Y-12 Decontamination a
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Prepared f
Office of Environme
U.S. Departmen

September

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Oak Ridge K-
Oak Ridge, Tenne
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MARTIN MARIETTA ENER
for the
U.S. DEPARTMENT
under contract DE-AC

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DISCLAIMER

Acknowle

John M. Googin, a member of the Senior Advisory Group, was a
death this year. We feel it appropriate to express our appreciation of him
failed to enliven the discussions and guide our thinking.

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ɿnificant contributor to this Technology Logic Diagram project before his
ıd our sense of loss. His insightful comments at project meetings never

ɘ DOE Overview Team for the Technology Logic Diagram Review and
tchins, William Schutte, and Randall Snipes.

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Forew

The *Y-12 Plant Decontamination and Decommissioning Technology Logic Diagra* decontamination and decommissioning (D&D) problems at Bldg. 9201-4 to potential tech *Roadmap for the Oak Ridge Reservation,* the *Oak Ridge K-25 Site Technology Logic* Hanford logic diagram.

This TLD identifies the research, development, demonstration, testing, and eva transfer and application to D&D and waste management (WM) activities. It is essential th studies will begin by selecting the most promising technologies identified in the TLD and between cost and risk.

The TLD consists of three fundamentally separate volumes: Vol. 1 (*Technology* *Sheets*). Volume 1 presents an overview of the TLD, an explanation of the program-s technologies. Volume 2 contains the logic linkages among environmental management solve these problems. Volume 3 contains the TLD data sheets.

Volume 2 has been divided into five sections: "Characterization," "Decontamin contains logical breakdowns of the Y-12 D&D problems by subject area and identifies tec

The technology evaluations contained in these volumes are based on the best solicited to improve the TLD data base. Please send comments to R. L. Fellows, Editor, *9201-4,* Martin Marietta Energy Systems, Inc., P.O. Box 2003, Oak Ridge, TN 37831-727

ord

for Building 9201-4 (TLD) was developed to provide a decision-support tool that relates logies that can remediate these problems. The TLD uses information from the *Strategic agram,* the *Oak Ridge National Laboratory Technology Logic Diagram,* and a previous

ation needed for sufficient development of these technologies to allow for technology follow-on engineering studies be conducted to build on the output of this project. These finding an optimum mix of technologies that will provide a socially acceptable balance

valuation), Vol. 2 (*Technology Logic Diagram*), and Vol. 3 (*Technology Evaluation Data* cific responsibilities, a review of identified technologies, and the rankings of remedial oals, environmental problems, and the various technologies that have the potential to

on," "Dismantlement," "Robotics/Automation," and "Waste Management." Each section ologies that can be reasonably applied to each D&D challenge.

ormation available during compilation of the TLD. New or more accurate information is *12 Plant Decontamination and Decommissioning Technology Logic Diagram for Building* FAX 615-576-8558.

Explanation and Understanding Key

Column headings in this diagram are paragraph headings in the data shee

EM Goals
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship

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EM Problems
• Facility Decontamination and Decommissioning (D&D) • Remedial Action (RA)—Soils, Groundwater and Surface Water • Waste Management (WM)

Y-12 Problems	Problem Areas/Constituents	Reference Requirements	Subelements
Describes the problem areas identified that are the responsibility of the Y-12 EM organizations (D&D, RA, and WM). These problems may be at sites other than Y-12, including the Oak Ridge Reservation. These descriptions come from the current "official" lists generated in each of these areas.	Addresses a subelement-specific list of problems, all of which are traceable directly to Y-12 problems. For example, the diagram for decontamination defines the problems/constituents in terms of (hazardous) contaminants and the substrate on which the contaminants reside. In contrast, the dismantlement diagram defines the problems/constituents in terms of substrate (massive concrete, structural steel, metal equipment, etc). In both examples, the problem/constituent is the dominating technical factor in selection of technologies to remediate the problems.	Refers to the applicable Regulatory Compliance Chapter in Vol. 1. Requirements can only be determined after consideration of detailed site-, waste-, and technology-specific characteristics. Any pertinent milestones associated with remediation of the problem are listed. **Disposition** indicates the (proposed) disposition or end state of the Y-12 facility or land that is, or contains, the problem.	Specifies the different components that must be addressed to solve the EM problem. For example, D&D activities are associated with characterization, decontamination, dismantlement, disassembly, materials disposition, robotics/automation, and regulatory compliance. The comparable subelements for RA are characterization, containment/isolation, treatment, retrieval, materials disposition, robotics/automation, and regulatory compliance.

for the Technology Logic Diagram

(Vol. 3) and are described in the "Technical Approach" section of Vol. 1.

Alternatives

ides the general or generic nology approaches to lem remediation.

Technologies

Provides a specific technology that may reasonably be applied to remediate the problem. **Technology Evaluation Data Sheet (TEDS) Codes**, located after the technology names in this column, refer to TEDSs in Vol. 3. The TEDSs address each technology in more detail. Each TEDS contains a single, unique logic path from the Diagrams.

Rankings appear after the TEDS code for each technology. The technologies are ranked according to the following criteria:

- Overall assessment of usefulness (E—essential, H—high, M—medium, L—low)
- Ranking of the site problem (1–5 from lowest significance to highest)
- Time required to bring the technology to commercial or mature state at the site—expressed in years.
- Cost for bringing the technology from its present state to large-scale commercial use (millions [$M] or thousands [$K] of dollars).
- Projected unit processing cost for mature technology ($ per ft^2 or other unit or N for no estimate).

An example of a ranking follows: H-5-5 ($3.5M;N). This technology has a high overall usefulness; the problem is of highest significance to the site; the technology is estimated to take 5 years before it is ready for application at the site; an approximate expenditure of $3.5 million will be required to bring the technology to this state of readiness; and the unit processing cost cannot be projected at the present time.

Status

Provides information on the status of the preceding technology.

- **In Use**—problem is in the process of being remediated with this technology.
- **Accepted**—accepted by industry and/or the problem owner. The demonstrated technology exists for use at the site.
- **Demonstration**—technology is available but is not demonstrated and/or accepted for the problem at the site.
- **Predemonstration**—technology is under laboratory-, bench-, or pilot-scale testing.
- **Evolving Technology**—technology status is at a conceptual or preconceptual stage.
- **Conceptual**—a scientific or knowledge basis for the technology exists.
- **Preconceptual**—only a partial scientific or knowledge basis of the technology exists.

The following areas further define the applicability of a technology to the problem:

- **Efficacy**—the effectiveness of the technology in remediating the problem. Normally, quantitative measures are given for the technology's performance in standard practice, such as decontamination, estimating the final dpm/cm^2 of surface contamination; dismantlement, the time to cut a 24-in. pipe; and characterization, the analysis time and lower detection limit.
- **Waste**—the potential output from the technology. This describes the nature and volume of both the waste and the potentially useful materials (recyclable) suitable for materials disposition evaluation.

Science/Technology Needs

Lists needs in Science and Technology where support should be applied to develop an "immature" technology to a field-deployable state.

Science needs are related to the fundamental understanding of the scientific phenomena that form the basis for the technology. These needs are typically for laboratory or bench-scale experiments, and, when possible, experiments addressing specific areas of uncertainty are suggested.

Technology development (TD) conversion of a scientifically understood phenomenon into an operating system (technology) that can be applied to, and can remediate an EM problem.

Technology improvement needs relate to improvements that make a current technology more economical to apply, safer, and more effective or efficient. The demonstration of a technology on a site-specific problem is classified as a technology improvement need.

If scientific needs are specified, it should be understood that the needs of scientific technology development or improvement are necessary to implement newly developed scientific understanding. Likewise, testing a TD opportunity implies that technology improvements are also likely to be needed.

Past and currently funded Technical Task Plans (TTP) were correlated with the technologies. If a match was found, "**TTP Match**" appears in this column.

Implementation Needs

Covers many of the areas of concern for technology transfer activities. Specialized needs for both development of a technology and deployment of a mature technology are identified.

These needs were evaluated in the areas of (1) resources (financial or personnel); (2)-hardware (process equipment, development equipment, and computers); (3)software (models, procedures, computer programs); (4) facilities (labs, shops, and buildings); and (5) education (training classes or degreed personnel). Only extraordinary needs are highlighted (i.e., those needs that would require long lead time or unusual procurements such as line items for facility construction).

Technology Integration identifies the technologies which can be integrated to produce a safer, better or cheaper remediation system.

The **cost** of applying the technology and the payback-cost potential has been estimated. There are many reasons for payback, such as reducing the waste volume compared to a reference process, the sale of useable products, and the reduction of labor compared to a reference technology.

Con

ents

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The Characterization section is grouped by large, genera the following "Problem Areas/Constituents" are then identifie and other metals, organics, physical, PCBs, and asbestos. O problem area/constituents are grouped by general method in are grouped according to these general methods: sampling measurements—field; detection/measurements—laboratory; methods.

erization

y inclusive "Y-12 Problems." Within these general problems,
: general, uranium and other radioactive elements, mercury
aracterization technologies that will remediate these
the "Alternative" column. All characterization technologies
esign; sample collection; sample preparation; detection/
data analysis/management; field methods; and laboratory

Characterization for Decontan

EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

ıation and Decommissioning

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
npling Design	M	Sequential Sampling Plans CHAR-252-OY *Ranking:** *M-5-.5 ($.1M;$.5Kam*)*	**Accepted** **TTP Match**	Experimental site data	Initial planning time
	L	Modeling of Heterogenous Materials Sampling CHAR-61-OY *Ranking:** *L-5-0 ($.3M;N)*	**Evolving technology** (conceptual) **TTP Match**	An experimental design. Models need to be established. A study needs to be performed.	**Development cost:** estimated at $300K
nple Collection	M	Ultrasonic Extraction CHAR-20-OY *Ranking:** *M-5-1 ($.2M;$400/sample)*	**Predemonstration** Technology not yet demonstrated. **TTP Match**	Testing needs to be performed to establish the enhancement of material retrieval from porous media using various solvents, acids, and bases.	**Hardware cost:** $2–5KDevelopment **Costs:** $200K. Inverse heads need to be designed for sampling from the floors and other horizontal (top-side) applications.
	H	Sampling and Mixing Methods CHAR-81-OY *Ranking:** *H-5-1 ($.2M;N)*	**Accepted** **TTP Match**	Need to optimize methods for collection of representative samples and to mix samples into a homogeneous state.	Requires statistical sampling design and proper laboratory blenders, mixers, and other equipment. **Development Costs:** $250K
	H	Membranes for Sample Collection and Concentration CHAR-55-OY *Ranking:** *H-3-1 ($300K;$50/sample)*	**Accepted** Membranes are predominantly permeable to selected components in mixtures allowing separation for accumulation or to facilitate analysis/detection. **TTP Match**	System development or adaptation for specific applications; validation.	Sample collection systems for Site-specific applications. **Development Costs:** $300K.
	H	Punch Cores CHAR-82-OY *Ranking:** *H-5-1 ($.3M;N)*	**Demonstration** Routine method for collecting contiguous core sample of solid objects.	None	Need to acquire and setup methods and equipment for coring Alpha-4 sample matrices.
	H	Metallographic Sectioning and Preparation CHAR-67-OY *Ranking:** *H-3-0 ($0M;<$500/sample)*	**Accepted** Routinely used for prearation of metallic, ceramic, and geological materials.	Procedure development for specific applications are needed; then protocols for standardized preparation should be developed.	None **Available at X-10, K-25.**
	L	Multi-angle Drilling for Depth Profiling of Contaminants CHAR-64-OY *Ranking:** *L-5-1 ($.2M;N)*	**Demonstration** Can utilize standard commercially available drilling equipment.	Model studies need to be performed.	**Development cost:** $200K **Available at K-25.**
	H	Solid Sorbent Sampling for Airborne Contaminants CHAR-254-OY *Ranking:** *H-5-1 ($125K;<M$50/sample)*	**Demonstration** Airborne target species and co-contaminants are collected by drawing air though tubes packed with one or more sorbent materials.	Reusable sorbent tube technology needs demonstration.	Depends on contaminants. **Development cost:** possible $250K

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

EM Problems
• Facility Decontamination and Decommissioning (D&D)
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erization

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Sample Collection	M	Sampling Interface System for Surface Contamination CHAR-271-OY *Ranking:** *M-5-3 ($.775M;N)*	**Conceptual** Would allow rapid identification of PCBs in walls, floors, insulation. **TTP Match**	Development of rapid heating interface and software for rapid contaminant identification by direct sampling ion trap mass spectrometry.	**Development cost:** $775K over 3 years.
	M	Flashlamp Heating to Release or Desorb Surface and Subsurface Contaminants CHAR-87-OY *Ranking:** *M-5-2 ($.5M;N)*	**Predemonstration**	Depth profiling and surface area sampled must be determined for each material. Means of sampling the plume must be developed for each analyte.	To be determined for specific applications. **Development cost:** estimated at $150K
Sample Preparation	H	Radioactive Sample Preparation CHAR-205-OY *Ranking:** *H-2-1 ($.1M;N)*	**Demonstration** Current work shows that methods can be adapted to meet these needs. **TTP Match**	Adaptation of EPA and other methods and development of new technologies for the safe and efficient preparation of radioactive samples for analysis.	**Development cost:** $500K each of 2 years; personnel and facilities are available. **Available at X-10.**
	L	Supercritical Fluid Extraction of Organics CHAR-208-OY *Ranking:** *L-3-1 ($.33M;$100/sample)*	**Predemonstration** Technology requires final development. **TTP Match**	Extraction conditions need to be optimized for the specific target analytes and matrices of Alpha-4.	**Hardware cost:** $30K **Development cost:** $300K. **Available at X-10.**
	H	Microwave Digestion CHAR-19-OY *Ranking:** *H-3-1 ($.2M;$100/sample)*	**Demonstration** **TTP Match**	This technology shows much promise in reducing the amount of waste produced in analyzing samples as well as increasing the quality of the data obtained.	Protocols are needed to optimize the digestion of environmental samples in preparation for subsequent analytical techniques. **Available at X-10.**
	L	High-Pressure Ashing for Sample Preparation CHAR-203-OY *Ranking:** *L-3-1 ($.1M;N)*	**Demonstration** Commercially available, but not mature.	High-pressure ashing (HPA) is useful for the dissolution of organics and other difficult to dissolve materials. Commercially available but lacks sufficient validation to meet quality assurance (QA) requirements. Some special sample types may be at the development stage.	Some equipment/personnel currently available to develop new procedures, but needs to be expanded to meet the increased work load. Estimated cost $60–120K/year for 2 years. **Available at X-10.**

