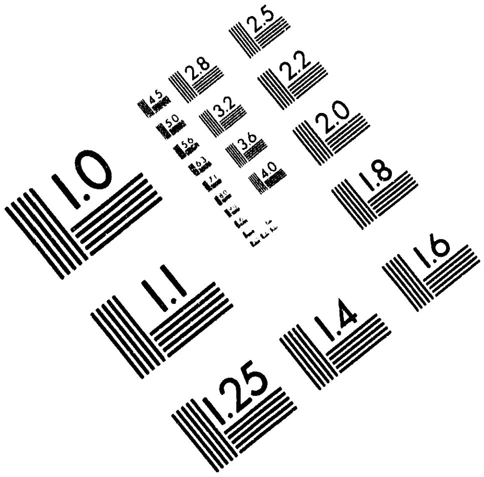

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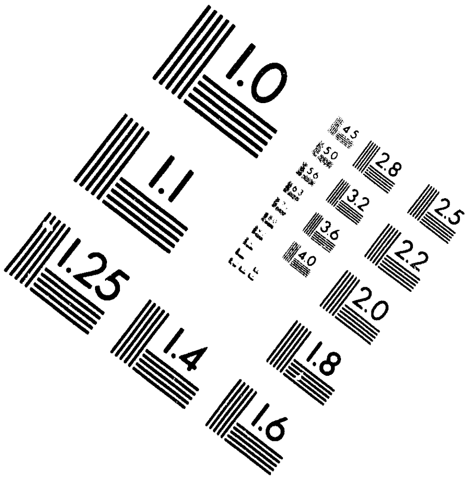

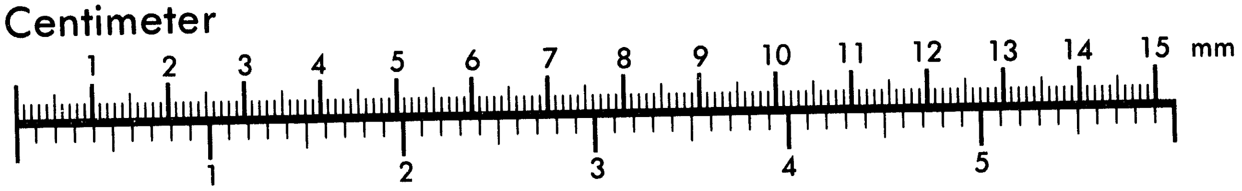

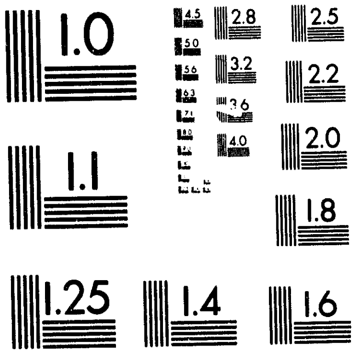

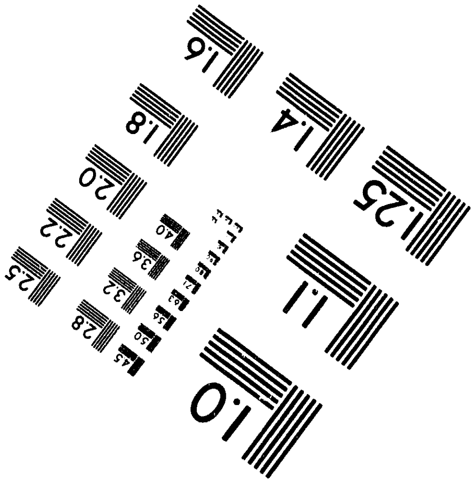

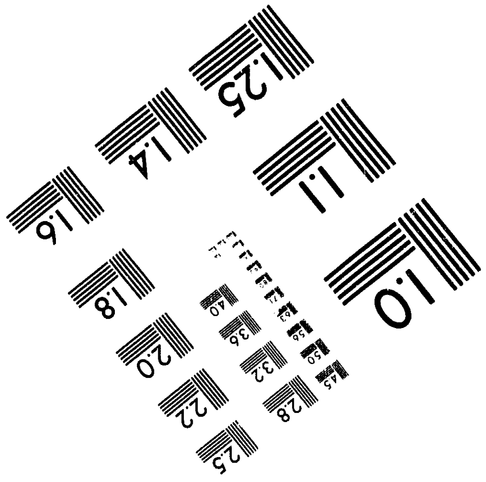

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Chemical Technology Division

Treatment Plan for Aqueous/Organic/Decontamination Wastes Under the Oak Ridge Reservation FFCA Development, Demonstration, Testing, and Evaluation Program

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NOTICE This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

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ABSTRACT

The U. S. Department of Energy (DOE) Oak Ridge Operations Office and the U.S. Environmental Protection Agency (EPA)—Region IV have entered into a Federal Facility Compliance Agreement (FFCA) which seeks to facilitate the treatment of low-level mixed wastes currently stored at the Oak Ridge Reservation (ORR) in violation of the Resource Conservation and Recovery Act Land Disposal Restrictions. The FFCA establishes schedules for DOE to identify treatment for wastes, referred to as Appendix B wastes, that currently have no identified or existing capacity for treatment. A treatment methods plan which documents the evaluation and selection of appropriate treatment methods as well as the location and schedule for the waste treatment must be submitted to EPA by March 1995.

A development, demonstration, testing, and evaluation (DDT&E) program was established to provide the support necessary to identify treatment methods for mixed waste meeting the Appendix B criteria. The Program has assembled project teams to address treatment development needs for major categories of the Appendix B wastes based on the waste characteristics and possible treatment technologies. The Aqueous, Organic, and Decontamination (A/O/D) project team was established to identify pretreatment options for aqueous and organic wastes which will render the waste acceptable for treatment in existing waste treatment facilities and to identify the processes to decontaminate heterogeneous debris waste. In addition, the project must also address the treatment of secondary waste generated by other DDT&E projects.

This report details the activities to be performed under the A/O/D Project in support of the identification, selection, and evaluation of treatment processes. The goals of this plan are (1) to determine the major aqueous and organic waste streams requiring treatment, (2) to determine the treatment steps necessary to make the aqueous and organic wastes acceptable for treatment in existing treatment facilities on the ORR or off-site, and (3) to determine the processes necessary to decontaminate heterogeneous wastes that are considered debris.

1. PURPOSE AND OVERALL APPROACH

The U. S. Department of Energy (DOE) Oak Ridge Operations Office and the U.S. Environmental Protection Agency (EPA)-Region IV have entered into a Federal Facility Compliance Agreement (FFCA) which seeks to facilitate the treatment of low-level mixed wastes currently stored in DOE facilities in violation of the Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions. The FFCA establishes schedules for DOE to identify treatment for wastes (hereafter referred to as Appendix B wastes) that currently have no identified or existing capacity for treatment. A treatment methods plan which documents the evaluation and selection of appropriate treatment methods as well as the location and schedule for the waste treatment must be submitted to EPA by March 1995.

Appendix B mixed wastes at Oak Ridge Reservation (ORR) facilities were generated from a variety of activities including weapons component production and disassembly, decontamination and decommissioning activities, remedial action, and radiological isotope production and research. Waste streams contain a wide range of hazardous and radiological contaminants as well as a wide range of waste matrixes. In order to develop treatment strategies for these varied wastes, waste categories (Fig. 1) were developed for wastes that exhibit similar characteristics for treatment, such as aqueous liquids and slurries, organic liquids, solid process residues, soils, debris waste, special waste, and inherently hazardous waste.

The waste categories covered by this project plan are aqueous liquids and slurries (category 1000), organic liquids (category 2000), and heterogeneous debris (category 5000). The aqueous liquids and slurries category includes aqueous solutions or slurries that have less than 1% organic content, contain up to 35-40% solids by mass, and are pumpable. Contaminants include radionuclides, mercury, lead, and trace amounts of other toxic metals and hazardous organics. Examples of this category are corrosive acids, corrosive bases, and aqueous liquids that contain reactive cyanides, toxic metals, and/or hazardous organics. The organic liquids category includes liquid streams that are either essentially a pure organic stream or contain both aqueous and organic materials, contain up to 35-40% solids by mass, and are pumpable. Contaminants include radionuclides, lead, mercury, and several other toxic metals and hazardous organics. Examples of this category are nonhalogenated organics, halogenated organics, spent solvents, polychlorinated biphenyls (PCBs), and oils. Heterogeneous debris includes mixtures of metals, nonmetals, combustibles, soils, and process residues that can be classified as debris and that are contaminated with radionuclides, toxic metals, and hazardous organics. Examples of this category are lead baths and chips, mercury-contaminated pump parts, and construction debris.

This plan details the activities to be performed under the Aqueous/Organic/Decontamination (A/O/D) Project in support of the identification, selection, and evaluation of treatment processes. The goals of this plan are (1) to determine the major aqueous and organic waste streams requiring treatment, (2) to determine the treatment steps necessary to make the aqueous and organic wastes acceptable for treatment in existing treatment facilities on the ORR or off-site, and (3) to determine the processes necessary to decontaminate heterogeneous wastes that are considered debris.

