins, T. L. Anderson; "Bench Scale Arc Melter for R&D in Thermal Treatment of Mixed Wastes"; EG&G INEL, EGG-MS-10646, May 1993.

W. J. Quapp; "Comparison of Melter Types for Vitrification of Mixed Low Level Waste Residues"; Idaho National Engineering Laboratory, Unpublished Report, January 1995.

C. J. Wolf, T. F. Foster, C. A. Powers; "A Review of Plasma Torch Design Technology"; Aerotherm Technical Report 2592-94-014. November, 1994.

"Proceedings of the International Symposium on Environmental Technologies: Plasma Systems and Application"; Co-sponsored by Georgia Institute of Technology and University of Bordeaux I France; Atlanta, Georgia, October 1995.