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Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
etection/Measurement - eld Methods L	Fiber-Optic Chemical Sensors CHAR-25-OY *Ranking:** *L-3-1 ($1M;$10/sample)*	**Accepted** **Demonstration** Remote detection using a variety of methods including optical absorption, Raman scattering, and luminesce spectroscopy. The fiber optic is used to deliver or return light to or from the sample. This technology allows remote sensing in hazardous environments. **TTP Match**	A combination of waveguides and spectroscopic techniques are needed that have been matched not only for each other but also for specific monitoring scenarios.	Waveguides are needed that can withstand the harsh chemical environment that may be present in some of the sampling locations.
L	Portable Raman Spectrometer CHAR-84-OY *Ranking:** *L-5-2 ($1M;$10/sample)*	**Demonstration** Raman spectra provide finger print identification of chemical species. No direct contact with the sample is necessary. Often interfaced with fiber optics for remote sensing in inaccessible areas. Hg is not Raman active. **TTP Match**	Need portable equipment (laser,etc.) for in situ use. Develop methods that exploit surface enhancement and resonance excitation for vastly improved sensitivity.	Equipment available at ORNL. Not assembled yet for specific applications.
M	Portable Optical Absorption Spectroscopy (OAS) CHAR-27-OY *Ranking:** *M-3-1 ($.6M;$50/sample)*	**Accepted/Demonstration** Measures the transmission of UV, visible, and near IR to determine the concentration of chemical species in gases, liquids, or solids. OAS can be applied to the analysis of any species that absorbs electromagnetic radiation in the region of excitation (UV through IR). **TTP Match**	Mature, field-portable technology available in IR, UV.	It can be implemented for site-specific needs. **Available at Y-12, K-25, and X-10.**
M	Air Filtering for Particulates Collection CHAR-59-OY *Ranking:** *M-5-0 ($.25M;$500/sample)*	**Accepted** Encompasses several methods of monitoring particulate loading and characteristics during RA and D&D activities. Collected samples can be analyzed for may different species. **TTP Match**	This is a mature sampling technology with EPA protocols.	**Available at Y-12, K-25, and X-10.**
L	Infrared Spectroscopy (Wavelength Dispersion) CHAR-18-OY *Ranking:** *L-3-1 ($.5M;$100/sample)*	**Accepted** This method includes long path (LP-FTIR), diffuse reflectance (DRIFT), and attenuated total reflectance (ATR) for determination of compounds found in the air, water, or on surfaces. **TTP Match**	No units currently exist on site. Several vendors are marketing equipment. Software development would enhance site-specific applications.	Centralized mounting areas with robotically controlled unit; would allow multiple site areas to be monitored with one unit. **Available at Y-12, K-25, and X-10.**

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EM Goals	Y-12 Problem	Problem Areas:Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

EM Problems

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
etection/Measurement—ield Methods	L	Portable Luminescence Detection CHAR-92-OY *Ranking:** *L-3-1 ($.5M;$10/sample)*	**Predemonstration** The detection of organic and inorganic chemicals using fluorescence, phosphorescence, and chemiluminescence. **TTP Match**	The technology is mature, but may not provide absolute identification of compounds in complex mixtures.	Hardware is available at Y-12 Specific techniques need development and procedures written. **Available at Y-12, K-25, and X-10.**
	M	Electrochemical Methods CHAR-10-OY *Ranking:** *M-5-2 ($.5M;$100/sample)*	**Accepted** Oxidizable or reducible species, excited by a voltage or current function in an electrical circuit and yields quantitative and qualitative information about species of interest. Selective and sensitive sampling is possible in many situations. **TTP Match**	Instrumentation and lab tests to be performed on complex systems are needed.	**Hardware cost:** $50K–$250K **Development cost:** $250K.
etection/Measurement—aboratory Methods	H	Rapid Secondary Ion Mass Spectroscopy (SIMS) CHAR-3-OY *Ranking:** *H-5-0 ($0M;$50–400/sample)*	**Accepted** Ionized gas impinges on sample to exist secondary ions that are subsequently analyzed.	This is a mature technology. Model studies are needed to calibrate for depth-profiling studies.	**Available at Y-12, K-25, and X-10.**
	H	Ultraviolet/Visible (UV-VIS) Spectroscopy CHAR-9-OY *Ranking:** *H-3-0 ($.1M;$50–200/sample)*	**Accepted** Available on site. Used often, in routine lab analyses. **TTP Match**	Model studies and application design. **Available at Y-12, K-25, and X-10.**	**Hardware cost:** <$200K **Development cost:** <$100K.
	H	Electrochemical Methods CHAR-10-OY *Ranking:** *H-5-1 ($.25M;>$100/sample)*	**Accepted** Oxidizable or reducible species, excited by a voltage or current function in an electrical circuit and yields quantitative and qualitative information about species of interest. Selective and sensitive sampling is possible in many situations. **TTP Match**	Adaptation and protocols for model studies to be performed on complex systems are needed.	**Hardware cost:** $50K–$250K **Development cost:** $250K.
ata Analysis/Management	M	Data Access Services DISM-154-OY *Ranking:** *M-5-1 ($.5M;$200Kam)*	**Demonstration** The particular network and communications configurations needed to support restoration activities may not exist. Would have to set up and demonstrate their successful operation.	Some software will be available commercially, some will have to be developed locally.	Requirements and specifications for such services must be identified and documented to serve as a common reference so that data can be accessed using a single set of services regardless of the type of computer at each node on the network.

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Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

ization

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
ta alysis/Management	M	Geographic Information System for Y-12 DISM-181-OY *Ranking:** *M-5-1 ($1M; $200K)*	**Accepted** Most information, data, and computer system components for a basic geographic information system (GIS) for each DOE site already exists but must be integrated to meet the needs of the environmental restoration program.	Existing technology must be enhanced by adding a tagging mechanism to permit the system to be used for tracking activities and to link information in databases associated with a physical location to appropriate map and drawing displays on desktop computers.	A large initial effort may be required to scan and digitize diagrams and drawings for electronic storage and quick retrieval or transfer across networks.
	M	Computer-Based Training Systems DISM-191-OY *Ranking:** *M-5-1($.3M; $100K)*	**Demonstration** Application software is available that permits rapid development of courses using many media (visual, audio), including support for a variety of testing strategies.	Further development is needed in the area of authoring support.	A well-defined course development life cycle does not yet exist. Currently used software engineering development life cycle methods should work well.
	L	Fractals Used to Select Models for Material Transport in Porous Media CHAR-225-OY *Ranking:** *L-5-2 (N;N)*	**Evolving** One of the early application areas of the mathematical concepts of fractals and fractal geometry has been to flow in porous media.	Application of fractal concepts to physical systems is a new field. Models of Hg transport in porous media could be useful prior to Phase I & II activities.	**Development of software:** ~$400K
	M	Client/Server Architecture for Database Access DISM-157-OY *Ranking:** *M-5-1 ($.5M; $200Kam)*	**Demonstration** The effectiveness and appropriateness of a particular architecture design to meet the requirements of the restoration activities needs to be demonstrated.	This technology will benefit most from improvements in network technology (higher transmission speeds, improved transmission protocols, and data access services) needed to support it.	Effectiveness depends strongly on the definition, design, and implementation of the data dictionaries, data directories, and data models that are the essential foundation for use of this technology.
	L	Hypertext Information Systems DISM-158-OY *Ranking:** *L-5-1 ($.3M; $150Kam)*	**Demonstration** A range of products exists to support development of hypertext information systems having many capabilities such as mechanisms for linking related items, for starting execution and controlling other applications, and for navigating documents for faster access to information.	Authoring and design tools are needed.	Hypertext information systems must be designed with great care to avoid problems with maintenance (e.g., modifying or replacing blocks of text from which or to which many links have been made to selected text strings within the block).
	M	Spatial Sample and Data Analysis Plans CHAR-253-OY *Ranking:** *M-5-.5 ($.1M; $.5Kam)*	**Accepted** **TTP Match**	None	Personnel and computer time, access to survey data. **Available at X-10.**

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	General	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization
	Uranium	Proposed federal (SDWA) standard for natural uranium in drinking water is 20 ug/L, MCL (equivalent to 30pCi/L). Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Data Analysis/Management	H	Quality Control for Measurement Processes CHAR-250-OY *Ranking:** *H-5-.25 ($.05M;$.5Kam)*	**Accepted** **TTP Match**	Data from standards evaluations.	Access to quality standard measurements. **Available at X-10.**
	M	Analysis of Censored Data CHAR-249-OY *Ranking:** *M-5-.25 ($.05M; $0.5Kam)*	**Demonstration** Some work is available in the literature. The application likely will have to be expanded to meet current needs.	Computer work station with access to appropriate data bases.	Access to appropriate data bases, computer time, mathematical development time, and programming time. **Available at X-10.**
	M	3-D CAD Database of Buildings and Structures DISM-156-OY *Ranking:** *M-5-2 ($2M; $300Kam)*	**Accepted** The basic technology is in wide use. A variety of commercial products is available for use on systems ranging from desktop computers to large mainframes.	Integration of this technology with other supporting technologies to provide the high level of automation needed to ensure proper compliance with environmental legislation governing restoration activities.	Identification of all possible uses (e.g., "training" robots, visual "walkthroughs," tags for tracking activities) of this technology and development of database requirements to support them are very important foundations for effective use of this technology.
Field Methods	H	Proportional Counter for Alpha and Beta Activity CHAR-108-OY *Ranking:** *H-2-0 ($.1M;$100/sample)*	**Accepted**	This is a well-established technology. Probes for measuring vertical or overhead items are needed.	Normal
	M	Bubble Dosimeters for Neutron Flux CHAR-216-OY *Ranking:** *M-2-1 ($.2M;$15/sample)*	**Accepted** These dosimeters are an integral part of a field neutron dosimetry system for use where neutron sources and shielding are not well known. They are capable of measuring neutron dose equivalent in low-level fields and of providing simple spectral information.	The technique is well established in measuring neutron flux around personnel. It must be evaluated in potential confounding effects in less benign environments.	**Development cost:** ~$200K is needed to develop acoustic coupler for applications requiring real-time measurement of neutron dose rate and for development of a less expensive, automated bubble counter for reliable processing of passive detector results.
	H	Inorganic Crystal Gamma-Ray Scintillometers CHAR-263-OY *Ranking:** *H-2-0 ($0; $100/sample)*	In either single-channel or multichannel format, they are available commercially. The instrument consists of a NaI crystal, photomultiplier tube, portable battery-operated power supply, pulse height analyzer, and readout. **TTP Match**	Robotic technology needed for remote control applications.	The technology is commercially available. Specialized detector holders may need to be developed for particular applications.
	H	Long-Range Alpha Detector CHAR-65-OY *Ranking:** *H-2-1 ($.4M;$100/sample)*	**Demonstration** A screening device for alpha detection on surfaces or personnel. Measures ionized air drawn from container holding contaminated object; irrespective of shape con be sensitive to ~ 1dpm alpha.	Measurement probes and other devices must be developed for specific applications.	Field testing is needed. **Development cost:** ~$300K
	H	Organic Scintillation Detectors for Gamma Rays CHAR-326-OY *Ranking:** *H-2-0 (N;N)*	**Accepted** Useful for survey of radioactive materials but usually cannot be used to identify specifics. Commercially available.	None	Normal

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	Uranium	Proposed federal (SDWA) standard for natural uranium in drinking water is 20 ug/L, MCL (equivalent to 30pCi/L). OSHA air contaminant limits for uranium (as U) are 0.05 mg/m^3 (soluble compound) and 0.25 mg/m^3 (insoluble compounds) For surface contamination, the average for uranium should be <5000 dpm/100 cm^2, defined by DOE Order 5400.5. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