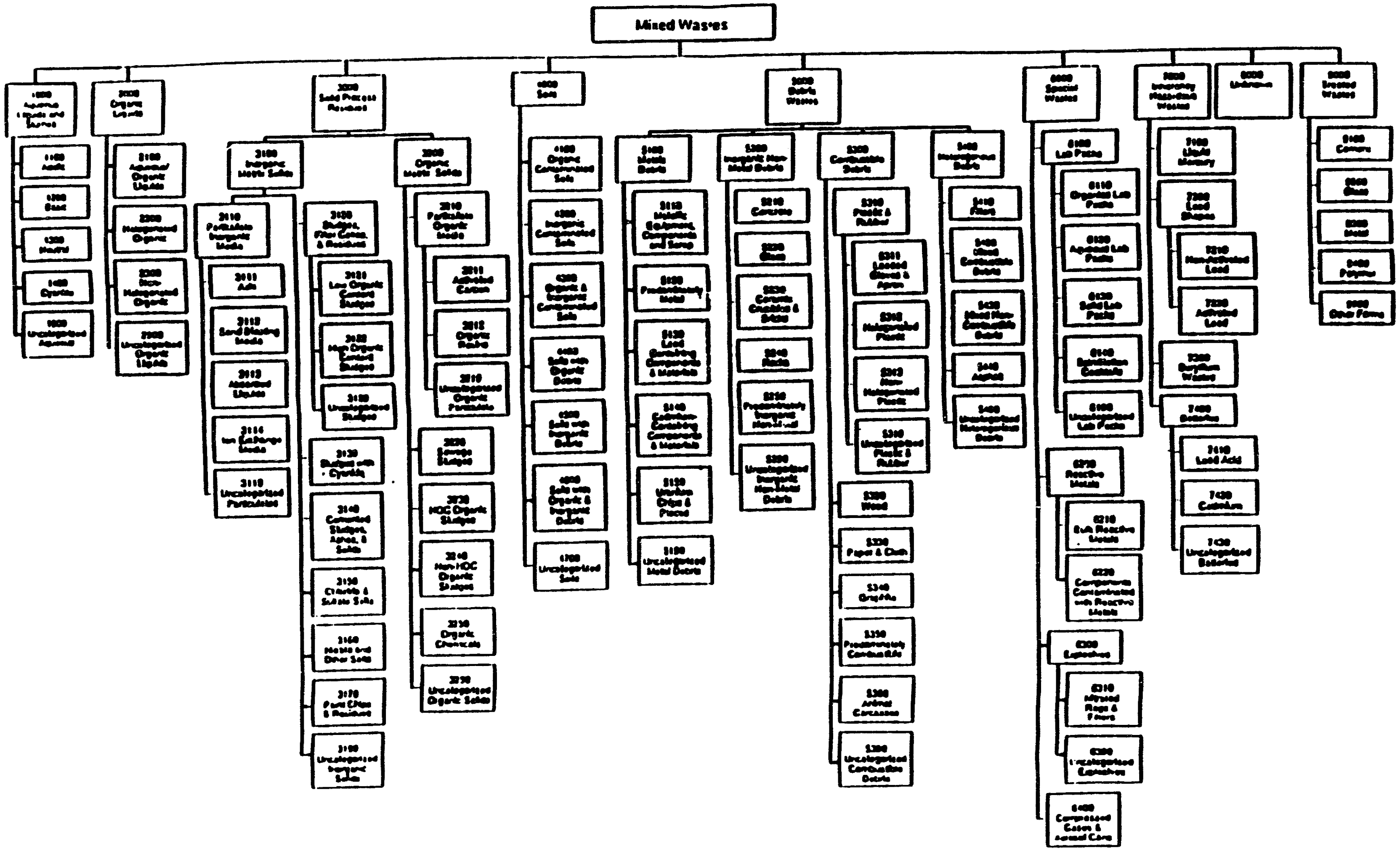


Fig. 1. Categories of mixed waste.

In addition to determining the treatment needs mentioned above, this effort must also be integrated with the efforts of other development, demonstration, testing, and evaluation (DDT&E) projects since secondary waste generated from those proposed projects may require treatment under the A/O/D treatment plan and vice versa. To successfully complete the development efforts in this project, communication must be maintained (timely and often) with DDT&E program management and with other projects in the DDT&E effort.

2. PROGRAM MANAGEMENT ACTIVITIES

2.1 ORGANIZATION STRUCTURE

All activities in support of the FFCA are managed by the Energy Systems Waste Management Organization (ESWMO) within Martin Marietta Energy Systems, Inc. (MMES). DDT&E activities in support of the FFCA Appendix B wastes have been divided into an organization structure to facilitate a timely and accountable division of responsibilities. This organizational structure is a team effort consisting of several MMES-managed facilities. The organization structure will be adjusted as personnel changes are necessary. This structure is shown in Fig. 2.

2.2 DELIVERABLES/MILESTONES

This plan includes a number of technical and programmatic deliverables that must be met in order to achieve success. These deliverables are discussed in Sects. 3 through 8 of this plan. Specific schedule requirements of this plan are presented in Sect. 7. The deliverables presented in this plan may be modified as programmatic factors dictate.

2.3 DOCUMENTATION

The principal reporting mechanism to DOE and EPA for these activities will be the quarterly technical progress reports issued by ESWMO. These reports will be used to fulfill documentation requirements agreed to under the FFCA and to provide an official documentation and communication of efforts expended. Task-specific reports may be issued by this project to provide additional detail and support to the progress reports. In addition, all experimental data generated by MMES personnel on this project will be contained in registered laboratory notebooks.

2.4 SAFETY PLANS

All development activities will be conducted in accordance with site-specific safety procedures at the testing facility. Safety appraisals and audits will be included as necessary to ensure the safety of laboratory workers.

2.5 QUALITY ASSURANCE

The quality assurance (QA) program provides a mechanism for achieving desired quality and performance levels. It integrates the organization with tools for achieving a quality process through planned and systematic actions. The Quality Assurance Program Plan for the DDT&E Program will be the governing guidance document for data quality objectives performed within this project. Development efforts will also be governed by task-specific quality assurance project plans, as necessary. These plans will be consistent with the overall

FEDERAL FACILITY COMPLIANCE AGREEMENT
DEVELOPMENT, DEMONSTRATION, TESTING, AND EVALUATION PROGRAM
MATRIX ORGANIZATION

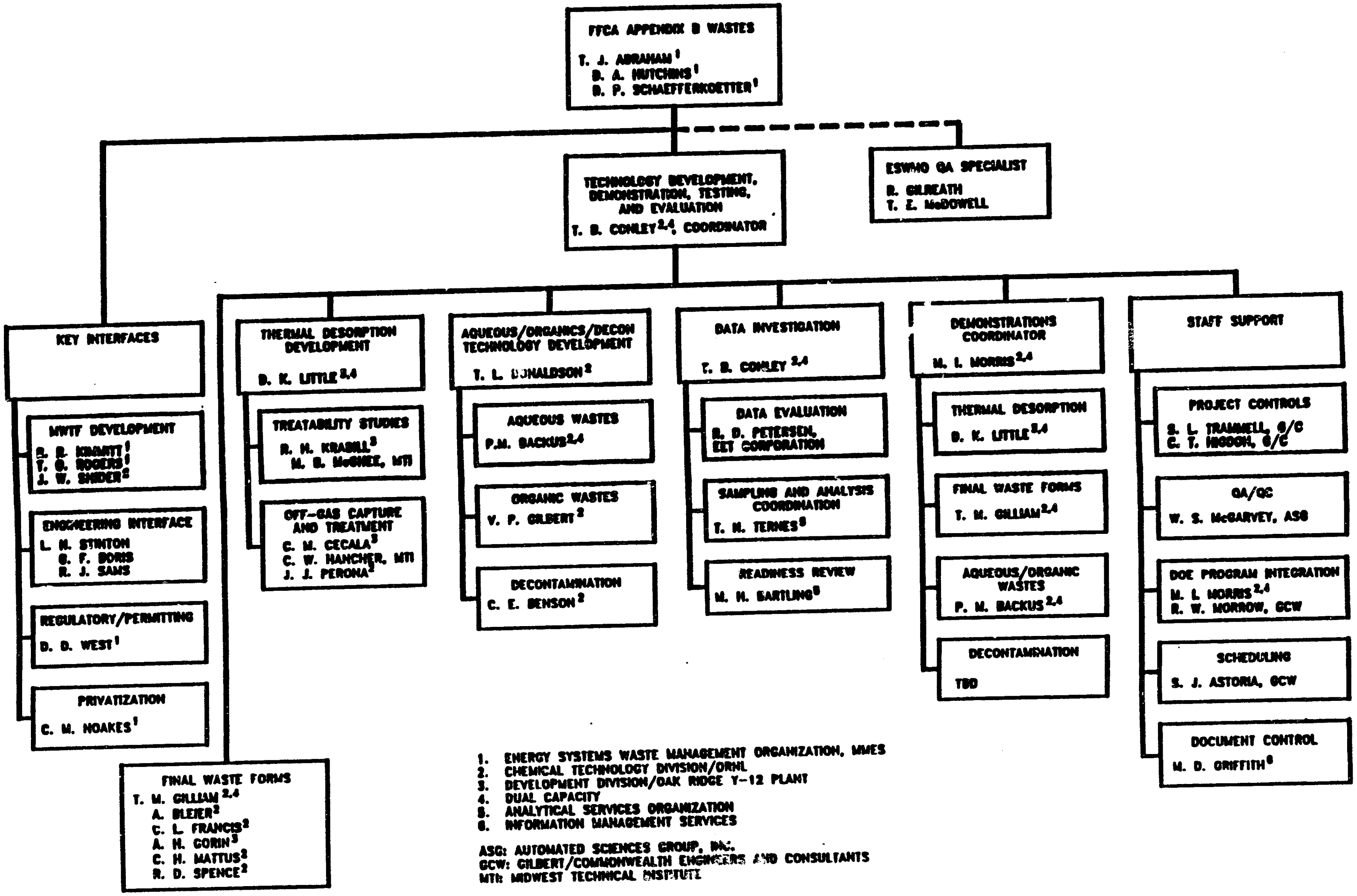


Fig. 2. Organization structure.

program plan and with applicable EPA requirements for treatability studies. A formal surveillance of activities within this project will be performed by independent QA personnel at least once a year. Technology services performed by private industry will have QA procedures included in the statement of work (SOW) as a part of the contract with the commercial company.