EM Problems

- Facility Decontamination and Decommissioning (D&D)
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- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
ld Methods	H	Solid-State Detector for Alpha, Beta CHAR-327-OY *Ranking:** *H-2-0 (N;N)*	**Accepted** Used for surface monitoring or can be adapted for airborne alpha/beta emitters. Commercially available.	None	Normal
	H	Alpha/Beta Detection with Organic Solid Scintillators CHAR-328-OY *Ranking:** *H-2-1 (N;N)*	**Accepted** A thin plastic scintillometer coupled to optically sensitive device. Components are commercially available.	Testing of response of red-emitting scintillators to alpha and beta radiation.	Normal
	H	Alpha/Beta Detection with Inorganic Scintillators CHAR-329-OY *Ranking:** *H-2-0 (N;N)*	**Accepted** Inorganic crystal (e.g., NaI, CsI, BGO) coupled to photomultipliers tube or other optically sensitive device. Commercially available.	Minimal. BGO may need investigation.	Normal
	M	Prompt Fission Neutron and Gamma Ray Detection CHAR-330-OY *Ranking:** *M-2-4 (<$1M;N)*	**Predemonstration** Detects fissile material. May probe through thick materials.	Extensive simulations may be required to determine efficacy of this technique. Calibration studies are needed.	Adequate shielding required, for personnel protection.
	H	Cd Zn Te Semiconductor Radiation Detector CHAR-336-OY *Ranking:** *H-2-3 (<$500K;N)*	**Predemonstration** Detects radioactive (gamma) material.Small sensing head can be threaded into hard to reach places.	None	Efficacy for uranium detection needs to be determined.
	H	Airborne Uranium Detection CHAR-337-OY *Ranking:** *H-2-0 ($0;<$10K/yr)*	**Accepted** a vacuum pump draws air through a filter with continuous monitoring for alpha activity. Commercially available.	None	None
boratory Methods	L	Fissile Material Locator/Profiler CHAR-212-OY *Ranking:** *L-2-1 (N;N)*	**Demonstration** 252 Cf Neutron/Gamma Noise Analysis Method. Determines the neutron multiplication constant without the need for calibration at or near the critical state.	Each new configuration needs to be studied to determine proper positioning of detectors to assure accurate measurements.	Has been used successfully at Y-12 and other DOE plants.
	M	Thermal Emission Mass Spectrometry CHAR-322-OY *Ranking:** *M-2-0 ($0M;$195/sample)*	**Accepted** Commercially available and in routine use at the Y-12 Plant for determining accurate isotopic composition of very small amounts of uranium. Commercially available.	None	**Hardware cost:** $250–625K Instrumentation is available at Y-12
	M	Proportional Counter for Alpha, Beta Activity CHAR-108-OY *Ranking:** *M-2-0 ($.1M;$100/sample)*	**Accepted**	This is a well-established technology. Probes for measuring vertical or overhead items are needed.	Normal

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	Uranium	Proposed federal (SDWA) standard for natural uranium in drinking water is 20 ug/L, MCL (equivalent to 30pCi/L). OSHA air contaminant limits for uranium (as U) are 0.05 mg/m^3 (soluble compound) and 0.25 mg/m^3 (insoluble compounds) For surface contamination, the average for uranium should be <5000 dpm/100 cm^2, defined by DOE Order 5400.5. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
aboratory Methods	H	Fluorescence Spectrometry CHAR-323-OY *Ranking:* *H-2-0 ($0M;$150/sample)*	**Accepted** Commercially available and in routine use in the Y-12 Plant. Uses an ultraviolet source to stimulate the emission of a wavelength specific for uranium. Highly sensitive; useful for submicrogram detection of uranium.	None	**Hardware cost:** $20K Instrumentation is available at Y-12.
	H	Solid-State Detector for Alpha, Beta CHAR-327-OY *Ranking:** *H-2-0 (N;N)*	**Accepted** Commercially available and in routine use at the Y-12 Plant. The technique uses semiconductory detectors to obtain high-resolution energy spectra of alpha particles. Picogram sensitivity for uranium and transuranics.	None	**Hardware cost:** $50K Instrumentation is available at Y-12.
	H	Neutron-Induced Radioactivity of Fissile Materials CHAR-331-OY *Ranking:* *H-2-4 (<$1M;N)*	**Predemonstration** Neutron irradiation of a sample containing fissile material produces gamma rays that are identified by a Ge detector. Can be very sensitive to trace amounts of fission product and U-239.	Sensitivity needs to be determined. Calibration is not straightforward.	Adequate shielding is required to protect personnel from neutron source. **Capital cost:** >$100K for assembled instrument.
	M	Neutron-Induced Prompt Gamma Ray Detection of Uranium CHAR-333-OY *Ranking:* *M-2-2 (<$500K.N)*	**Predemonstration** The gamma rays following the capture or scattering of neutrons by uranium are detected. No commercial device is known at this time.	Simulations would probably be required to determine the efficacy of this technique. Instrument could be assembled from purchased components.	Adequate neutron/gamma shielding required.
	M	Photon Electron Rejecting Alpha Liquid Scintillation (PERALS) CHAR-97-OY *Ranking:* *M-2-0 ($0;$50/sample)*	**Accepted** Commercially available. Has the lowest detection limit (1 pCi/g) of rapid radiological techniques. Ideal for uranium.	Scintillation cocktails that are not toxic under RCRA need to be developed for use in PERALS.	A PERALS laboratory is already set up at the Y-12 Plant and the ORNL DESAR facility. It can be adapted for rapid on-line monitoring of both airborne and loose contamination.
	M	Neutron Activation Induced Gamma Analysis CHAR-266-OY *Ranking:** *M-2-1 ($.2M;$300/sample)*	**Accepted** **Mature technology.** **TTP Match**	Startup studies to be done to evaluate possible interferences.	Instrumentation and personnel currently exist but need to be expanded to meet the expected work load. Estimated cost of upgrade and expansion $250K. **Available at X-10 and Y-12.**
	H	Gamma-Ray Spectrometry CHAR-268-OY *Ranking:** *H-2-0 ($.1M;$100/sample)*	**Accepted** **Mature technology.** **TTP Match**	None	Some equipment/personnel currently available but need to be expanded to meet the expected increase in work load. Detector costs range from $10K to $50K. **Available at X-10.**
	H	Sodium Iodide-Germanium Gamma Spectroscopy CHAR-106-OY *Ranking:** *H-2-0 ($0M;N)*	**Accepted** **TTP Match**	Correction factor methodology needs to be published.	None

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EM Problems
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• Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Mercury and other metals	The Federal (SDWA) standard for mercury in drinking water is 2 ug/L. For mercury in air, the personnel exposure limits are 0.025 mg/m^3 TWA (Y-12 Ind. Hg.) and 0.05 mg/m^3 (OSHA and ACGIH) For EPA exemption from regulation, the limit at the plant property line is <50 pg/m^3. Maximum acceptable surface contamination Hg: 100 ug/100 cm^2 (Y-12 Ind. Hg.). Waste disposal limits: 12 mg/kg at Y-12 sanitary landfill, 4 mg/kg at Envirocare. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Field Methods M	Atomic Emission Spectroscopy CHAR-76-OY *Ranking:** *M-5-1 ($.2M;N)*	**Accepted** Common excitation source is an electrical discharge. Element-specific light is detected, either on film or photo detector tubes. Semiquantitative but is an excellent screening analysis. **TTP Match**	The technology is well-developed and applicable as is.	**Available at the Y-12 Plant.**
H	Modeling Migration of Mobile Mercury CHAR-53-OY *Ranking:** *H-5-2 ($500K;N)*	**Demonstration** Modeling for surface contamination measurements.	Models need to be developed that are applicable to site-specific scenarios.	Software and hardware are needed to implement the modeling systems.
H	Body/Biological Monitoring for Mercury CHAR-52-OY *Ranking:** *H-5-N (N;N)*	**Preconceptual** Method to detect and measure body contamination with mercury is available (but low capacity, no indication of saturaton).	The specific technology to be used for field monitoring is unknown.	Model studies are needed, to correlate exposure and quantitative analysis.
H	X-Ray Fluorescence for In Situ Monitoring of Toxic Heavy Metals CHAR-6-OY *Ranking:** *H-5-1 ($.2M;$25/sample)*	**Accepted** Can be useful for in situ monitoring of toxic heavy metals in paints, on surfaces, and in soils. Portable XRF units are commercially available and have been widely used for screening painted surfaces for lead contamination. **TTP Match**	Mature technology for manual applications. Excellent candidate for automated or robotic deployment systems.	Substrate effects need to be studied. The lower limit of detection for some metals on surfaces needs to be measured (~$200K).
L	Laser Ablation; Inductively Coupled Plasma; Atomic Emission Spectroscopy CHAR-111-OY *Ranking:** *L-5-3 ($1M;N)*	**Demonstration** Integration of these three technologies allows multiple element analysis. **TTP Match**	Improvement of the robotic process for site-specific conditions (e.g., floor, wall, ceiling) is needed.	Normal instrumentation development. **Development cost:** estimated at $1M.
E	Mercury Air Monitoring CHAR-302-OY *Ranking:* *E-5-1 (<$200K;N)*	Several instruments exist in the market for area and personal monitoring. Their reliability must be proven before using in a D&D situation.	None	None
M	Surface Acoustic Wave (SAW) Sensors CHAR-14-OY *Ranking:* *M-5-2 ($400K;<$20/sample)*	**Predemonstration** Adsorption of analyte on crystal surface alters speed, frequency, or phase of acoustic wave.	Optimization of higher temperature, small probe unit devices. Development of on-line monitoring.	Normal
H	Anodic Stripping Voltammetry CHAR-338-OY *Ranking:* *H-5-1 (<$300K;<$100/sample)*	**Demonstration** The instrument is being developed and tested at Y-12. Instrument is portable and automated. Analytical range is 3-2000 ppb ionic Hg.	Minimal. In general, the technology is ready to use.	Instrument needs to be field packaged.

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EM Problems
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Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Mercury and other metals	The Federal (SDWA) standard for mercury in drinking water is 2 ug/L. For mercury in air, the personnel exposure limits are 0.025 mg/m^3 TWA (Y-12 Ind. Hg.) and 0.05 mg/m^3 (OSHA and ACG ind. HG.) For EPA exemption from regulation, the limit at the plant property line is <50 pg/m^3. Maximum acceptable surface contamination Hg: 100 ug/100 cm^2 (Y-12 Ind. Hg.). Waste disposal limits: 12 mg/kg at Y-12 sanitary landfill, 4 mg/kg at Envirocare. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Field Methods	H	Gold Amalgam Resistance Detector CHAR-316-OY *Ranking:* *H-5-1 (<$200K;<$10/sample)*	**Accepted** Mercury vapor in air flowing past a thin gold wire deposits and forms a thin gold amalgam. The resistance of the gold wire, a function of the amount of amalgam present is monitored to quantify the amount of Hg present.	The reliability of the technolgy needs to be improved.	**Instrument cost:** <$5K **Operating cost:** <$20/sample **Available at Y-12.**
	M	Colorimetric Mercury Analysis CHAR-314-OY *Ranking:* *M-5-1 (<$200K;<$50/sample)*	**Accepted** Commercially available. An aqueous solution of mercury (II) forms a complex with and organic dye; monitoring and detection is by UV-visible spectrometry. Hg detection limit is in microgram (10^6pg) range. Simple and inexpensive.	None	None **Overall cost:** $80/test ($35/kit; 20-30 tests per person per day)
	M	Piezelectric Mercury Vapor Detector CHAR-313-OY *Ranking:* *M-5-2 (<$400K;N)*	**Predemonstration** The device contains a gold-coated piezoelectric crystal whose oscillations change with increase in absorbed Hg. Hg detection limit; 10^6 pg.	Identification of interferences. Optimizing sensitivity. Tests for methyl mercury detection.	**Development cost:** $250K **Capital cost:** <$10K **Operating cost:** <$5/sample
	H	Neutron Induced Prompt Gamma Ray Detection of Mercury and other Metals CHAR-333-OY *Ranking:* *H-5-3 (<$600K;N)*	**Predemonstration** Natural mercury emits a characteristic gamma ray on interaction with a neutron. The device is capable of probing concrete and steel structures to detect mercury hidden from view.	No commercial device exists, but instrument could be assembled from purchased components. Testing and verification would be required.	Adequate neutron/gamma shielding to protect personnel from neutron source. **Overall Cost:**>$100K for a complete instrument.
	H	Neutron Activation Analysis for Mercury CHAR-334-OY *Ranking:* *H-5-2 ($400K;N)*	**Accepted** Can perform trace analysis. May require sending samples to a reactor and performing analysis there. HFIR at ORNL has been used for this purpose.	None for detector. Depending on application, may need to develop portable accelerator-based neutron source.	Shielding to protect personnel from neutron source. **cost:** >$100K if portable local accelerator-based neutron source is to be developed.
	H	Portable Mercury Headspace Analyzer CHAR-308-OY *Ranking:** *H-5-1 (<$200K;<$100/sample)*	**Predemonstration** Uses a chemical pre-treatment followed by analysis of the headspace mercury vapor.	Reliability of the portable analyzer under heavy use needs confirmation.	Minimal implementation needs
Laboratory Methods	H	Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) CHAR-78-OY *Ranking:** *H-5-2 ($1M;$200/sample)*	**Demonstration** Available, but not fully developed. Suitable for routine use. Applicable for multi-element analysis of aqueous solutions more selective than ICP-AES Hg detection levels.	Development is in progress to use the technology for surface analysis using laser ablation techniques, and for low–specific activity, long-lived radionuclides.	It is now available at the Y-12 Plant. **Capital cost:** $250-350K **Development cost:** ~$400K. (to extend long-lived, low specific activity radionuclides.) **Available at Y-12.**
	H	Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) CHAR-77-OY *Ranking:** *H-5-0 ($.1M;$200/sample)*	**Accepted** In routine use for multielement analysis of methods; allows analysis in the ppb range. Hg detection level: 0.5 pg. Accepted by EPA. **TTP Match**	Applicable as is. Well-developed technology.	**Available at Y-12.**