2.6 REGULATORY CRITERIA

All development activities conducted under this plan will adhere to applicable DOE orders as well as regulations issued by the Tennessee Department of Environment and Conservation (TDEC), the EPA, the U.S. Department of Transportation (DOT), and any other agency with oversight authority. All treatability studies performed on hazardous wastes will be conducted in compliance with the treatability exclusion exemption under RCRA or under an approved research and development (R&D) permit. Studies using wastes regulated under the Toxic Substances Control Act (TSCA) will be conducted under an approved TSCA R&D permit.

2.7 INTEGRATION WITH OTHER RELEVANT PROGRAMS

An important part of this plan will be to coordinate with the work of other organizations. Other organizations include additional activities in support of the FFCA and existing treatment facilities as well as environmental restoration activities. In addition, these activities will be coordinated with national mixed waste programs such as the Mixed Waste Integrated Program and the Decontamination and Decommissioning Integrated Demonstration. Technology demonstrations by other DOE facilities, the EPA, and private vendors/companies will also be evaluated and integrated as appropriate. This interaction will aid in determining what development activities are needed and whether they should be performed by MMES or others.

3. TECHNOLOGY AND WASTE STREAM SELECTION

3.1 FFCA STRATEGY FOR A/O/D WASTES

The FFCA states that DOE will submit a plan documenting the evaluation and selection of technologies to treat those wastes generated and stored on the ORR as land disposal restricted and mixed waste without identified or existing treatment technologies. The strategy for the treatment of aqueous and organic liquid wastes is to pretreat to allow treatment in either on-site or commercially available treatment facilities. The focus of efforts for these waste groups will be to more fully characterize the waste, to understand which contaminants must be removed to facilitate treatment, and to define the pretreatment technologies to remove the contaminants.

The strategy for the decontamination of containers and heterogeneous debris waste is to treat the waste using existing decontamination equipment and techniques. The focus of the efforts for decontamination will be to more fully characterize the waste, to determine which contaminants must be removed, and to identify the appropriate equipment and technique for each waste stream.

3.2 WASTE CHARACTERIZATION NEEDS

Existing waste record information is being complied for the aqueous, organic, and heterogeneous debris wastes. Records indicate contamination by numerous heavy metals, organics, and radionuclides. Additional waste characterization will be needed depending on the quality of the existing data, on the data requirements to assess compliance with the waste acceptance criteria (WAC) of existing facilities, and on the data requirements to formulate treatability and development testing. Characterization activities will include the preparation of sampling and analysis plans, the physical sampling of waste containers, and the performance of sample analyses. A complete list of analyses which may be required is listed for aqueous liquids in Appendix A and for organic liquids in Appendix B. Information that is needed for decontamination plan development is listed in Appendix C.

3.3 IDENTIFICATION OF PERFORMANCE CRITERIA

The performance criteria for technologies selected for the pretreatment of aqueous and organic liquid wastes will be the WAC of existing on-site facilities since the removal of certain contaminants from the waste streams will allow them to be treated on-site. If final treatment of specific waste streams requires the use of a commercial facility, the WAC of the chosen facility will be used to establish pretreatment performance requirements. This decision will be made after all waste characterization information is complied.

Because of the diversity of the aqueous waste streams and of the on-site treatment capabilities, pretreatment technologies will be dependent on the pairing of the streams with a final treatment facility. Aqueous wastewater treatment facilities on the ORR that are currently processing wastes and that may be used for final treatment include the Process

Waste Treatment Plant and the Nonradiological Wastewater Treatment Plant at the Oak Ridge National Laboratory site, the Central Pollution Control Facility and the West End Treatment Plant at the Oak Ridge Y-12 Plant Site, and the Central Neutralization Facility at the Oak Ridge K-25 Site. WAC for these facilities are listed in Appendix D.

For organic liquids, the strategic plan lists incineration as the preferred treatment. The designated pretreatment scheme will most likely be required to meet the WAC used at the TSCA Incinerator, located at the K-25 Site. Depending upon the EPA hazardous waste codes assigned to the original waste and the chosen final disposal option, additional performance criteria may be added. The WAC for the TSCA Incinerator are listed in Appendix E.

The performance criteria for decontamination efforts are typically determined on a case-by-case basis based on the disposition of the material. It is yet to be determined how implementation or application of the debris rule may affect the performance criteria for these efforts. As the project moves forward, the debris rule will be given proper consideration. Health Physics coverage during the decontamination and final survey determines the acceptance of the operation. Most decontamination tasks are to levels below release limits of the site. Some of the values of these limits are listed in Appendix F.

3.4 SELECTION OF CANDIDATE WASTE STREAMS

Candidate waste streams for treatability studies will be selected and prioritized based on the relative volume of the waste streams and on the components present in the waste streams that would be problematic to the existing facilities. A review of waste records and of existing treatment plant capabilities and waste acceptance criteria is under way to provide the data to support candidate stream selection.

Existing waste records for aqueous liquids indicate approximately 60% of the wastes in storage are laboratory acids that are characteristic for corrosivity, chromium, lead, and mercury but that also may contain other contaminants. The remaining wastes are characterized corrosive, characteristically hazardous for mercury, ignitable, or reactive. A small quantity is contaminated with F- and U-listed materials. Existing facilities can treat most of the contaminants individually, but they are not capable of treating the combination of these components with radionuclides. Candidate aqueous liquids waste streams will include the most prevalent combinations of toxic metals, organics, and radionuclides as indicated from the waste characterization effort.

It is anticipated that a majority of the liquid organic stored wastes can be treated by incineration at the TSCA Incinerator. The selection of appropriate waste streams for this project plan should include waste streams with minimum, average, and high levels of beryllium, lead, mercury, uranium, and other particulate metal fines that are representative of all types of stored organic wastes, not just those wastes with <50 ppm PCBs. In all cases, the concentrations of these problem constituents will be above the WAC for the TSCA Incinerator.

3.5 SELECTION OF APPROPRIATE TECHNOLOGIES

Potential treatment technologies for aqueous liquids and slurries, organic liquids, and decontamination have been identified. Upon completion of the waste characterization effort, the characteristics of Appendix B wastes can be compared with the pretreatment performance criteria to determine the appropriateness of the potential technologies for treating the wastes.

4. POTENTIAL TREATMENT TECHNOLOGIES

The various technologies discussed below are being considered as options for pretreatment or treatment methods for the A/O/D waste group. Many of the technologies are currently being used as integral parts (unit operations) in existing waste treatment processes located on the ORR. Information from operation of the existing unit operations can aid in the design of treatment regimes for the mixed waste.

4.1 AQUEOUS LIQUIDS

4.4.1 Activated Carbon Adsorption

Carbon adsorption is a process by which organic molecules and some inorganic molecules are removed from an aqueous waste stream as a result of their preferential sorption onto the surfaces of carbon particles. Carbon used for adsorption is usually treated (or "activated") to produce a product with a high surface-to-volume ratio, thus exposing a practical maximum number of carbon atoms to be active adsorbers. Activated carbon adsorption is a widely used, commercially available separation technique for low-level concentrations of organic contaminants. Waste stream factors important to determine the applicability of carbon adsorption are the chemical characteristics, the molecular weight, the solubility, the polarity of the contaminants to be removed, and the pH of the stream. Rule-of-thumb guidelines are that the contaminant concentrations should be less than 10,000 ppm, suspended solids less than 50 ppm, and dissolved inorganics and oil and grease less than 10 ppm. Activated carbon that has adsorbed so much contaminant that its adsorptive capacity is severely depleted is said to be "spent" and requires regeneration or replacement.

4.1.2 Advanced Oxidation

Advanced oxidation processes increase the oxidizing capability of certain chemical oxidants such as ozone, hydrogen peroxide, sodium hypochlorite, certain acids, or aggressive cations such as Ag^{2+} through the addition of chemical or physical catalysts (e.g., ultraviolet light and electrochemical potential). In general, catalysts increase the oxidative potential of these chemicals through the formation of highly reactive intermediate components such as hydroxyl radicals. These free radicals typically react to completion with organic wastes to form carbon dioxide and water. Wastes suitable for treatment by this process are limited to aqueous liquids with low total organic carbon content.

4.1.3 Air Stripping

Air stripping is a mass transfer process whereby volatile organic compounds (VOCs) are transferred from a liquid to a gas phase until equilibrium is established between the phases. Factors important in the removal of organics from wastewater by air stripping are temperature, air-to-water ratio, and surface area available for mass transfer. Air stripping can be accomplished in either columns or trays, with contaminated liquid forced over various types of packing material to create large air-water interfaces. Volatile constituents migrate into the air phase, which can be treated to remove the VOCs before emission to the atmosphere.

Depending on flow conditions and contaminant properties, extraction efficiencies of more than 99 % are possible. Air stripping is used to treat aqueous organic waste with relatively high volatility and low water solubility and aromatics. If the concentration of the VOCs exceeds approximately 100 ppm, other separation precesses are usually preferred.