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- Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Mercury and other metals	The federal (SDWA) standard for mercury in drinking water is 2 ug/L. For mercury in air, the personnel exposure limits are 0.025 mg/m^3 TWA (Y-12 Ind. Hg.) and 0.05 mg/m^3 (OSHA and ACGIH.) For EPA exemption from regulation, the limit at the plant property line is <50 pg/m^3. Maximum acceptable surface contamination Hg: 100 ug/100 cm^2 (Y-12 Ind. Hg.). Waste disposal limits: 12 mg/kg at Y-12 sanitary landfill, 4 mg/kg at Envirocare. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
aboratory Methods — M	Atomic Emission Spectroscopy (AE) CHAR-76-OY *Ranking:** *M-5-0 ($.1M;$200/sample)*	**Accepted** Semiquantitative, but an excellent screening analysis. **TTP Match**	The technology is well-developed and applicable as is.	**Available at the Y-12, K-25, and X-10.**
M	Ion Chromatography (IC) CHAR-50-OY *Ranking:** *M-5-0 ($.1M;$100/sample)*	**Accepted** Can separate and quantify ions in solution. Ppm to ppb detection limits. **TTP Match**	A detector system that is optimized for the expected waste streams that will be generated needs to be determined.	We have systems available for process control of D&D efforts. **Available at the Y-12, K-25, and X-10.**
M	Wavelength Dispersive X-Ray Spectroscopy (WDS, WDX) CHAR-36-OY *Ranking:** *M-5-0 ($0M;$100/sample)*	**Accepted** Delicate apparatus may limit field use. Used for quantitative and quantitative elemental analysis.	None	None **Available at the Y-12, K-25, and X-10.**
M	Energy Dispersive X-Ray Spectroscopy (EDS, EDX, EDAX) CHAR-35-OY *Ranking:** *M-5-0 ($0M;$100/sample)*	**Accepted** Useable in laboratory or field. Allows rapid elemental and quantitative analysis of solid samples. **TTP Match**	Mature technology.	None **Available at Y-12, K-25, and X-10.**
M	Transmission Electron Microscopy (TEM) CHAR-34-OY *Ranking:** *M-5-0 ($0M;$500/sample)*	**Accepted** For micro-analysis of solid samples. In conjunction with X-ray techniques, can give elemental analysis. **TTP Match**	Mature technology.	None **Available at Y-12, K-25, and X-10.**
L	Scanning Electron Microscopy (SEM) CHAR-33-OY *Ranking:** *L-5-0 ($0M;$500/sample)*	**Accepted** Spot and broad surface elemental analysis. **TTP Match**	Mature technology.	None **Available at Y-12, K-25, and X-10.**
H	Cold Vapor (Mercury) Analysis CHAR-24-OY *Ranking:** *H-5-0 ($0M;$100/sample)*	**Accepted** This technique is based on the atomic absorption spectroscopy of mercury and is very sensitive and highly selective.	This is a mature technology.	This is a mature technology which needs to be part of a mobile laboratory.
H	Neutron Activation/Induced Gamma Analysis CHAR-266-OY *Ranking:** *H-5-0 ($0M;$200/sample)*	**Accepted** Detection limit for Hg: 500 picograms. Mature technology. **TTP Match**	Mature technology. Startup studies to be done to evaluate possible interferences.	Estimated cost of upgrade and expansion $250K. **Available at X-10.**
L	Powder X-Ray Diffraction CHAR-31-OY *Ranking:** *L-5-0 ($0M;>$100/sample)*	**Accepted** Used for identification of crystalline phases in solid samples.	Mature technology.	None **Available at Y-12, K-25, and X-10.**
L	Electron Spectroscopy for Chemical Analysis (ESCA) CHAR-1-OY *Ranking:** *L-5-0 ($0M;$200–600/sample)*	**Accepted** Provides semiquantitative surface elemental analysis and some chemical information.	Model studies are needed to identify binding energies for standard compounds of U for suspected matrices.	Instrumentation and personnel currently exist. **Available at Y-12, K-25, and X-10.**

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Y-12 Problem	Problem Areas.Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Mercury and other metals	The federal (SDWA) standard for mercury in drinking water is 2 ug/L. For mercury in air, the personnel exposure limits are 0.025 mg/m^3 TWA (Y-12 Ind. Hg.) and 0.05 mg/m^3 (OSHA and ACGIH.) For EPA exemption from regulation, the limit at the plant property line is <50 pg/m^3. Maximum acceptable surface contamination Hg: 100 ug/100 cm^2 (Y-12 Ind. Hg.). Waste disposal limits: 12 mg/kg at Y-12 sanitary landfill, 4 mg/kg at Envirocare. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, regulatory requirements will be specified.	Characterization
	Organics (Oils, etc.)	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Laboratory Methods	H	Biological Monitoring for Mercury CHAR-52-OY *Ranking:** *H-5-0 (0;N)*	**Accepted** Standard lab methods in use by Industrial Hygiene.	None	None
	L	Auger Electron Spectroscopy (AES) CHAR-2-OY *Ranking:** *L-5-0 ($0M;$300–800/sample)*	**Accepted** Similar to ESCA, but mapping of sample surface is possible. **TTP Match**	Mature technology. Model studies are needed to probe the host/contaminant effects for accurate depth profiling.	**Available at Y-12, K-25, and X-10.**
	H	Analysis for Mercury in Water CHAR-303-OY *Ranking:** *H-5-0 (<$100K;<$50/sample)*	**Accepted** On-line electrometric monitors are commercially available. Optical methods are also available.	None. Mature technology.	Demonstration of electrode reliability and calibration scheme.
	L	GC/ECD for Measuring Organic Mercury CHAR-311-OY *Ranking:** *L-5-0 ($0;<$50/sample)*	**Accepted** Requires conversion of organic Hg to a gaseous halide form. Hg detection limit: 50 pg.	None	**Capitol cost:** GC/ECD devices: ~$15K **Available at Y-12, K-25, and X-10.**
	H	Photoacoustic Spectrometry (PAS) CHAR-312-OY *Ranking:* *H-5-1 (<$200K;<$100/sample)*	**Accepted** Potential to be the most sensitive for Hg in air. Hg. detection limit: ~10 pg.	None	**Development cost:** $200K Need confirmation of analytical quantitation over range of Hg concentrations.
Field Methods	L	Fluorescence Diagnosis of Contaminated Surfaces CHAR-110-OY *Ranking:** *L-3-2 ($1M;$10/sample)*	**Predemonstration** **TTP Match**	Needs separation/speciation laboratory and field tests.	The required equipment such as a laser (light source), optics, detectors, personal computers (for data acquisition), and interfaces must be purchased.
	H	Portable Gas Chromatography -Mass Spectrometry CHAR-339-OY *Ranking:* *H-3-2 ($500K;<$200/sample)*	**Conceptual** Commercial instrument is not available but portable gas chromatographs and transportable (ion trap) mass spectrometers are available.	Minimal. This is a technology integration issue.	Instrument needs to be field packaged.

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Organics (oils, etc.)	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
ield Methods — M	Portable Gas Chromatograph/Electron Capture Detection CHAR-100-OY *Ranking:** *M-3-0 ($.25M;$50/sample)*	**Accepted** **TTP Match**	Standard procedures need to be written.	We need to order GC/ECD devices (~$15K each). **Available at Y-12.**
M	Portable Volatile Organic Compound Detectors CHAR-5-OY *Ranking:** *M-3-0 ($.25M;$10/sample)*	**Accepted** A quick, and inexpensive method to screen for the contamination of soils based on flame ionization or photoionization of sampled air. Useful at a variety of sites including leaking underground tanks pits in spillage. **TTP Match**	Mature technology.	For quick screening and surveying, instruments are available commercially. Interfacing the instruments with an ion mobility mass spectrometer would allow detection of some individual compounds (~$30K). **Available at X-10, Y-12.**
M	Direct Sampling Ion Trap Mass Spectrometry (DSITMS) CHAR-90-OY *Ranking:** *M-3-2 ($.2M;$50/sample)*	**Predemonstration** Method development needed. **TTP Match**	Methods need to be developed for specific applications.	**Hardware cost:** $100K; Development, training, and implementation cost: $200K. **Available at X-10.**
M	Gas Chromatography in the Field CHAR-262-OY *Ranking:** *M-3-0 ($.25M;$50/sample)*	**Accepted** Using flame ionization, electron capture, thermal conductivity, photoionization, flame photometric, or thermionic detectors with gas chromatography can determine a variety of environmentally important analytes. **TTP Match**	Technology needs are minimal. While improvements can be made, in general, the technology is ready to use.	A variety of gas chromatography equipment exists already at Y-12 and may be useful for many needs. **Available at Y-12, K-25, and X-10.**
L	Synchronous Fluorescence Screening for Polycyclic Aromatic Hydrocarbons CHAR-101-OY *Ranking:** *L-3-1 ($.2M;<$50/sample)*	**Demonstration/ Predemonstration** When light of a specific wavelength is directed onto a sample, certain organic compounds (such as PAHs) absorb and re-emit that light (fluoresce) at a higher wavelength. In this technique, exciting and fluorescing wavelengths are scanned synchronously. Analytes can be differentiated because they absorb and fluoresce at different wavelengths. **TTP Match**	Technology needs to be validated in the EPA program.	**Hardware cost:** $25K Development **cost:** $200K. **Available at X-10.**
M	Absorption Spectroscopy CHAR-27-OY *Ranking:** *M-3-0 ($0; <$200/sample)*	**Accepted** Commercially available. Can be used in pretreatment, treatment and post-treatment applications: Is applicable to organic and inorganic contaminant analyses. **Efficacy:** fast response time, ppm to ppb level of detecton for selected compounds, and remote nondestructive field analysis proven. Mixtures may be an analysis challenge. **Waste:** none to minimal, solvent	Minimal technology needs.	It can be implemented for direct site/scenario needs. **Overall cost:** $10–$50/sample; Instrumentation, $1–$100K Mature, field-portable IR technology is available; UV technology is being developed at ORNL.

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	Organics (oils, etc.)	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Labor atory Methods	M	On-line Supercritical Fluid Extraction-Multidetector Gas Chromatography (SPE-GC) CHAR-115-OY *Ranking:** *M-3-1 ($.25M;$300/sample)*	**Predemonstration** Technology requires final development and demonstration. **TTP Match**	The technology requires optimization for the most efficient extraction and chromatography of both total petroleum hydrocarbons and PCBs in a single operation.	**Capital cost:** $60K **Development cost:** $250K
	M	Gas Chromatography-Fourier Transform Infrared Spectroscopy (GC-FTIR) CHAR-66-OY *Ranking:** *M-3-2 ($.5M;$400/sample)*	**Demonstration** Technology is available. It is a routine lab service that might be used on a non-routine basis.	Specific methods for targeted analytes and general methods for unknown identification need to be developed.	**Hardware cost:** $200K **Development cost:** $400K **Available at X-10.**
	H	Liquid Chromatography—Mass Spectroscopy (LC-MS) CHAR-89-OY *Ranking:** *H-3-1 ($.3M;$500/sample)*	**Demonstration** Not yet available on site for service work. **TTP Match**	Case-by-case development and demonstration for specific applications is needed.	**Hardware cost:** $200K **Development cost:** $300K **Available at X-10.**
	H	Gas Chromatography—Mass Spectroscopy (GC-MS) CHAR-88-OY *Ranking:** *H-3-0 ($0M;$200–800/sample)*	**Accepted** Available on site. **TTP Match**	Technology is applicable as is. Benefit would be derived from faster chromatography to shorten analysis time.	**Technology is available at Y-12, K-25, and X-10.**
	M	Synchronous Fluorescence Screening for Polycyclic Aromatic Hydrocarbons (PAHs) CHAR-101-OY *Ranking:** *M-3-1 ($.2M;$10/sample)*	**Demonstration** Technology available. When light of a specific wavelength is directed onto a sample, certain organic compounds (such as PAHs) absorb and re-emit that light (fluoresce) at a higher wavelength. In this technique, exciting and fluorescing wavelengths are scanned synchronously. Analytes can be differentiated because they absorb and fluoresce at different wavelengths. **TTP Match**	Technology needs to be validated in the EPA program.	**Hardware cost:** $25K **Development cost:** $200K **Available at X-10.**
	L	Gas Chromatography CHAR-94-OY *Ranking:** *L-3-0 ($0M;$300/sample)*	**Accepted** Technology available on site. Detection limit for organic forms of mercury is 50 pg. **TTP Match**	Technology needs are minimal. While improvements can be made, in general, the technology is ready to use.	A variety of gas chromatography equipment exists already at Y-12. **Available at Y-12, K-25, and X-10.**
	M	Laser Ablation Organic Mass Spectrometry CHAR-93-OY *Ranking:** *M-3-1 ($.3M;< $500/sample)*	**Predemonstration** Technology under development. **TTP Match**	Develop a sampling methodology (perhaps using a wipe of the surface), and test it on target compounds.	**Hardware cost:** $120K **Development cost:** $300K **Available at X-10.**
	M	Fourier Transform Infrared Spectroscopy (FT-IR) CHAR-8-OY *Ranking:** *M-3-1* *($.2M;$100–500/sample)*	**Accepted** Measures the absorbance spectrum of the material, in the infrared region, to identify and quantify it. **TTP Match**	Data base for rapid materials identification and model studies of materials interaction is needed.	**Hardware cost:** $25K–$500K **Development cost:** <$200K **Available at Y-12, K-25, and X-10.**

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EM Goals

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- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
All problems associated with Building 9201-4 (Alpha-4)	Organics (oils, etc.)	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization
	Physical		Characterization

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
aboratory Methods	L	Surface Enhanced Raman Scattering (SERS) CHAR-265-OY *Ranking:** *L-3-1 ($.15M;N)*	**Evolving** A combination of electrochemical and spectroscopic techniques. **TTP Match**	System development and validation for specific needs.	**Overall cost:** possibly $250K–$400K **Hardware cost:** $10K–$250K **Development cost:** ~$150K **Available at X-10.**
	M	Capillary Electrophoresis CHAR-207-OY *Ranking:* *M-3-1 ($.25M;$300/sample)*	**Demonstration** The technology is gaining wide-spread acceptance in biomedical applications and appears useful for RA/WM. **TTP Match**	Adaptation and validation for the specific target compounds and sample matrices at Y-12.	**Hardware cost:** $30-60K **Development cost:** $250K **Available at Y-12, K-25, and X-10.**
ield Methods	M	Fiber-Optic Systems for Measuring Multiple Physical Variables CHAR-248-OY *Ranking:** *M-5-3 ($1M;$.25/sample event)*	**Predemonstration** Proof of principle of this technology can be demonstrated in devices suitable for use in underground waste storage tanks. The technology may be useful for monitoring structural integrities. **TTP Match**	A range of applications can be developed using this technology.	This technology should lend itself well to economies of scale in the manufacture of rugged, replaceable devices that should require low (or no) maintenance. **Available at X-10.**
	M	Coating Assayers CHAR-309-OY *Ranking:* *M-5-1 (<$200K;N)*	**Preconceptual** Complete elemental analysis of wall and floor surface areas.	Technolog integration.	TBD
	H	Structural Sensors CHAR-306-OY *Ranking:** *H-5-1 ($0;$1M Project)*	**Conceptual** Real-time sensors for detecting stress/strain. These sensors would provide continuous "real-time" data to a centralized data handling annunciator system	None	**Development cost:** $1M, which includes $600k for testing implementation and completion. **Capitol cost:** <$50K
	H	3-D Wind Gauge CHAR-300-OY *Ranking:** *H-5-0 ($0;N)*	**Accepted** Commercially available.	None	None
	M	Noise Measurement Technology CHAR-304-OY *Ranking:** *M-5-0 ($0;N)*	**Accepted** Commercially available.	None	None
	H	Radiation Gauging CHAR-335-OY *Ranking:* *H-5-1 (<$100K;N)*	**Accepted** Transmission measurement of a structure is made with neutrons, gamma rays, or X-rays. Requires access to opposite sides of a sample.	None	Shielding is necessary, to protect personnel from radiation source. **Overall cost:** <$20K for gamma ray based device, <$50K for neutron based device.

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	Physical	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization
		PCBs	The Federal (SDWA) standard for PCBs in drinking water is 0.5 ug/L, MCL The OSHA standard for PCBs in air is 0.5 mg/m3. Clean landfill requirements for PCBs in soil are <1 ppm (EPA) and <2 ppm (Y-12 Sanitary Landfill), or higher with special approval. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Laboratory Methods	H	Particle Size Analysis CHAR-26-OY *Ranking:** *H-5-0 ($0M;$1000/sample)*	**Accepted**	None. Mature technology.	In situ devices need to be implemented for more aggressive IH-HP protection of personnel and to ensure the control of radioactive contamination. **Available at Y-12., K-25, and X-10.**
	H	Optical Microscopy CHAR-32-OY *Ranking:** *H-3-0 ($0M;$100–800/sample)*	**Accepted** Useable for wide variety of samples. Requires highly skilled operators.	A particle atlas of site-specific materials is needed to allow rapid identification.	A centralized image collection system is needed to establish a site-specific database. **Available at Y-12. K-25, and X-10.**
Field Methods	H	Portable Gas Chromatograph /Electron Capture Detection for Analyzing PCBs CHAR-100-OY *Ranking:** *H-3-0 ($0;<$50/sample)*	**Accepted** **TTP Match**	None	**Capitol cost:** GC/ECD devices (~$15K each). **Available at Y-12.**
	H	PCB Immunoassay Kit CHAR-99-OY *Ranking:** *H-3-0 ($0;<$100/sample)*	**Accepted** As a screening method for PCBs in situ.	None	The technology is ready to apply and should be used for routine analyses. **Available at X-10, K-25.**
	H	Direct Sampling Ion Trap Mass Spectrometry (DSITMS) CHAR-90-OY *Ranking:** *H-3-2 ($.2M;$50/sample)*	**Predemonstration** Method development needed. **TTP Match**	Methods need to be developed for specific applications.	**Hardware cost:** $100K Development, training, and implementation costs, $200K. **Available at X-10.**
	H	Sampling Interface System for Surface Contamination by Organics CHAR-271-OY *Ranking:** *H-3-3 $775K;N)*	**Conceptual** **TTP Match**	Development of rapid-heating interface and software for rapid contaminant identification by direct sampling ion trap mass spectrometry.	**Development cost:** $775K over 3 years.
	H	Chemical Reaction Screening for PCBs CHAR-341-OY *Ranking:* *H-3-0 ($0;$6/sample)*	**Demonstration** Kits were tested under EPA auspices in EPA region 7 in August 1992 and a final report will be issued in 1994.	Minimal. In general, the technology is ready to use.	NA
Laboratory Methods	H	Gas Chromatography CHAR-94-OY *Ranking:** *H-3-0 ($0M;$300/sample)*	**Accepted** Technology available on site. **TTP Match**	Technology needs are minimal. While improvements can be made, in general, the technology is ready to use.	A variety of gas chromatography equipment exists already at Y-12 and may be useful for many needs.
	L	On-line Supercritical Fluid Extraction—Multidetector Gas Chromatography (SFE-GC) CHAR-115-OY *Ranking:** *L-3-1 ($.25M;$300/sample)*	**Predemonstration** Possible use in decon of objects and materials, or as efficient sample extraction technique. **TTP Match**	None	**Capital cost:** $60K **Development cost:** $250K Technology requires final development and demonstration. **Hardware cost:** $5K **Development cost:** $100K

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	**All problems** associated with Building 9201-4 (Alpha-4)	Asbestos	The OSHA standard for asbestos in air is 0.2 fibers/cm3, TWA. Refer to the Regulatory Compliance chapter for other potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Characterization

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
boratory Methods	H	Optical Microscopy CHAR-32-OY *Ranking:* *H-3-0 ($0;$50/sample)*	**Accepted** Commercially available. EPA approval method.	None	**Operating cost:** $50/sample **Capital cost:** $100K+
	M	Powder X-Ray Diffraction CHAR-31-OY *Ranking:* *M-3-0 ($0;<$100/sample)*	**Accepted** Commercially available. Used for phase identification of crystalline phases in solid samples.	Model studies of the complex mixtures of interest are needed for quantitative analysis.	**Cost/Sample:** $100 **Capital cost:** $150K+ **Available at Y-12, K-25, and X-10.**
	M	Scanning Electron Microscopy (SEM) CHAR-33-OY *Ranking:* *M-3-0 ($0;$500/sample)*	**Accepted** Commercially available. Used for spot and broad surface elemental analysis.	None	**Cost/Sample:** $100K+/sample **Capital cost:** $75K+
	H	Transmission Electron Microscopy (TEM) CHAR-34-OY *Ranking:* *H-3-0 ($0;$500/sample)*	**Accepted** Commercially available. EPA approval method.	None	**Cost/Sample:** $250+ **Capital cost:** $150K+

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

Deconta

The Decontamination section addresses concepts and a
from process equipment and building materials in Building 9
by TLDs are

1. In situ decontamination of the interior of steel and nic
   and HNO_3.
2. In situ decontamination of the exterior of steel and nic
   Hg, LiOH, H_2SO_4, HNO_3, asbestos, and PCBs.
3. Ex-situ decontamination of steel and nickel process e
   Hg, LiOH, H_2SO_4, HNO_3, asbestos, and PCBs.
4. Painted concrete and clay tile contaminated with Hg,
5. Air contaminated with Hg.
6. Insulation and building paper contaminated with Hg, a
7. Packing contaminated with Hg, LiOH, H_2SO_4, and H
8. Carbon chunks contaminated with Hg, LiOH, H_2SO_4,
9. Wood and sheet rock contaminated with Hg, LiOH, H

It was observed that exactly the same technologies were
used for these two problems.

Because of the large number of variables that could affec
team had great difficulty estimating reasonable values for thi
unit-processing cost, operating costs were based on deconta
the decontamination of metals, the operating cost was based
technologies that were not applicable to either concrete or m
applications that would give the lowest cost. Even so, the co
best, treated only as relative values, and not used for estima

mination

›roached for removing mercury and other contaminants
)1-4. Specific decontamination problems that are addressed

l process equipment contaminated with Hg, LiOH, H_2SO_4,

el process equipment contaminated with

uipment contaminated with

CBs, oil, U (and daughters), electrolytes, Cd, Pb, and Cr.

d U (and daughters).
$)_3$.
nd HNO_3.
O_4, HNO_3,U (and daughters), asbestos, and/or PCBs.

pplicable to problems six and nine; thus a single TLD was

the projected unit processing cost, the decontamination
parameter, To achieve greater specificity for estimating the
nination of relatively large areas of concrete applicable to
on decontamination of large sections of metal. For
tals, unit processing costs were estimated for the
s given in Table 5.3 should be regarded as approximated at
ng job costs.

Deconta

EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #1 In situ decontamination of the interior of nickel & steel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
lechanical Surface Removal H	Ultra High Pressure Water DCON-35-OY *Ranking:** *H-5-1 ($1.3M; $1/ft^2)*	**Accepted** Technology has been used by industry. **Efficacy:** The decontamination efficiency should be essentially 100% unless the contamination has diffused deep into the substrate. **Waste:** Unless a recycle system is developed, waste would be 3-5 gal water/ft^2 cleaned that contains the contaminants removed.	**Technology Improvement:** To minimize waste generation, a system is needed to treat the water so that it can be recycled. **Technology Improvement:** Automation, especially vertical surfaces.	A water treatment system is needed to minimize liquid wastes from this technology. Robotic delivery will be required to clean the inside of pipes and equipment. **Development cost:** $1.3M **Capital cost:** ~$500K **Operating cost:** ~$1/ft^2
H	Centrifugal Cryogenic CO_2 Blasting DCON-39-OY *Ranking:** *H-5-2 ($750K; <$1t^2)*	**Demonstration** Centrifuge pellet acceleration has been demonstrated in the DOE fusion energy program, as a decontamination tool in the Y-12 facility waste minimization effort, and more recently as an aircraft depaint mechanism. **Efficacy:** Technology is likely to be successful with very high decontamination factors, for the inside of the large tanks and pipes. **Waste:** The waste will be filters and sorbents containing the combination of contaminants and substrate material.	**Development:** Demonstration of mobile system with high velocity pellets delivered at a sufficient rate and adequate collection of removed contaminants. **Technology Improvement:** 1) Demonstration of an on-line, real time contaminant sensor which would minimize the decontamination effort and limit the waste stream; 2) automation	Design and construction of a vacuum waste-handling system to handle the vaporized CO_2 containing the removed contaminants plus oxygen-depletion precautions. Robotic delivery will be required to clean the inside of pipes and equipment. **Development cost:** <$1M **Capital cost:** $100K **Operating cost:** <$1/ft^2
H	Ice Blasting DCON–40–OY *Ranking:** *H-5-1 ($750K; $t^2)*	**Demonstration** **Efficacy:** Efficacy of commercial system for this application needs demonstration. **Waste:** Waste would be about 14 to 18 gallons per hour waste water containing removed contaminants, located inside the process equipment.	**Development:** Demonstration of efficacy of commercial system. **Technology Improvement:** Automation/robotics, especially for curved surfaces. Waste handling improvement required.	A water treatment system is needed to minimize liquid wastes from this technology. Robotic delivery will be required to clean the inside of pipes and equipment. **Development cost:** $750K **Capital cost:** $100K-$1M **Operating cost:** ~$2/ft^2
M	Supercritical CO2 Blasting DCON-41-OY *Ranking:** *M-5-3 ($750K; >$1/t^2)*	**Predemonstration** **Efficacy:** Likely to be effective with very high decontamination factors. **Waste:** Waste would be the removed contaminants of Hg, LiOH, H2SO4, and HNO3 and moderate amounts of metal substrate contained in a cyclone, and/or sorbent filter.	**Development:** Investigate the effect of operating parameters on removal rates and efficiencies for removal and collection of contaminants. Demonstrate efficacy for the intended contaminants.	Design and fabrication of the vacuum waste-handling system to handle the vaporized CO2 containing the removed contaminants. Address concern for depleted oxygen conditions. Robotic delivery will be required to clean the inside of pipes and equipment. **Development cost:** $250K-1M **Capital cost:** $500K-750K **Operating cost:** $1+/ft2