4.1.4 Biological Treatment

Biological treatment processes use microorganisms and fungi to metabolize organic substrates and to sorb, chelate, flocculate, or enhance the dissolution or precipitation of inorganic compounds. Under aerobic conditions, biodegradation products are typically carbon dioxide and water. Under anaerobic conditions, reaction pathways are more complex, with the formation of intermediate compounds such as organic acids, followed by carbon dioxide and methane. Biological treatment is used extensively in the commercial wastewater treatment field, with activated sludge systems and biological digesters serving as the preferred treatment alternatives for removing organic compounds from municipal wastewaters. Such biological treatment has proven to be cost-effective for aqueous waste containing large quantities of organic matter.

4.1.5 Chelation

Chelation is a chemical process in which chelating chemicals are added to a waste in order to concentrate or extract various cations, especially heavy metals and radionuclides, from the waste. The chelating agents are chemicals containing ligands which attach to a central metal ion that form highly stable and soluble complexes when the ligands complex with the cations. This process keeps the cations in solution and aids in dissolution for subsequent transport and removal. Chelating chemicals are often highly selective and can be selected for their affinity to a particular cation. The chelating chemicals can also be sorbed onto an inert stationary support (e.g., resin with small particle size) such that cations may be extracted by passing an aqueous liquid through a packed column of the support.

4.1.6 Electrochemical Metal Removal

Electrochemical metal removal processes apply the use of electrostatic attraction and repulsion to remove metallic ions from aqueous waste. Electrochemical processes discussed here include electrodialysis, electrowinning, and electrodecontamination. Each of these processes is commercially available.

Electrodialysis is used commercially in the electroplating industry to concentrate and separate metals in process waste streams. An aqueous waste stream, containing metal salts, is fed into the center chamber of a three-chamber electrodialysis cell. The chambers are separated by alternating cation-permeable and anion-permeable membranes. When a direct-current charge is applied to the cell, anions—primarily sulfates and chlorides—pass through the anion-permeable membranes and concentrate at the anode while cations pass through the cation-permeable membranes and concentrate at the cathode. The deionized water remaining in the center chamber is then reused, discharged, or treated further. The concentrated anionic and cationic solutions require additional processing prior to disposal.

Wastes containing nickel, copper, cyanide, chromic acid, iron, and zinc have been successfully treated using electrodialysis. This process is best suited to acidic wastes that contain a single concentrated metal.

Electrowinning is a process whereby an acidic solution is electrolyzed to cause the deposition of positively charged metal ions on the cathode, while forming additional acid at the anode. This process has been successfully used to create high-purity metals. Electrowinning is normally conducted at or above standard ambient temperatures.

Electrodecontamination is an electropolishing or electrolytic dissolution process used to remove surface contamination from metal components. The contaminated surface is dissolved anodically in a concentrated acid or alkaline solution. Radioactive contamination present on the surface or trapped in scratches and other surface imperfections is removed and released into the electrolytic solution. Electrodecontamination is capable of reducing radioactivity on metal surfaces down to background levels.

4.1.7 Evaporation

Evaporation is a physical process by which a liquid is separated from a dissolved or suspended solid by application of energy to volatilize the liquid. The process removes the solvent as a vapor from the solution or slurry to produce a concentrated solution, thick liquor, or slurry. Evaporation can be applied to any mixture of liquids and nonvolatile solids, provided the liquid is volatile enough to evaporate under reasonable heating or vacuum conditions and both phases are stable at the evaporation temperature. Organics, inorganics, metals, and radionuclides may be separated by this process.

4.1.8 Ion Exchange

Ion exchange is a physical treatment process used for the removal of undesirable anions and cations from wastewater. The process involves the exchange of ions between the contaminated liquid phase and the surface of treated resins, which are contained in a packed column. Most ion exchange resins are synthetic resins made by the polymerization of organic compounds into a porous three-dimensional structure. Functional ionic groups are usually introduced by reacting the polymeric matrix with a chemical compound containing the desired group. Upon saturation with waste ions, the ion exchange resin may be either disposed of or regenerated. Ion exchange techniques typically are used to detoxify large flows of wastewater containing relatively low levels of heavy metals, salts, and acids. Limitations are selectivity/competition, pH, and suspended solids. Highly concentrated waste streams (greater than about 25,000 mg/L contaminants) can usually be separated more cost-effectively by other means. High solids concentrations (greater than about 50 mg/L) should be avoided to prevent resin blinding. Commercially available ion exchange processes have been used extensively to remove heavy metal cations (including uranium) from water and are often considered as polishing processes due to their inherently high efficiencies.

4.1.9 Neutralization

Neutralization is the process of changing the constituents in an ionic solution until the number of hydrogen ions (H^+) present is balanced by the number of hydroxyl ($OH-$) ions.

The process is used to treat waste acid and bases in order to eliminate or reduce their reactivity and corrosiveness. Neutralization is a relatively simple and widely used process with the neutralization and pH buffer chemistry well understood for most mixtures. Residuals include a neutral effluent containing dissolved salts and any precipitated salts. Various neutralization processes and strategies are commercially available. The process can be a very inexpensive treatment, especially if waste acids and bases are used.

4.1.10 Precipitation

Precipitation is the process of reducing the solubility of a species in solution by either adding specific compounds to a solution or changing the temperature and pressure of the solution. Once the solubility limit of a solute is reached, it will precipitate out of solution, generally assuming an insoluble form with a density greater than that of water. This solid, insoluble material can then be removed from the liquid phase using a physical separation process such as filtration. Precipitation is a chemical treatment technique that has been widely used for the removal of soluble metal species from aqueous waste. Coagulation and flocculation are similar processes that are used to remove colloidal substances, or turbidity, from drinking water. Both precipitation and coagulation processes are commercially available.

4.1.11 Oxidation-Reduction

Oxidation-reduction reactions, or "redox" reactions, are chemical reactions whereby reactants are chemically transformed as the result of an exchange of electrons between pairs of atoms or molecules. Such transformations result in the reduction, or lowering of the oxidation number of one atom or molecule, and the oxidation, or raising of the oxidation number of another atom or molecule. Redox reactions can be used to reduce the toxicity of various organic compounds and metals. For example, cyanide compounds can be detoxified through the addition of oxidizing agents such as ozone, hypochlorite, chlorine, or hydrogen peroxide. Reducing agents such as sodium borohydride, sulfur dioxide, ferrous sulfate, and sodium sulfate can be used to reduce highly toxic metallic species such as chromium(VI) to less toxic species such as chromium(III). Redox reactions can be conducted using a variety of commercially available equipment.

4.1.12 Reverse Osmosis

Reverse osmosis is the process by which a solvent is separated from a solution of dissolved solids by the application of a hydrostatic pressure significantly greater that the solution's normal osmotic pressure to the solution side of a semipermeable membrane. When the pressure is applied, the waste stream flows past the membrane, while the solvent, such as water, is pulled through the membrane's pores. The remaining solutes such as organic or inorganic components do not pass through, but become more and more concentrated on the influent side of the membrane.

The reverse osmosis process has shown positive results for concentrating high-molecular-weight organic compounds, as well as anions and cations of various metallic and nonmetallic species. Favorable results have been demonstrated for the removal of aldehydes, ketones, amines, and alcohols from aqueous waste. Reverse osmosis units are available commercially and are widely used for the purification of potable water.

4.1.13 Solvent Extraction

Solvent extraction is a physical separation process in which constituents are separated from a liquid solution by contact with another immiscible liquid in which the constituents are more soluble. Generally aqueous-phase waste streams are placed in contact with organic extractants to remove the desired constituents. The solvent extraction process is applicable to waste containing both metallic and organic substances and has recently been enhanced by the development of synthetic chelators and natural biochelators. Other applications of solvent extraction technology range from the chemical extraction of soil contaminants to the purification of aqueous waste.

4.2 ORGANIC LIQUIDS

4.2.1 Acid Digestion

Acid digestion is a chemical treatment process whereby combustible wastes are dissolved in the presence of an acid and an oxidant at temperatures ranging from 230 to 300°C. Carbonization of the combustible organic material results in the production of carbon dioxide. The carbonization process is enhanced by the addition of an oxidant such as acid or hydrogen peroxide. These oxidants also provide the added benefit of converting the digestion gases to acid, which can be reused. Off-gas scrubbing is a necessary component of all acid digestion systems. Acid digestion is currently a developmental process.

4.2.2 Catalytic Dehalogenation

Catalytic dehalogenation is a process under development for the replacement of halogen atoms with hydrogen atoms on a variety of organic molecules. The process is conducted under controlled temperature and pressure conditions using an appropriate catalyst (e.g., ultraviolet light). The potassium polyethylene glycolate process has been specifically developed for the treatment of PCB-contaminated waste. A similar pilot-scale process uses aprotic solvents and other reagents combined with ultrasonic radiation to dehalogenate PCBs to inert biphenyls and sodium chloride. Halogenated liquids, sludges, sediments, and soils can be treated using dehalogenation technology.

4.2.3 Fluidized-Bed Incineration

Fluidized-bed incineration uses a combustion chamber that contains a bed of inert, granular material, usually silica sand or a catalyst. This heated bed material is expanded by combustion air which is forced upward through the bed. As waste from the feed stream is mixed with the hot fluidized-bed material, heat is rapidly transferred to the waste. As the waste dries and burns, heat is transferred back to the bed. Significant turbulence in the bed ensures thorough mixing between combustion gases and waste feed, which reduces excess air requirements. Continuous removal and make up of bed material is necessary due to entrapment and buildup of inorganic material from the waste feed. Off-gas treatment may be necessary.

Circulating-bed combustion is a variation of fluidized-bed technology that can be used for waste treatment. Complete destruction of organic contaminants can be accomplished at relatively low temperature due to the high degree of turbulence, thus eliminating the need for secondary combustion chambers. Off-gases are passed directly into a cyclone separator that captures solids and recirculates them to the combustion zone. Combustion gases pass through a heat recovery system and then through an air pollution control system prior to discharge to the atmosphere.

The application of conventional fluidized-bed and circulating-bed systems to waste treatment is based on extensive commercial operating experience for coal refinery sludge, paper mill sludge, and sewage sludge combustion.

4.2.4 Glass Melting (Vitrification)

Glass melting (vitrification) is used for processing wastes by trapping inorganic and metallic constituents in a glass matrix, while destroying the organic constituents. (Ceramic matrices have shown good stability and strength features for the capture of radioactive constituents.) Organic liquids, dry sludges, and combustibles are mixed with glass former (i.e., silica or alumina), then introduced into the cavity of a glass melter, which may be either rotated or fixed. The process operates in a temperature range of 950 to 1250°C. Oxygen is added to the combustion chamber in excess of the stoichiometric requirement, with sufficient residence time maintained to ensure complete destruction of all organic contaminants.

Off-gas treatment is required, with sludges formed during off-gas treatment recycled through the melter. The molten glass, along with the trapped ash, is drawn from the bottom of the melter into heated drums. The drums are slowly cooled to approximately 700°C, then forced-air cooled to prevent undesirable crystallization. Drums are then sealed and leak tested prior to shipment or storage. Glass melting reduces the total waste volume by up to 30%, while creating a leach-resistant and disposable waste form. Glass melters are commercially available.

4.2.5 Molten Salt Oxidation

Molten salt oxidation is a noncombustion alternative to incineration. The basic concept of molten salt oxidation when used as a primary waste treatment technology is as follows: (1) introduce wastes and air into a ceramic-lined vessel containing a bed of molten salt, (2) oxidize organic waste in the molten salt, (3) use the heat of oxidation to keep the salt molten, and (4) remove the salt for disposal or for processing and recycling. This process occurs at temperatures approximately 300°C lower than equivalent incineration temperatures and is capable of neutralizing acid gas, thus requiring no wet off-gas scrubbing system. Because of wetting, encapsulation, and chemical reaction with the molten salt, the process has excellent capture of heavy metals and radionuclides. Molten salt oxidation has the best potential for off-gas treatment from other systems and treatment of high-heating-value organic liquids (e.g., solvents and waste oils) and low heating-value liquids (e.g., chlorinated organic liquids). The process will not work well for debris.

4.2.6 Plasma Melting

Plasma melting is a thermal process that uses the heat generated from a plasma arc to treat wastes. Extremely high temperature plasma (7000 to 15000°C) is generated by the joule heating of a gaseous electrical conductor between two high-voltage electrodes. The waste is introduced into the furnace into a molten bath of material. The high-temperature plasma zone and the molten bath combust the organics and melt all other inert materials into the bath.

Volatile gases released from the waste are subjected to the ultrahigh temperatures of the plasma gas, which completely decompose the organic molecules to individual atoms. The high-temperature off-gas is quenched in the presence of oxygen to promote the formation of carbon dioxide and water. The off-gas is then treated using conventional air pollution control equipment to remove acid gases, particulates, and volatile metals prior to release to the atmosphere.

Slag formed in the reactor is discharged into waste disposal containers to solidify. Thus, hazardous constituents such as toxic and radioactive metals are rendered relatively leach resistant. Plasma melting is also reported to be capable of processing a wide variety of material, including both liquid and solid waste.

4.2.7 Rotary Kiln Incineration

Rotary kiln incineration employs an inclined rotating combustion chamber (kiln) to efficiently oxidize combustible material while gradually transporting the combustible waste to the ash discharge end of the chamber. Dry waste feed is shredded and ram charged into the refractory-lined combustion chamber, which rotates at approximately 1 to rpm. A fast rotary kiln process with rotational speeds up to 20 rpm has improved efficiencies over the slower-speed rotating kiln and allows for better heat transfer and combustion. Auxiliary fuel is also added to the kiln to maintain temperature in the chamber between 650 and 950°C. Residence time varies from several seconds for gases to several hours for solid materials. Exhaust gases are treated in an afterburner at temperatures between 760 and 1315°C, followed by a wet off-gas scrubber and particulate collection system. Ash is gravity fed into a collection basin for appropriate treatment (e.g., immobilization) prior to final disposal. Rotary kilns can process a wide variety of wastes, including solids up to four in. in diameter.

Rotary kiln technology is available on-site for liquid incineration at the TSCA Incinerator; commercial vendors can also provide rotary kiln incineration for liquids and solids.

4.3 AQUEOUS LIQUIDS OR ORGANIC LIQUIDS

4.3.1 Centrifugation

Centrifugation is a physical separation technique in which the components of a fluid are separated based on their relative densities. Waste is placed into a rigid vessel and rotated at high speeds to subject the mixture to forces thousands of times stronger than gravitational forces. The denser materials in the mixture are forced to the outer wall of the centrifuge, while the liquid supernate is left near the center. Centrifugation is a commercially available separation technique, which is used to dewater sludges and to separate oil and water emulsions.

4.3.2 Filtration

Filtration is a physical separation method used to remove suspended solids from a fluid by forcing the fluid through a filter medium. Filtration requires a pressure differential that can be induced using either gravity or mechanical means. Both the filtrate and the filter medium may require additional treatment prior to disposal. Numerous filter media are commercially available, including woven and nonwoven fibrous media as well as granular media. As with activated carbon and ion exchange resin, filtration media must be periodically regenerated or replaced. Filtration is useful for dewatering sludges and slurries as well as for separating other materials that are more amenable to treatment when separated. Pretreatment by filtration is appropriate for membrane- separation processes, ion exchange, and carbon adsorption in order to prevent plugging or overloading of these processes. Filtration is widely used for both water and air treatment, with a variety of filtration methods commercially available.

4.4 DECONTAMINATION

4.4.1 Superheated Water

Superheated water (e.g., at conditions of 300 psi and 300°F) equipment successfully employs the "spray-vacuum" cleaning technique by combining the best features of pressure washer, stream cleaners, and wet vacuums. The system uses a low-volume, pressurized spray of superheated water in combination with a powerful high-efficiency particulate air (HEPA) filtered vacuum system to provide a fast, effective and easy-to-use decontamination method that practically eliminates the solid wastes, such as mops and rags, while minimizing the liquid waste volumes and radiological concerns associated with conventional decontamination techniques.

4.4.2 Ultrahigh-Pressure Water

An ultrahigh-pressure intensifier pump pressurizes water up to 55,000 psi and forces it through small-diameter nozzles, generating high-velocity waterjets at speeds up to 3000 ft/s. The nozzles may be mounted in various types of cleaning heads for different contaminant surfaces. The waterjets thoroughly penetrate and remove surface contamination. Ultrahigh-pressure accessories transport the pressurized water to cutting or cleaning stations and convert it into a high-velocity waterjet with or without abrasive.

4.4.3 Strippable Paint Process

The paint is a one-component water-based vinyl, cavity-grade, strippable, decontamination coating manufactured under a nuclear QA program. Chemical composition (chlorides, fluorides, sulfur compounds, and heavy metal concentration) conforms to requirements for use on primary system components. Applied over a contaminated surface, the paint attracts and binds heavy metal isotopes. The coating migrates into microvoids of the surface to contact contaminants. Upon cure, the product mechanically locks the contaminants into a polymer matrix. Removal of the film decontaminates the substrate and produces a solid radioactive waste. The strippable paint provides a high level of protection as well as decontamination. The process reduces airborne activity, immobilizes surface contamination, and reduces waste volumes.

4.4.4 Scabblers/Scarifiers

This technology decontaminates a concrete substrate by using mechanical impact methods to remove the contaminated surface. Many vendors market units that use high-speed reciprocating tungsten-carbide-tipped pistons to pulverize protective coatings and concrete substrate in a single-step process. Other types of units use a shrouded needle scaler to remove concrete from outside edges and inside corners, as well as from wall surfaces. These units are also used for removing lead-based coatings and contamination from steel surfaces. The solid debris produced by mechanical scabbling is removed and collected by a vacuum system.

4.4.5 Vacuum Systems

HEPA-filtered vacuum systems are used for general decontamination area cleanup. A very important (if not the most important) aspect of equipment usage is containment. All of the high-pressure blast systems must have very efficient vacuum systems. Selection of the correct vacuum unit and design of special decontaminations heads are principal tasks for development of the equipment.

5. TREATABILITY TESTS

5.1 DEVELOPMENT OF EXPERIMENTAL PLAN

5.1.1 Experiment Design

A key component of the A/O/D project plan is the execution of treatability tests. Bench-scale testing will help to determine (1) the effectiveness of the candidate treatment on surrogate and actual waste, (2) the operating parameters of the technologies, (3) the differences in performance between alternative technologies, (4) the relative cost of the technologies, and (5) the technologies which will require pilot-scale testing. Initial experiments will be designed to obtain information applicable to the largest volume of waste streams needing pretreatment. Statistical design principles will be used to ensure adequate testing to provide meaningful results. An experimental test plan will be prepared for each treatability test which will specify the test objective, the variables to be included, the conditions to be tested, the parameters to be measured, and the experimental procedure to be followed during the test. As more waste information becomes available through the waste characterization effort and initial experiments, additional treatability testing may be indicated.