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #1 In situ decontamination of the interior of nickel & steel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Surface Cleaning	Compressed Air Cryogenic CO2 Pellet Blasting DCON-51-OY M *Ranking:** *M-5-1 ($250K; $2/ft²)*	**Demonstration** This technology is commercially available. It has been used at nuclear reactor sites to decontaminate hand tools and some equipment. **Efficacy:** The efficacy of this technology for removing the listed contaminants from the various substrates has not been demonstrated and is doubtful. **Waste:** Wastes would be HEPA filters and sorbents filled with the removed contaminants. Large airflow is required to accelerate pellets.	**Development:** Evaluate technology that has recently been demonstrated in Department of Defense programs regarding automation and improvements in pellet delivery. Demonstrate efficacy for removing Hg, etc. from inside of pipes and equipment.	Robotic delivery will be required to clean the inside of pipes and equipment. Design and construction of a vacuum waste-handling system to handle the vaporized CO_2 and large volumes of air containing the removed deposits are needed to use this technology. **Development cost:** $500K **Capital cost:** : ~$200K **Operating cost:** $2-10/ft²
	High Pressure Water Blasting DCON-52-OY H *Ranking:** *H-5-1 ($1.2M; <$2/ft²)*	**Accepted** High pressure water blasting has been used very successfully to decontaminate various large and complex surfaces at nuclear power plants. **Efficacy:** Technique is expected to be effective with a DF of about 50 for loosely adhering contamination. DFs will be higher if chemical cleaning agents are also used. **Waste:** Waste is 4 to >100 gpm of contaminated waste water.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. **Improvement:** Remote operation will necessitate the adaptation of the high pressure water system to robotic system control.	A water treatment system is needed to minimize waste. Robotic delivery will be required to clean the inside of pipes and equipment. **Development cost:** Water treatment system: About $1.2M Remote operation: $3-4M **Capital cost:** $50K-$75K (about $250K with remote operation) **Operating cost:** <$1.00/ft²
	Superheated Water DCON-53-OY M *Ranking:** *M-5-1 ($1.2M; <$2/ft²)*	**Accepted** Technology is available and has been used by industry. **Efficacy:** The removal of loosely bound Hg should be complete, but the removal of more tightly bound contaminants is likely to be slight. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. Improvement - Remote operation will necessitate the adaptation of the superheated water system to robotic system control.	Robotic delivery will be required to clean the inside of pipes and equipment. Design and construction of a water recycle system are needed to use this technology. **Development cost:** about $1.2M **Capital cost:** ~$175K **Operating cost:** $2/ft²

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #1 In situ decontamination of the interior of nickel & steel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

ination

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
urface Cleaning	M	Steam Cleaning DCON-55-OY *Ranking:** *M-5-1 ($1.2M; $1-2/ft²)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology is expected to be effective for Hg but not for more tightly bound contaminants. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused.	Design and construction of a water recycle system are needed to use this technology. **Development cost:** about $1.2M **Capital cost:** $50-75K **Operating cost:** $1-$2/ft²
	M	Automated Brushing DCON-57-OY *Ranking:** *M-3-2 ($1M; $300/ft²)*	**Demonstration** This technology has been used at Rocky Flats to remove plutonium contamination from the inside of pipes. Tests would be needed to demonstrate its effectiveness for other contaminants on other substrates. **Efficacy:** Brushing is effective for smearable and loose contamination. The interior of the pipes at Rock Flats was cleaned to shiny metal. **Waste:** HEPA filters and adsorption canisters on the vacuums used to pick up the particles of contamination and the worn brushes.	**Development:** Test to demonstrate that this technology is effective for the problems at Alpha 4.	**Normal implementation needs.** **Development cost:** $1,000K **Capital cost:** $250K **Operating cost:** $300/ft of pipe
	H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-2 ($2M; $3/ft²)*	**Demonstration** The technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the warm air stream. A filter and charcoal sorbent should remove the contaminants and constitute the final waste stream.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of a hot air cleanup system is needed.	An air cleanup system is needed to use this technology. **Development cost:** ~$1M **Operating cost:** $3/ft2 **Capital cost:** $2M
	M	Dry Heat DCON-60-OY *Ranking:** *M-5-2 ($1M; >$1/ft²)*	**Conceptual** The use of heat to increase the vapor pressure of semi-volatile materials is will known, but the use of heat for insitu decontamination, withdrawal of gases from equipment, and treatment of the contaminated off gases is unproven. Efficacy: This process should work for contaminants which can be volatilized. Waste: This will initially consist of volatilized contaminants along with hot air and other vaporized materials. The contaminants must normally be removed by scrubbing, sorption, or possible filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system.	An air cleanup system is needed to use this technology. **Development cost:** $1M **Capital cost:**~$1M **Operating cost:** $1.00/ft2

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #1 In situ decontamination of the interior of nickel & steel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Thermal Surface Removal	Plasma Torch DCON-72-OY H *Ranking:** *H-5-2 ($500K; >$2/ft^2)*	**Evolving Technology** **Conceptual** Plasma torches exist commercially to weld and cut materials that have very high melting temperatures or require an inert atmosphere. Plasma torches have not been used for decontamination. **Efficacy:** Plasma torches should be effective in removing Hg, etc. **Waste:** Wastes would consist of materials used to trap reaction products from the decomposition of organics, vaporized substrate, and removed contaminants.	**Science:** Laboratory tests are needed to demonstrate efficacy of vaporizing Hg, etc., by-products, and suitable trapping materials. Computer modeling of plasma-surface interactions and heat transfer are needed. **Development:** Plasma torches having geometries and conditions suitable for decontamination need to be developed along with suitable collection and gas treatment systems.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** ~$500K **Capital cost:** ~$100K **Operating cost:** $1.00/ft^2 **Available at Y-12.**
	Laser Heating DCON-73-OY M *Ranking:** *M-4-4 ($500k; >$1/ft^2)*	**Demonstration** Currently being used to remove contamination from metal surfaces. Current prototype systems are capable of removing 2-mil-thick coating at the rate of 100 ft2/hr. **Efficacy:** Likely to be effective in removing Hg and inorganic acids. **Waste:** Waste will be sorbents and filters filled with contaminants.	**Development:** Current prototype needs to be evaluated for possible use on contaminated areas.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** $0.5M **Capital cost:** $0.5M+/machine **Operating cost:** ~$1.00/ft^2
	Laser Ablation DCON-74-OY M *Ranking:** *M-4-4 ($1M; >$1/ft^2)*	**Prodemonstration** Several research groups at university and government laboratories have used the technology to remove radiological and organic contaminants form various surfaces. The technique is slow to remove large deposits. **Waste:** Wastes would be removed deposits, some substrate material, and sorbents and filters from the off gas treatment system.	**Development:** Existing lasers, delivery systems, sand off gas treatment systems need to be integrated into a prototype system for demonstration.	A collection system with an adequate off gas treatment system would be need to implement this technology. **Development cost:** $1M **Capital cost:** $0.5-1M+/machine **Operating cost:** ~$1.00/ft^2
	Plasma Surface Cleaning DCON-75-OY M *Ranking:** *M-5-3 ($1M; >$1.75/ft^2)*	**Demonstration** Plasma surface cleaning by glow discharges are commonly and effectively utilized for cleaning high bonding energy contaminants from surfaces of metals prior to the operation of fusion devices. **Efficacy:** Technology is expected to be effective for removing deposits from interior surfaces of process equipment, but whether the plasma can follow the irregular shapes involved is uncertain. **Waste:** Wastes would be the vaporized deposits plus filters and charcoal sorbent from the collection system.	**Science:** Data on cleaning rates for Hg and other contaminants and various substrates of interest are needed. **Development** - The capability of plasma generation and cleaning on complex internal surfaces of contaminated equipment with large surface areas needs to be established.	A collection system with appropriate sorbents and filters for the vaporized deposits would be needed to use this technology. An electric power supply would be needed. **Development cost:** $1M **Capital cost:** $0.5-1M /machine **Operating cost:** > $1/ft^2 **Available at Y-12.**

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #1 In situ decontamination of the interior of nickel & steel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
rmal Surface Removal	Plasma Etching DCON–76–OY M *Ranking:** *M-5-3 ($1.3M; $3/ft²)*		**Predemonstration** Plasma etching processes are used in material processing and microelectronic manufacturing. **Efficacy:** Extrapolating these plasma processes for vaporizing and recovering Hg is considered feasible. **Waste:** Wastes would be the vaporized deposits plus filters and charcoal sorbent from the collection system.	**Science:** Data on cleaning rates for contaminants and substrates of interest are needed. **Development:** The capability of plasma etching on deposits in complex equipment with large surface areas needs to be established.
	Flashlamp Cleaning DCON–77–OY M *Ranking:** *M-5-2 ($2M; $3/ft²)*	**Demonstration** Flashlamp systems are being used to remove organic contamination from metals, precious metals, and fragile substrates. Hanford-Westinghouse Laboratory is conducting tests of xenon flashlamp systems for removing radiological contamination from surfaces inside metal storage vessels. **Efficacy:** Technology is likely to be effective for surface Hg contamination. **Waste:** Wastes would be removed deposits, some substrate material, and charcoal sorbent from the gas treatment system.	**Development:** Commercially available flashlamp systems need to be evaluated for Hg deposit removal.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** ~$2 M **Capital cost:** $50-100K/machine **Operating cost:** ~3.00/ft²
emical Surface Cleaning	Chemical Leaching DCON-5-OY M *Ranking:** *M-1-1.5 ($500M; <$1/ft²)*	**Predemonstration** Chemical leaching is an accepted technique for some applications. **Efficacy:** Leaching with the proper chemicals is likely to be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a waste treatment system for treatment or recycle of spent chemical leaching solution is needed. **Development cost:** Efficacy Demo: $500K **Capital cost:** $150K **Operating cost:** <$1/ft2 or $5-$50/lb
	Chemical Foams DCON–8–OY M *Ranking:** *M-5-1 ($1M; $/.5-2/ft²)*	**Demonstration** Widely used throughout the nuclear industry. Foam is used as a carrier of chemical decontamination agents, not as the agent itself. It can be sprayed on and wiped, rinsed, or vacuumed off. **Efficacy:** Effectiveness for listed contaminants and substrates has not been demonstrated. **Waste:** Small amount of contaminated sulfonated detergents, synthetic wetting agents, coupling agents, rinse water, and drying cloth.	**Development:** Scale-up/development of the process to a size appropriate for Y-12 use. The technology itself is inexpensive, but development of the proper chemical and appropriate foam carrier and scale-up will probably require support. **Improvement:** Full control over the mean bubble dimensions and the volume swell factor are needed, indicating that some basic research will be necessary.	A waste treatment systems is needed for the foam and wastewater. **Development cost:** $1M-$4M; **Capital cost:** $50K **Operating cost:** $0.50-$2/ft²

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EM Goals
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship

EM Problems
• Facility Decontamination and Decommissioning (D&D)
• Remedial Action (RA)—Soils, Groundwater and Surface Water
• Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR); radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Bulk Decontamination	Chemical Leaching DCON-5-OY *Ranking:** M *M-1-11/2 ($500K; <1/ft²)*	**Predemonstration** Chemical leaching is an accepted technique for some applications. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a waste treatment system for treatment or recycle of spent chemical leaching solution. **Development cost:** Efficacy Demo: $350K **Capital cost:** $150K **Operating cost:** <$1/ft² or $5-$50/lb
	Vacuum (Low Pressure) with Heat DCON-7-OY *Ranking:** M *M-5-1 ($1M; $1.20/ft²)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of Hg and some other contaminants, however, this must be balanced against its cost. **Waste:** sorbent containing removed contaminants and other volatiles or filters from a filtration system.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of decontamination by volatilization under vacuum conditions for the specific heating applied. **Improvement:** In-situ conditions need more streamlined designs to apply the vacuum and heat combination efficiently.	Off-gas treatment is needed to use this technology. **Development cost:** ~$250K-500K **Operating cost:** $2/ft² **Capital cost:** $1M
Chemical Surface Cleaning	Chemical Foams DCON-8-OY *Ranking:** M *M-5-1 ($1M; $0.5-$2./ft²)*	**Demonstration** Widely used throughout the nuclear industry. Foam is used as a carrier of chemical decontamination agents, not as the agent itself. It can be sprayed on and wiped, rinsed, or vacuumed off. **Efficacy:** Effectiveness for listed contaminants and substrates has not been demonstrated. **Waste:** Small amount of contaminated sulfonated detergents, synthetic wetting agents, coupling agents, rinse water, and drying cloth.	**Development:** Scale-up/development of the process to a size appropriate for Y-12 use. The technology itself is inexpensive, but development of the decontamination chemical and appropriate foam carrier and scale-up will probably require support. **Improvement:** Full control over the mean bubble dimensions and the volume swell factor are needed, indicating that some basic research will be necessary.	Normal implementation requirements **Development cost:** $1M-$4M; **Capital cost:** $50K **Operating cost:** $0.50-$2/ft²
	Hypochlorite Oxidation DCON-202-OY *Ranking:** *Not Ranked*	**Accepted** Core process is commercially available and practiced on an industrial scale. Integrated process needs to be demonstrated. **Efficacy:** Dependant on solution flushing efficiency. Core process reduces Hg in water effluent to <2ppb. **Waste:** Cleanup debris, some salts, spent resin and carbon.	Core technology is ready to use.	Normal implementation requirements and a fluid delivery and cleanup system needs to be integrated with core technology

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas.Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning	Chemical Gels DCON–9–OY M *Ranking:** *M-4-1 ($1M; $0.5-$2/ft²)*	**Demonstration** The use of chemical gels is most suited to decontamination of large surfaces. Gel is used as a carrier of chemical decontamination agents, not as the agent itself. It is sprayed on component walls; allowed to work; and then scrubbed, wiped, rinsed, or peeled off. **Efficacy:** Expected to be effective only for smearable contamination. **Waste:** Wastes would be carboxymethylcellulose gelling agent, aluminum nitrate chelating agent, wash water, acidic chemical agent (possibly nitric-hydrofluoric-oxalic acid), and the removed contaminants. Wastes are reportedly 4-5 times less compared to chemical solutions.	**Development:** Complex gel formulation with a number of compounds may be required, depending on the objectives. Laboratory optimization will be necessary, with any change in variables.	Normal implementation needs: **Development cost:** $1M-$4M **Capital cost:** <$50K **Operating cost:** $0.50-$2.00/ft²
	Electropolishing DCON–15–OY M *Ranking:** *M-4-3 ($1M; $>2/ft²)*	**Demonstration** Electropolishing is a surface removal technique and the amount of surface removed is proportional to factors such as current, time, and voltage. Electropolishing is essentially a "line of sight" process so cracks, crevices, areas out of sight of, or shadowed by, the electrode will not be decontaminated.Contaminated electrolyte must be removed for complete decontamination to be achieved. The electrolyte must be held in contact with the outside of the equipment. **Efficacy:** Electropolishing is difficult to apply to in situ equipment. **Waste:** Waste would be removed contaminants along with the small amount of substrate removed.	**Development:** Primary and secondary waste treatment and solution recycle need to be developed. Cleanup principles (e.g., ion exchange and filtering) are well established, so that only design and demonstration are needed. For in situ conditions, a feasible method to hold the electrolyte in contact with the outside of the equipment is needed. **Improvement:** Better methods to remove the electrolyte and contaminant would be helpful.	Treatment an;d recycle of the electrolyte is needed to minimize wastes from this process. **Development cost:** ~$400K to $1M **Operating cost:** >$2/ft² with additional capital cost. **Capital cost:** $1M

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

mination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning	Amalgamation DCON-16-OY *Ranking:** *H-5-1 ($500K;N)* H	**Predemonstration** Although amalgamation of mercury with metals of interest is well known, application to Y-12 problems has not been demonstrated. Copper and zinc are main metals of interest for amalgamation. **Efficacy:** Method transforms liquid Hg into a solid that is often easy to recover. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** Resulting amalgam, which is unreactive, is chief waste. Zn amalgam is ~57wt% Hg. The Cu amalgam is <76wt% Hg.	**Development :** Laboratory and bench scale assessment is needed to determine the suitability of this process to the Y-12 problems.	The availability of a suitable facility to do development work is assumed. **Development cost:** $500K (mainly personnel costs) **Duration:** 8 months **Capital cost:** $100K **Operating cost:** NA
	Biological DCON–17–OY *Ranking:** *L-5-2 ($500K; $0.1-$3/ft²)* L	**Evolving Technology / Pre-conceptual** The knowledge base exists for biological treatments of various contaminants; however, there is not a data base for application of the technology for surface decontamination. **Efficacy:** This technology is quite likely to be successful for HNO_3 and perhaps, H_2SO_4. It could be successful for Hg and LiOH, but the Hg and Li would remain in the bacterial sludge. **Waste:** The waste generated would be the contaminated layer of microbes removed from the treated surface.	**Science:** Literature study and bench-scale tests of microbes on Hg, LiOH, and H_2SO_4. **Development:** Develop methods for applying a layer of microbes, supplying needed nutrients, and removing the microbe layer from the decontaminated item. **Available at X-10, K-25.**	Facilities for cultivating the bacteria and disposing of the bacterial sludge would be needed. **Development cost:** $300K-$600K **Capital cost:** ~$200K **Operating cost:** $0.10-$3.00+/ft² **Available at X-10, K-25.**

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EM Goals
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EM Problems
• Facility Decontamination and Decommissioning (D&D) • Remedial Action (RA)—Soils, Groundwater and Surface Water • Waste Management (WM)

Y-12 Problem	Problem Areas·Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning M	Chelation DCON–21–OY *Ranking:** *M-4-2 ($1.5M; <$1/ft²)*	**Demonstration** The technology has been employed at various facility operations and nuclear power plant sites. **Efficacy:** Excellent DFs achieving acceptable decontamination levels resulting in unconditional release. Easy to apply in situ as agent acts at neutral pH and are non-hazardous, non-fuming, have no gas evolution and are biodegradable. **Waste:** Simple waste minimizing treatment and disposal as a non-RCRA waste. Minimizes waste through oxidative destruction of chelate agent, partitioning of organics (including PCBs) and concentration of radionuclides precipitated out in the flocculent sludge which can be further de-watered.	**Development:** Validation of updated chelating agents is needed and is currently underway at ORNL to confirm total efficacy and economic advantage.	Application equipment for in situ decontamination. Support personnel and equipment to sample, analyze, develop appropriate concentrations, ensure oxidation of organics and/or complete partitioning will be necessary. **Development cost:** ~$1.5M **Capital cost:** ~$1.5M **Operating cost:** <$1/ft²
Mechanical Surface Removal M				
	Sulfide Conversion DCON-22-OY *Ranking:** *M-3-1 ($500K;N)*	**Evolving Technology** Must evaluate the kinetics of the room temperature reaction of sulfur with elemental Hg to form Hg S, which is not water soluble and which is often easier to collect than elemental Hg. **Efficacy:** Method applicable only to elemental Hg. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** The chief waste is the recovered HgS which is about 84wt% Hg.	**Science/Development:** Both lab and bench scale experiments are required to determine the kinetics of the S and Hg reaction at room temperature and to evaluate the suitability of the method to th Y-12 Hg problems.	The required lab and bench-scale experiments are expected to be relatively simple. Existing equipment and facilities will likely support these activities with slight modifications. **Development cost:** $500K (mainly personnel costs) Duration: ~ 8 months **Capital cost:** $100K **Operating cost:** NA
H	Ultra High Pressure Water DCON-35-OY *Ranking:** *H-5-1 ($1.3M; $1/ft²)*	**Accepted** Technology has been used by industry. **Efficacy:** The decontamination efficiency should be essentially 100% unless the contamination has diffused deep into the substrate. **Waste:** Unless a recycle system is developed, waste would be 3-5 gal water/ft² that contains the contaminants removed.	**Technology Improvement:** To minimize waste generation, a system is needed to treat the water so that it can be recycled. **Technology Improvement:** Automation, especially vertical surfaces.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** $1.3M **Capital cost:** ~$500K **Operating cost:** ~$1/ft²

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EM Goals
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EM Problems
• Facility Decontamination and Decommissioning (D&D) • Remedial Action (RA)—Soils, Groundwater and Surface Water • Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR); radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

mination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Mechanical Surface Removal H	Shot Blasting DCON–36–OY *Ranking:** *H-4-0 ($0; $1/ft²)*	**Accepted** Commercial iron shot blasters are in use. **Efficacy:** They are generally effective but leave some hot spots. **Waste:** Waste would be spent shot, abraded substrate, and removed contaminants in filters and charcoal sorbents.	**Improvement:** Automation, especially for walls and ceilings.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$50K **Operating cost:** ~$1/ft²
M	Grit Blasting DCON–38–OY *Ranking:** *M-5-1 ($250K; $2.50/ft²)*	**Accepted** Has been used successfully for many applications in the nuclear industry. **Efficacy:** Technology is generally effective. **Waste:** Waste would be used grit, abraded substrate, and removed contaminants on filters and charcoal sorbent.	**Improvement:** automation, especially for walls and ceilings. Better vacuum system demonstration. Needs system for handling waste.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$50K **Operating cost:** $~5/ft²
H	Centrifugal Cryogenic CO_2 Blasting DCON–39-OY *Ranking:** *H-5-2 ($.75M; <$1/ft²)*	**Demonstration** Centrifuge pellet acceleration has been demonstrated in the DOE fusion energy program, as a decontamination tool in the Y-12 facility waste minimization effort, and more recently as an aircraft depaint mechanism. **Efficacy:** Technology is likely to be successful with very high decontamination factors. **Waste:** The waste will be filters and sorbents containing the combination of contaminants and substrate material.	**Development:** Demonstration of mobile system with high velocity pellets delivered at a sufficient rate and adequate collection of removed contaminants. **Technology Improvement:** 1) Demonstration of an on-line, real time contaminant sensor which would minimize the decontamination effort and limit the waste stream; 2) automation	Design and construction of a vacuum waste-handling system with sorbents and filters to handle the vaporized CO_2 containing the removed contaminants. plus oxygen-depletion precautions. **Development cost:** <$1M **Capital cost:** $100K **Operating cost:** <$1/ft²
H	Ice Blasting DCON–40–OY *Ranking:** *H-5-1 ($.75M;)*	**Demonstration** **Efficacy:** Efficacy of commercial system for this application needs demonstration. **Waste:** Waste would be about 14 to 18 gallons per hour waste water containing contaminants, removed from the process equipment.	**Development:** Demonstration of efficacy of commercial system. **Technology Improvement:** Automation/robotics, especially for curved surfaces. Waste handling improvement required.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** $250K **Capital cost:** $100K-$1M **Operating cost:** <$1/ft²

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111).	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
lechanical Surface Removal	Supercritical CO2 Blasting DCON-41-OY *Ranking:** *M-5-3 ($0.75M; >$1//ft²)*	**Predemonstration:** **Efficacy:** Likely to be effective with very high decontamination factors. **Waste:** Waste would be the removed contaminants of Hg, LiOH, H_2SO_4, and HNO_3 and moderate amounts of metal substrate contained in a cyclone, filter, and/or sorbent.	**Development:** Investigate the effect of operating parameters on removal rates and efficiencies for removal and collection of contaminants. Demonstrate efficacy for the intended contaminants. Asbestos is not considered a viable candidate for removal by this process.	Design and fabrication of the vacuum waste-handling system with filters and sorbents to handle the vaporized CO_2 containing the removed contaminants. Address concern for depleted oxygen conditions. **Development cost:** $250K-1M **Capital cost:** $500K-750K **Operating cost:** $1+/ft^2
M	Plastic Pellet Blasting DCON-42-OY *Ranking:** *M-4-1 ($0.2M; >$1//ft²)*	**Accepted** Plastic pellet blasting is a widely used alternate to sand blasting for applications in which it is desired to impart minimal damage to the substrate. **Efficacy:** Technology should remove Hg and smearable contamination, but not fixed contamination. **Waste:** Waste would be spent plastic pellets plus removed contamination.	**Improvement:** Develop and demonstrate system for processing waste. **Improvement:** Minimize blast media erosion to minimize waste; automation/robotics; improve containment of waste and removed contaminants.	A system for processing waste to an acceptable form is needed. **Development cost:** (Improvements) <$0.2M **Capital cost:** $200K **Operating cost:** >$1.0/ft^2
M				
H	Hand Grinding, Honing, Scraping DCON-43-OY *Ranking:** *H-5-0 ($0M; $1//ft²)*	**Accepted** Grinding with hand-held power grinders has been successfully used for small-scale decontamination. **Efficacy:** Is effective for surface contamination. **Waste:** Surface area of item being decontaminated, spent grinding media (such as emery paper), and the adsorption canisters and filters on the vacuum system.	None	A system to collect and remove mercury vaporized by the heat generated during grinding will be needed. **Development cost:** None **Capital cost:** $150 ($10K with vacuum system) **Operating cost:** $1/ft2

EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Surface Cleaning	Automated Grinding DCON-44-OY M *Ranking:** *M-5-3 ($1M; $1/ft²)*	**Conceptual** Grinding has been successfully used for small scale decontamination. This grinding was done with hand-held power grinders. Remotely-operated grinding equipment is available, but no reverences to its use for decontamination have been found. **Efficacy:** Is effective for surface contamination. **Waste:** Surface area of item being decontaminated, spent grinding media (such as emery paper), and the adsorption canisters and filters and sorbent on the vacuum system.	**Development:** The applicability of this technology for decontamination needs to be demonstrated.	A system to collect and remove mercury vaporized by the heat generated during grinding will be needed. **Development cost:** ~$1M **Capital cost:** $250K **Operating cost:** $1/ft²
	Slurry Blasting DCON-50-OY M *Ranking:** *M-5-2 ($0.5M; $1.75/ft²)*	**Demonstration** The use of a combination of grit and water is well known to effectively remove a variety of contaminants. It is a moderately aggressive removal process. **Efficacy:** Likely to improve the decontamination rate over the high pressure water process; however, this must be balanced against a slightly more complex process. **Waste:** Aqueous solution of spent grit and removed contaminants. The inclusion of volatiles in the solution is a major question.	**Development:** The characteristics of the specific contaminants must be matched to the increased removal rate for the grit blasting concept. Separation of the contaminants from the aqueous spent grit matrix must be accomplished satisfactorily. **Improvement:** The on-line recycling process may need improvement for satisfactory operations.	A variety of commercial engineered systems are available with considerable operating experience. **Development cost:** $750-1250K **Capital cost:** >$0.5M **Operating cost:** $1.75/ft²
	Compressed Air Cryogenic CO2 Pellet Blasting DCON-51-OY M *Ranking:** *M-5-1 ($0.25M; $2/ft²)*	**Demonstration** This technology is commercially available. It has been used at nuclear reactor sites to decontaminate hand tools and some equipment. **Efficacy:** The efficacy of this technology for removing the listed contaminants from the various substrates has not been demonstrated. **Waste:** Wastes would be sorbent and filters filled with the removed contaminants. Large airflow is required to accelerate pellets.	**Development:** Evaluate technology that has recently been demonstrated in Department of Defense programs regarding automation and improvements in pellet delivery.	Design and construction of a vacuum waste-handling system with filters and sorbent to handle the vaporized CO_2 and large volumes of air containing the removed Hg and other contaminants plus oxygen depletion precautions are needed to use this technology. **Development cost:** $250K **Capital cost:** CO_2 System: ~$200K **Operating cost:** ~$2/ft²