Based on preliminary characterization information, treatability studies for the aqueous liquids will include experiments focusing on the neutralization of the wastes, the removal of dissolved heavy metals (primarily lead and mercury), the removal of radionuclides, and the removal of organics to levels sufficient to permit acceptance by existing treatment facilities. Examination of process trains may also be required because of the unique capabilities of existing treatment plants. Treatability tests will also monitor the production of secondary waste which may require additional treatment.

For organic liquid wastes, treatability studies will address the removal of metal fines, that in some cases, cause difficulties with treatment at the TSCA Incinerator. It may be presumed that experiments utilizing some type of graded filtration to remove particulates will be carried out since some work has already been done in the area for the removal of beryllium and uranium from mixed oil/solvents generated at the Oak Ridge Y-12 Plant. It is also anticipated that experiments concerning the removal of mercury prior to incineration, which is the best demonstrated available technology for liquid organic waste streams, will need to be conducted for some organic waste streams.

A final decision concerning the types of treatability and/or pilot scale decontamination studies will not be made until all currently known information about all waste streams is compiled. Various decontamination and decommissioning activities are being conducted at other ORR facilities; a concerted effort will be made to conduct studies that will add to knowledge gained from both previous and ongoing studies.

5.1.2 Facility Needs

Each experimental test plan will establish the requirements for implementation. These requirements will be used to identify facilities and equipment needed to support the project. Necessary equipment and supplies will be identified, purchased, and installed.

5.1.3 Material Management Plan

Most, if not all, of the waste materials described in this section of the experimental plan will be mixed wastes. Strict regulatory and internal requirements govern the handling of these types of materials. Considering the potential number of waste streams to be addressed, a material management plan will be prepared to ensure compliance with these requirements. This plan will be an adjunct to the experimental plans.

5.1.4 Project Quality Assurance Plan

To ensure regulatory acceptance, the test data must be obtained in accordance with applicable QA standards and guidelines. Consequently, a project QA plan will be developed to supplement the experimental plans. The project QA plan will be consistent with applicable requirements of the QA plan for the DDT&E Program, with NQA-1, and with the CERCLA Treatability Study Guidance Document, as well as conform to applicable RCRA and TSCA requirements.

5.1.5 Safety Summary

To ensure protection of personnel working with materials in the treatability tests, a safety summary will be prepared. This document, which will be a supplement to the experimental plan, will assess the hazard potential of the experiments and the administrative and physical protection of personnel from these hazards.

5.2 SELECTION OF TEST FACILITY/ORGANIZATION (MMES OR PRIVATE INDUSTRY)

5.2.1 Facility/Organization Requirements

Each experimental test plan will establish the requirements for implementation. These requirements will be used to identify vendors with the necessary capabilities for completion of the treatability tests. In this project plan, a vendor is defined as a testing facility or laboratory operated by MMES, by another DOE contractor, or by a private company. Requirements may include such issues as regulatory permits, QA plans, waste management plans, testing procedures, and training documentation. When private industry has been identified as the best source of technology services, the experimental plan will be used as the SOW and all MMES and DOE procurement policies will be followed during the contract development and award process.

5.2.2 List of Potential Vendors

A complete capabilities list of all potential vendors of technology services cannot be prepared until the specific testing requirements are determined during development of the experimental plans. Development of experimental plans will continue as more waste characterization information is obtained and development needs are identified. A summary of the capabilities of potential MMES and private-industry vendors will be prepared in order to facilitate the vendor selection process.

5.2.3 Selection of Vendors

Vendor screening for development testing will be performed using the vendor requirements and vendor capabilities lists outlined in the previous sections. As previously stated, all MMES and DOE procurement policies will be followed during the contract development and award process if private industry is chosen to provide the technology service.

5.3 REGULATORY COMPLIANCE

As previously stated, all development activities conducted under this plan will adhere to applicable DOE orders as well as to regulations issued by TDEC, EPA, DOT, and any other agency with oversight authority. All treatability studies conducted on hazardous wastes will be conducted in compliance with the treatability exclusion exemption under RCRA or under an approved R&D permit. Studies using wastes regulated under TSCA will be conducted under an approved TSCA R&D permit.

5.4 PERFORMANCE OF TREATABILITY TESTS

Once the testing plan and vendor selection process have been completed, the experimental test plan will be implemented. Quarterly progress reports will be required during the testing period. Deviations from the test plan must be approved in advance.

5.5 EVALUATION AND RECOMMENDATION OF FUTURE TESTING AND DEMONSTRATIONS

At the conclusion of the testing period, a final report will be prepared summarizing the treatability test results, conclusions, and recommendations for implementation or future testing.

6. PILOT-SCALE DEMONSTRATIONS

6.1 IDENTIFICATION OF PILOT DATA NEEDS

Due to the wide variety of aqueous and organic wastes found on the ORR and the great array of decontamination activities that must occur, pilot-scale demonstrations may be needed to demonstrate pretreatment processes. Additionally, sponsors other than the FFCA program may plan demonstrations. If possible, the data needs and goals of all sponsors will be integrated to facilitate the demonstrations in a timely and cost-effective manner.

6.2 DEVELOPMENT OF STATEMENT OF WORK/SCREENING VENDORS

A list of potential vendors to provide technology service will be developed through literature reviews and through consultation with the Procurement Division. Once the performance criteria goals for the pilot demonstration are developed, a SOW will be prepared. Vendors will be screened based on the comparison of requirements and capabilities, bid specifications, and other appropriate measures.

6.3 BID AND AWARD CYCLE

A contract or contracts will be put in place as part of the normal procurement process. The schedule and budget information for each demonstration will be included in the SOW. All MMES and DOE procurement policies will be followed during the contract development and award process.

6.4 IMPLEMENTATION OF DEMONSTRATION CONTRACT

Once awarded, the contract will be monitored during execution by MMES personnel.

6.5 EVALUATION OF DEMONSTRATIONS

After completion, the contract will be evaluated and recommendations made for further testing, if necessary.

7. SCHEDULE AND FINANCIAL PLAN

The schedule for the A/O/D project is provided in Fig. 3, Fig. 4, and Fig. 5 contain, respectively, estimated monthly spending totals and a spending curve for the various components of the project.

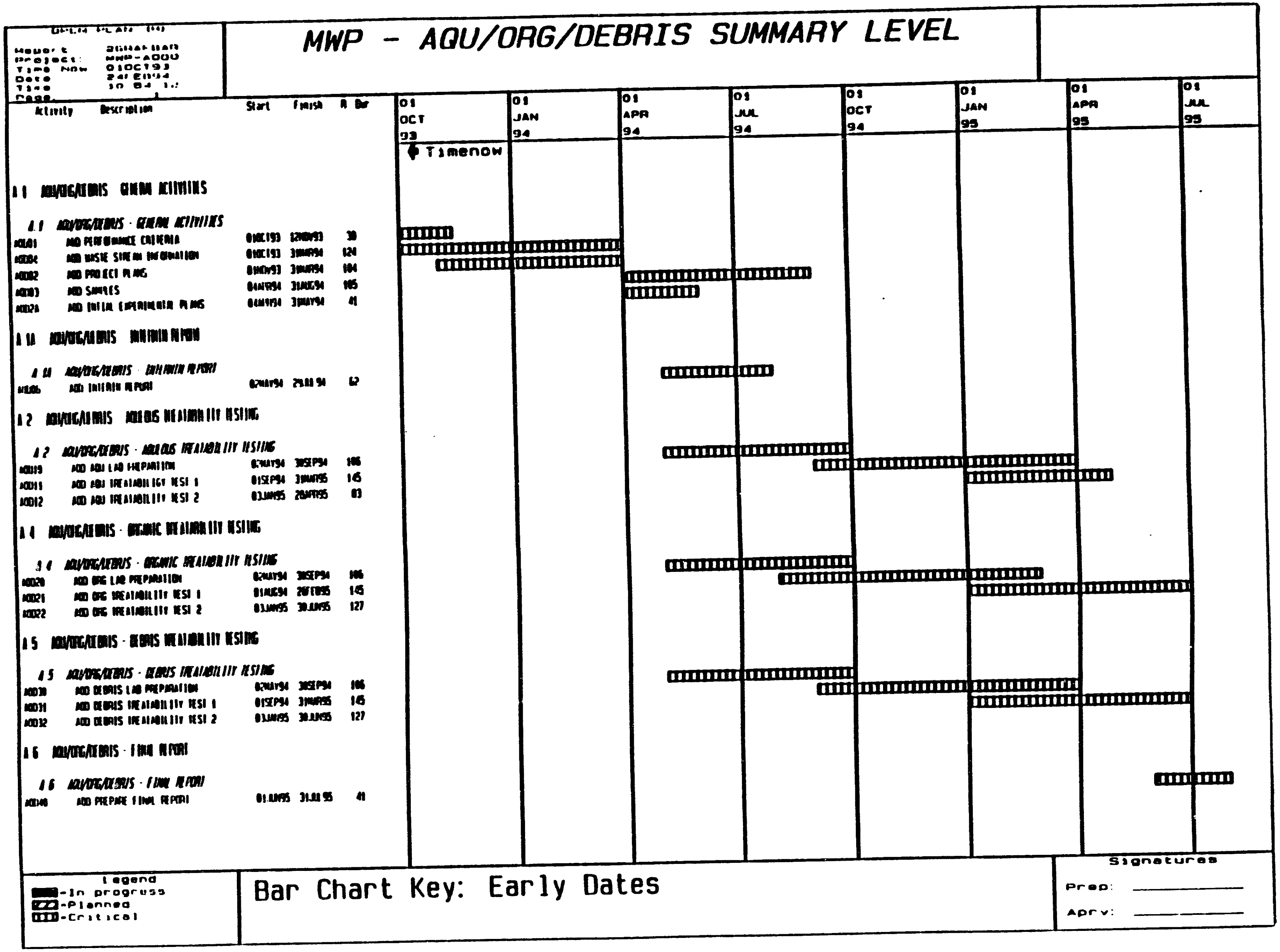


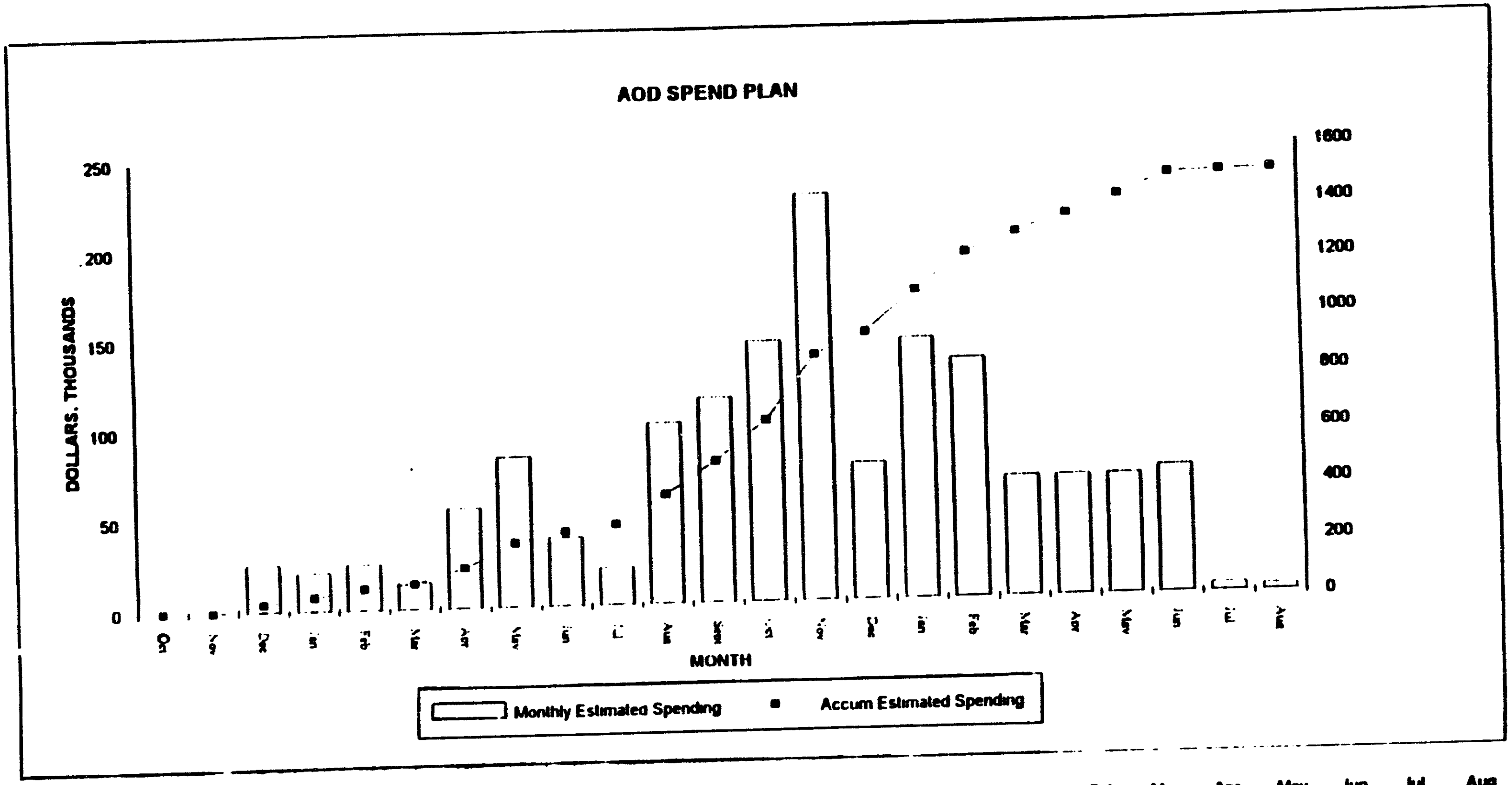
Fig. 3. Schedule for the project.

Federal Facilities Compliance Agreement
Aqueous/Organic/Debris

Spend Curve

	Oct 93	Nov 93	Dec 93	Jan 94	Feb 94	Mar 94	Apr 94	May 94	Jun 94	Jul 94	Aug 94	Sept 94	Oct 94	Nov 94	Dec 94	Jan 95	Feb 95	Mar 95	Apr 95	May 95	Jun 95	Jul 95	Aug 95	Total All
Performance Criteria			5																					5
Project Plans			10.8	7.77	2.23	1.2																		22
Samples							4	8			4													16
Waste Stream Information				10	20	10																		40
AQU Experiemental Plans							16	12			16													44
ORG Experimental Plans							16	12			16													44
Debris Experimental Plans							16	12			16													44
AOD Interim Report									7.5	7.5														15
AQU Lab Preparation								12	9		25	20												66
AQU Treatabiliby Testing 1												10	24	24	24	24	22							128
AQU Treatabiligy Testing 2																23	21	21	21	21	21			128
ORG Lab Preparation								12	9	10	20	30	30											111
ORG Treatability Testing 1												10	24	24	24	24	22							128
ORG Treatability Testing 2																23	21	21	21	21	21			128
Debris Lab Preparation								12	9		0	30	39	151										241
Debris Treatability Testing 1												10	24	24	24	24	22							128
Debris Treatability Testting 2																23	21	21	21	21	21			128
AOD Final Report																						4	1	5
Program Management	0	0	10.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	80.5
Total	0	0	26.3	21.3	25.7	15	56	83.5	38	21	101	114	144.5	226.5	75.5	144.5	132.5	66.5	66.5	66.5	70.5	4.5	3.5	
Acc Total	0	0	26.3	47.5	73.3	88	144	227	265	286	387	500	644.5	871	946.5	1091	1224	1290	1357	1423	1494	1498	1502	1502

Fig. 4. Project spending plan.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Monthly Estimated Spending	0	0	26.3	21.3	25.7	14.7	55.5	83.5	38	21	100.5	113.5	144.5	226.5	75.5	144.5	132.5	66.5	66.5	66.5	70.5	4.5	3.5
Accum Estimated Spending	0	0	26.3	47.5	73.3	88	144	227	265	286	386.5	500	644.5	871	946.5	1091	1224	1290	1356.5	1423	1494	1498	1501.5

Fig. 5. Spending curve for the project.

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APPENDIX A—ANALYSES FOR AQUEOUS WASTE

The treatment strategy for aqueous mixed waste is to pretreat the waste to allow treatment in either on-site or commercially available aqueous treatment facilities. The majority of the aqueous mixed waste has been classified as characteristic for corrosivity, chromium, lead, and mercury. However, many more of the characteristic and listed codes have been identified in individual records. Pretreatment may require removing priority pollutants or other contaminants that would violate the final treatment facility's National Pollutant Discharge Elimination System (NPDES) permit in addition to RCRA hazardous or radioactive constituents. The following list is based on standard methods for analyzing wastewater, EPA methods for RCRA wastes, and EPA NPDES permit methods.

Physical and Aggregate Properties

Acidity (quantitative capacity to react with a strong base to a designated pH)
Alkalinity (acid-neutralizing capacity)
Conductivity
Solids (total dissolved solids, total suspended solids, settleable solids)
Density
Corrosivity

Metals Analysis

Dissolved metals
Suspended metals
Total metals
Acid-extractable metals

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Cesium
Chromium (total)
Chromium (hexavalent)
Cobalt
Copper
Iron
Lead
Magnesium
Mercury
Nickel
Selenium (volatile and nonvolatile)
Silver
Sodium
Strontium
Thallium
Thorium
Uranium
Zinc

Inorganic Nonmetallic Constituents

Boron
Cyanide
Chlorine (residual)
Chloride
pH value (H^+)
Nitrogen (ammonia)
Nitrogen (nitrite)
Nitrogen (nitrate)
Nitrogen (organic)
Phosphate
Sulfate

Organic Constituents

Chemical oxygen demand (COD)
Total organic carbon (TOC)
Total toxic organics (TTO)
Dissolved organic halogen (DOX)
Oil and grease
Volatile organics
Volatile aromatic organics
Volatile halocarbons
Extractable base/neutrals and acids (semivolatile compounds)
Phenols
Polychlorinated biphenyls (PCBs)

May be needed:
Specific compounds such as listed RCRA wastes or NPDES priority pollutants

Radioactivity

Gross alpha and gross beta radioactivity (total, suspended, and dissolved)
Co-60
Cs-137
Eu-142
Eu-154
Eu-155
Ru-106
Total radioactive strontium and strontium-90
Uranium
ZrNb-95

APPENDIX B—ANALYSES FOR ORGANIC WASTE

The treatment strategy for organic mixed waste is to pretreat the waste to allow treatment in either the TSCA incinerator or commercially available treatment facilities. Metal fines create treatment difficulty at the TSCA Incinerator due to particulate problems. Presently, the incinerator cannot accept wastes that contain cesium and strontium; this regulation is under examination for change. Most of the remaining organic mixed wastes are F-listed solvents and are also characteristically ignitable. Pretreatment may require removing metal fines and other problematic contaminants. The following list of analytical requirements is based on the TSCA Incinerator waste acceptance criteria.

Physical Parameters

Specific gravity
Flash point (°F)
Number of phases
Heating value (Btu/lb)
Ash content (wt %)
Viscosity
Corrosivity
pH
Solids (TDS, TSS)

Metals Analysis

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Copper
Iron
Lead
Lithium
Magnesium
Manganese
Mercury
Nickel
Silver
Selenium
Sodium
Thallium
Titanium
Zinc

Radioactivity

Total uranium
Uranium-235
Pu-239

Nonmetal Chemical Parameters

Total chloride
Total sulfur
Total fluoride
Phosphorus
Water content
Polychlorinated biphenyls (PCBs)

APPENDIX C—INFORMATION NEEDED TO DEVELOP DECONTAMINATION PLAN

Consideration should be given to the following items prior to making any decision regarding a choice of an optimum decontamination process:

1. objectives of the decontamination,
2. surface to be decontaminated,
3. radioisotopes and location of radioisotopes within the corrosion film,
4. chemical form if known,
5. volume and composition of radwaste expected,
6. facility operation considerations, and
7. compatibility of decontamination technique with component material and geometry.

APPENDIX D—WASTE ACCEPTANCE CRITERIA FOR EXISTING TREATMENT PLANTS

The waste acceptance criteria for existing treatment plants at the three Oak Ridge sites are provided in Tables D.1 through D.5.

Table D.1. Waste acceptance criteria for the ORNL Process Waste Treatment Plant

Contaminant	Concentration
Radionuclides:	
Gross alpha	175 Bq/L
Gross beta	10,000 Bq/L
Sr-90	10,000 Bq/L
Cs-137	400 Bq/L
Co-60	185 Bq/L
Eu-152	740 Bq/L
Eu-154	740 Bq/L
Eu-155	3,700 Bq/L
Ru-106	222 Bq/L
ZrNb-95	1,480 Bq/L
Metals:	
Ag	0.4 mg/L
As	40.0 mg/L
B	40.0 mg/L
Ba	120.0 mg/L
Be	0.2 mg/L
Cd	0.3 mg/L
Cr	7.5 mg/L
Cu	2.5 mg/L
Fe	500.0 mg/L
Hg	0.004 mg/L
Ni	65.0 mg/L
Pb	30.0 mg/L
Sb	65.0 mg/L
Se	15.0 mg/L
Zn	60.0 mg/L
Others:	
Chlorine (Cl)	20.0 ppm
Cyanide (CN)	0.2 ppm
Nitrate (NO_3)	10.0 ppm
Oil and grease	100.0 ppm
pH	>6.0
Phosphate(PO_4)	5.0 ppm
Sulfate (SO_4)	3000.0 ppm
Total organic carbon (TOC)	50.0 ppm
Total suspended solids (TTS)	1000.0 ppm
Total toxic organics (TTO)	100.0 ppm

Table D.2. Waste acceptance criteria for the ORNL Nonradiological Wastewater Treatment Plant

Contaminant	Concentration
Silver (Ag)	0.007 mg/L
Arsenic (As)	35.0 mg/L
Boron (B)	35.0 mg/L
Barium (Ba)	100.0 mg/L
Beryllium (Be)	0.16 mg/L
Cadmium (Cd)	0.01 mg/L
Chromium (Cr)	3.3 mg/L
Copper (Cu)	0.1 mg/L
Iron (Fe)	330.0 mg/L
Mercury (Hg)	0.004 mg/L
Nickel (Ni)	11.0 mg/L
Lead (Pb)	30.0 mg/L
Antimony (Sb)	60.0 mg/L
Selenium (Se)	15.0 mg/L
Zinc (Zn)	45.0 mg/L
Chlorine (Cl)	20.0 mg/L
Cyanide (CN)	0.2 mg/L
Nitrate (NO_3)	10.0 mg/L
Oil and grease	100.0 mg/L
Ph	>6.0
Sulfate (SO_4)	3000.0 mg/L
Total organic carbon (TOC)	50.0 mg/L
Total suspended solids (TSS)	1000.0 mg/L
Total toxic organics (TTO)	100.0 mg/L

Table D.3. Waste acceptance criteria for the Y-12 Central Pollution Control Facility

Contaminant	Concentration
Nitrate (NO_3)	200.0 mg/L
Cyanide (CN)	1.0 mg/L
PCB	1.0 mg/L
Mercury (Hg)	0.5 mg/L
Cadmium (Cd)	5.0 mg/L
Chromium (Cr)	10.0 mg/L
Copper (Cu)	10.0 mg/L
Lead (Pb)	10.0 mg/L
Nickel (Ni)	50.0 mg/L
Silver (Ag)	5.0 mg/L
Zinc (Zn)	50.0 mg/L
Phenol	100.0 mg/L
Total organic carbon (TOC)	2000.0 mg/L
U × U-235 (metal calc)	15.0 mg/L
Oil and grease	<1 in. of oil

Table D.4. Waste acceptance criteria for the Y-12 West End Treatment Facility

Contaminant	Concentration
PCB	0.1 mg/L
Cyanide (CN)	1.0 mg/L
Mercury (Hg)	0.5 mg/L
Cadmium (Cd)	5.0 mg/L
Chromium (Cr)	5.0 mg/
Nickel (Ni)	5.0 mg/L if pH >7.0
Metal calc. (<1.0%)	15.0 mg/L
Oil and grease	<1 in. of oil

Table D.5. Waste acceptance criteria for the K-25 Central Neutralization Facility

CONTAMINANT	CONCENTRATION
Cadmium	2.6 mg/L
Chromium	2.89 mg/L
Copper	20.7 mg/L
Lead	14.2 mg/L
Nickel	17.0 mg/L
Silver	1.2 mg/L
Zinc	9.25 mg/L
Cyanides	0.65 mg/L (pH = 7.0)
Total toxic organics (TTO)	2.13 mg/L
Oil and grease	6.0 mg/L
Total suspended solids (TSS)	270.0 mg/L
PCB	0.014 μg/L(detection)
Uranium	160 mg/L
^{234}U	500 pCi/L[a]
^{235}U	600 pCi/L[a]
^{236}U	500 pCi/L[a]
^{238}U	600 pCi/L[a]
^{99}Tc	100,000[a]
^{3}H	2,000,000[a]
^{36}Cl	50,000[a]
^{125}I	4,000 pCi/L[a]
^{32}P	20,000[a]
^{35}S	200,000[a]
^{45}Ca	50,000[a]
^{51}Cr	1,000,000[a]
^{57}Co	100,000[a]
^{65}Zn	9,000[a]
^{131}I	3,000[a]
^{237}Np	30[a]
^{238}Pu	40[a]
^{239}Pu	30[a]
^{228}Th	400[a]
^{230}Th	300[a]
^{232}Th	50[a]
^{137}Cs	3,000[a]

Acceptance of radionuclides will be based upon these values, which represent 100 % of the derived concentration guide (100-mrem/year exposure listed in DOE Order 5400.5).

APPENDIX E—CRITERIA FOR THE K-25 TSCA INCINERATOR

When incineration is determined to be the preferred waste treatment, pretreatment schemes are designed to meet the waste acceptance criteria of the TSCA Incinerator at the Oak Ridge K-25 Site, as shown in Table E.1.

Table E.1. Waste acceptance criteria for the TSCA Incinerator

Contaminant	Concentration	
	Drummed	Bulk
Aluminum	20,000 mg/L	11,000 mg/L
Beryllium	10 mg/L	10 mg/L
Cadmium	1,500 mg/L	500 mg/L
Lead	6,000 mg/L	3,300 mg/L
Mercury	2,500 mg/L	2,000 mg/L
Zinc	65,000 mg/L	65,000 mg/L
Corrosivity	< 6.35 mm/year for SS	
	or pH >6	or pH 8-10
Boiling point	>100°F (negotiable)	
Viscosity	<5,000 cp at 100°F	
Suspended solids	<10% by wt	
Total chloride	<89% by wt	
Total fluoride	≤85% by wt	≤25% by wt
Sulfur	≤6% by wt	≤3% by wt
Plutonium-239	246 Ci/g or 4 ppb	
Uranium-235	≤1% by wt or if ≥1%, then total radioactivity must be ≤5 ppm	
Total radioactivity	<0.08 Ci/shipment if ^{235}U <1% by wt or <5 ppm/shipment if ^{235}U >1% by wt	

Prohibitions:

1. dioxins: F020-F023, F026-F028;
2. cyanides: F007-F011;
3. explosives which detonate on heating or percussion, ignite spontaneously in air or meet the definition of reactive waste;
4. waste which does not retain its form upon opening the storage container.

APPENDIX F—DECONTAMINATION RELEASE VALUES

The general release values for most isotopes are as follows:

ORNL radiological release limits:

<1000 dpm $\beta\gamma$ direct (probe)
<300 dpm α Direct (probe)
<200 dpm/100 cm^2 $\beta\gamma$ transferable (smear)
<20 dpm/100 cm^2 α transferable (smear)

From the Energy Systems Radiological Control Manual:

Nuclide (See Note 1)	Removable (dpm/100 cm^2) (See Note 2)	Total (fixed + removable) (dpm/100 cm^2) (See Note 3)
U-natural, U-235, U-238 and associated decay products	1,000 alpha	5,000 alpha
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90	1,000 beta-gamma	5,000 beta-gamma
Tritium organic compounds, surfaces contaminated by HT, HTO and metal tritide aerosols	10,000	10,000

Notes:

1. The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of, the contaminated item. Where contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for the alpha and beta-gamma-emitting nuclides apply independently.

2. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of know efficiency. For objects with a surface area less than 100 cm^2, the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

3. The levels may be averaged over 1 m^2 provided the maximum activity in any area of 100 cm^2 is less than three times the values in the table.

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