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

ination

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
urface Cleaning	H	High Pressure Water Blasting DCON-52-OY *Ranking:** *H-5-1 ($1.2M; <$1/ft^2)**	**Accepted** High pressure water blasting has been used very successfully to decontaminate various large and complex surfaces at nuclear power plants **Efficacy:** Technique is expected to be effective with a DF of about 50 for loosely adhering contamination. DFs will be higher if chemical cleaning agents are also used. Technique is expected to be ineffective for fixed contamination. **Waste:** Waste is a 4 to >100 gpm of contaminated waste water.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. **Improvement:** Remote operation will necessitate the adaptation of the high pressure water and vacuum collection systems to robotic system; control.	A water treatment system is needed to minimize waste.. **Development cost:** Water treatment system: About $1,2M Remote operation: $3-4M **Capital cost:** $50K-$75K (about $250K with remote operation) **Operating cost:** <$1.00/ft^2
	M	Superheated Water DCON-53-OY *Ranking:** *M-5-1 ($1.2M; <$2/ft^2)*	**Accepted** Technology is available and has been used by industry. **Efficacy:** The removal of loosely bound Hg should be complete, but the removal of more tightly bound contaminants is likely to be slight. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. **Improvement:** Remote operation will necessitate the adaptation of the superheated water and vacuum collection systems to robotic system control.	Design and construction of a water recycle system is needed to use this technology. **Development cost:** about $1.2M **Capital cost:** ~$175K **Operating cost:** $1-$2/ft^2
	M	Water Flushing DCON-54-OY *Ranking:** *M-5-1 ($1.2M; <$1/ft^2)*	**Accepted** Flushing with hot water is often used following scrubbing. **Efficacy:** The technique may be effective for the listed contaminants (except asbestos). **Waste:** The waste generated is the contaminated water from the flushing operation.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the hot water cleaning operation.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** About $1.2M **Capital cost:** <$5K **Operating cost:** <$1/ft^2
	M	Steam Cleaning DCON-55-OY *Ranking:** *M-5-1 ($1.2M; $1-$2/ft^2)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology is expected to be effective for Hg but not for more tightly bound contaminants. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. Remote operation will necessitate the adaptation of the steam and vacuum collection systems to robotic system control.	Design and construction of a water recycle system is needed to use this technology. **Development cost:** about $1.2M **Capital cost:** $50-75K **Operating cost:** $1-$2/ft^2

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111).	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning	H	Hand Brushing for Surface Contamination DCON-56-OY *Ranking:** *H-4-0 ($0M; $1/ft^2)*	**Accepted** Brushing is a common decontamination technique. **Waste:** Adsorption canisters on the vacuum cleaner used to pick up the particles generated by brushing and the worn brushes. **Efficacy:** Brushing is effective for smearable contamination, and less effective for fixed contamination.	None	A vacuum cleaner is needed to pick up the particles collected by brushing. **Development cost:** None **Capital cost:** Negligible **Operating cost:** $1.00/ft2
	M	Sponge Blasting DCON-58-OY *Ranking:** *M-4-1.5 ($1.2M; $2/ft^2)*	**Accepted** Although the technology is relatively new, it is currently being used by at least two sites including a nuclear power plant. **Efficacy:** Although extensive data on decontamination factors are not available, this technology is likely to be effective for the listed contaminants and substrates. **Waste:** Wastes consist of about 0.01 ft^3 of blasting media and removed contaminants per ft^2 of area decontaminated plus any liquid cleaning agents that may have been added.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the sponge blasting operation.	A wastewater treatment / recycle system will be needed to use this technology. **Improvement cost:** About $1.2M **Capital cost:** Sponge blasting system: About $20K (with sifter system) **Operating cost:** About $2/ft^2
	H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-2 ($2M; $3/ft^2)*	**Demonstration** The technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the warm air stream. Filters and sorbents should remove the contaminants and constitute the final waste stream.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of a hot air cleanup system is needed.	An air cleanup system is needed to use this technology. **Development cost:** ~$2M **Capital cost:** $250-500K **Operating cost:** $3/ft2

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards; DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
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ination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Thermal Surface Removal	Dry Heat DCON-60-OY *Ranking:** *M-5-2 ($1M; <$1/ft^2)*	**Conceptual** The use of heat to increase the vapor pressure of semi-volatile materials is well known, but the use of heat for surface removal of Hg, etc. is unproven. **Efficacy:** This process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other vaporized materials. The contaminants must normally be removed by scrubbing, sorption, or possibly filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system.	An air cleanup system is needed to use this technology. **Development cost:** $1M **Capital cost:**~$1M **Operating cost:** >$1.00/ft2
	Solvent Washing to Remove Radiological Contamination DCON-61-OY *Ranking:** *M-5-1 ($1M; <$1/ft^2)*	**Conceptual** Plutonium contaminated items at Richland, WA were rinsed with Freon. The vendor who supplied the equipment for Richland ten years ago no longer sells it. **Efficacy:** This technique is mainly applicable to loose and smearable contamination. **Waste:** Waste would be spent solvent containing removed contaminants.	**Science:** Solvents that are less damaging to the environment need to be identified and demonstrated.	Vapor collection system **Capital cost:** $300K (1980 dollars) **Development cost:** <$1M to identify and demonstrate the replacement solvent. **Operating cost:** ~$1.00/ft^2 (An average of 7.5 minutes per item was required when decontaminating small items.) **Available in Private Sector.**
	Strippable Coatings DCON-63-OY *Ranking:** *M-4-0($0M; $1.50/ft^2)*	**Accepted** Technology has been used for decontamination applications involving hazardous and radioactive contaminants. **Efficacy:** Decontamination factors of over 90% can be expected with two applications. **Waste:** Waste is a solid polymer containing the removed contaminants. The average thickness of the applied coating is a mm. This may be incinerated to reduce the final volume.	**Improvement:** Develop coating with lower material costs and greater ease of application.	**Minimal implementation needs.** **Development cost:** None **Capital cost:** <20K **Operating cost:** >$1.50/ft^2
	Vacuum Cleaning DCON-64-OY *Ranking:** *M-2-0 ($0M; <$0.75 /ft^2)*	**Accepted** Vacuum cleaners have long been used to clean up loose contamination. **Efficacy:** Any contaminants which are in a loose, solid form will be collected effectively in a HEPA filter vacuum system. A charcoal sorbent will be needed for Hg. **Waste:** A filter and/or sorbent with the collected contaminants.	None	Normal implementation needs. **Development cost:** None **Capital cost:** <$25K **Operating cost:** <$0.75/ft2

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EM Goals

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EM Problems

- Facility Decontamination and Decommissioning (D&D)
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- Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #2 In-situ decontamination of the exterior of steel and nickel process equipment contaminated with: Hg LiOH H_2SO_4 HNO_3 Asbestos.	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

mination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Surface Removal	H Plasma Torch DCON-72-OY *Ranking:** *H-5-2 ($2M; $3/ft²)*	**Evolving Technology Conceptual** Plasma torches exist commercially to weld and cut materials that have very high melting temperatures or require an inert atmosphere. **Efficacy:** Its efficacy in removing various organic contaminants or to remove layers of contaminated metal has not been investigated. **Waste:** Wastes would consist of materials used to trap reaction products from the decomposition of organics, vaporized substrate, and removed contaminants.	**Science:** Laboratory tests are needed to evaluate the efficacy of vaporizing or decomposing organics and determine the decomposition reaction by-products: Hg, etc. and suitable trapping materials. Computer modeling of plasma-surface interactions and heat transfer are needed. **Development:** Plasma torches having geometries and conditions suitable for decontamination need to be developed along with suitable collection and gas treatment systems.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** ~$500K **Capital cost:** ~$100K **Operating cost:** $0.01-$1.00/ft² **Available at Y-12.**
	H Laser Heating DCON-73-OY *Ranking:** *H-5-2 ($2M; $3/ft²*	**Demonstration** Currently being used to remove contamination from metal surfaces. **Efficacy:** Likely to be effective in removing Hg and inorganic acids. Current prototype systems are capable of removing 2-mil-thick coatings at the rate of 100 ft2/hr. **Waste:** Waste will be prefilters and sorbent filled with contaminants.	**Development:** Current prototype needs to be evaluated for possible use on contaminated areas.	A collection system with adequate off-gas treatment would be needed to implement this technology. **Development cost:** $0.5M **Capital cost:** $0.5M /machine **Operating cost:** $1.00/ft²
	H Laser Ablation DCON-74-OY *Ranking:** *H-5-2 ($2M; $3/ft²*	**Demonstration** Several research groups at university and government laboratories have used the technology to remove radiological and organic contaminants from various surfaces. **Efficacy:** The technique is slow to remove large deposits. **Waste:** Wastes would be removed contaminants some substrate materials, and filters and sorbent from the off-gas treatment system.	**Development:** Existing lasers, delivery systems, and gas treatment system need to be integrated into a prototype system for demonstration.	A collection system with adequate off-gas treatment would be need to implement this technology. **Development cost:** $1M **Capital cost:** $0.5-1M/machine **Operating cost:** >$1.00/ft²
	H Flashlamp Cleaning DCON–77–OY *Ranking:** *H-5-2 ($2M; $3/ft²*	**Demonstration** Flashlamp systems are being used to remove organic contamination from metals, precious metals, and fragile substrates. Hanford-Westinghouse Laboratory is conducting tests of xenon flashlamp systems for removing radiological contamination from surfaces inside metal storage vessels. **Efficacy:** Technology is likely to be effective for surface Hg contamination. **Waste:** Wastes would be removed contaminants, some substrate material, and filters and sorbent from the collection system.	**Development:** Commercially available flashlamp systems need to be evaluated for Hg deposit removal.	A collection system for the vaporized contaminants would be needed to implement this technology. **Development cost:** ~$2 M **Capital cost:** $50-100K/machine **Operating cost:** ~3.00/ft²

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111) Initiate the design of pilot mercury roaster for the 9201-4 D&D project - Target Date 10/01/95. (Milestone No. OR270124) Complete the construction of the pilot mercury roaster for the 9201-4 D&D project - Target Date 9/30/98. (Milestone No. OR270123) Initiate the design of mercury roaster for the 9201-4 D&D project - Target Date 10/01/97. (Milestone No. OR270115) Complete Design of mercury roaster - Target Date 9/30/99. (Milestone No. OR270116) Begin construction of mercury roaster for 9201-4 D&D project - Target Date 4/01/2000. (Milestone No. OR270117) Complete construction of mercury roaster for 9201-4 D&D project - Target Date 3/31/2002. (Milestone No. OR270118)	• Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
3ulk Decontamination Methods	**H** Dry Heat (Thermal Desorption) DCON-4-OY *Ranking:** *H-4-2 ($0.5M; $12/lb)*	**Demonstration** This is a common industrial process when the contaminated materials can be taken to the thermal desorption process, but has not been used for Hg-contaminated materials. **Efficacy:** The like Hg, should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other combustion products. The contaminants must normally be removed by sorption and filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system. Engineering design data is needed.	Existing furnace designs can be used with a specific off-gas collection system for the contaminants removed. **Development cost:** $500K **Capital cost:**~$1M **Operating cost:** >$1.00/ft2
	M Chemical Leaching DCON-5-OY *Ranking:** *M-1-1.5 ($0.5M; <$1/ft^2)*	**Predemonstration** Chemical leaching is an accepted technique for some applications, but has not been used for Hg-contaminated materials. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a waste treatment system for treatment or recycle of spent chemical leaching solution. **Development cost:** Efficacy demo: $500K **Capital cost:** $150K **Operating cost:** <$1/ft2 or $5-$50/lb
	M Catalytic Extraction Process DCON-6-OY *Ranking:** *M-4-4 ($5M; $0.90/lb)*	**Predemonstration** Has not been used to smelt metal bearing Hg contamination. **Efficacy:** Effectiveness for separation of Hg is unknown. **Waste:** Slag containing contaminants plus contaminants in a scrubber solution and sorbents.	**Science:** Find a suitable fluxing agent to remove Hg and asbestos from the melt **Development:** Demonstrate the ability to remove Hg and asbestos.	"Off the shelf" induction of arc furnace. **Development cost:** $5 million **Capital cost:** ~$16 million **Operating cost:** $0.9/lb
	M Vacuum (Low Pressure) with Heat DCON-7-OY *Ranking:** *M-5-1 ($1M; $1.20/ft^2)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of some contaminants, however, this must be balanced against its cost. **Waste:** Sorbent containing removed contaminants and other volatiles.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of decontamination by volatilization under vacuum conditions for the specific heating applied.	**Development cost:** ~$1M **Operating cost:** $1.00-1.40/ft^2 or $2/lb **Capital cost:** $1M

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EM Goals
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship

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EM Problems
• Facility Decontamination and Decommissioning (D&D) • Remedial Action (RA)—Soils, Groundwater and Surface Water • Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4 Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	Chemical Foams DCON–8–OY *Ranking:** M *M-5-1 ($1M; $0.5-<$2/ft^2)*	**Demonstration** Widely used throughout the nuclear industry. Foam is used as a carrier of chemical decontamination agents, not as the agent itself. It can be sprayed on and wiped, rinsed, or vacuumed off. **Efficacy:** Effectiveness for listed contaminants and substrates has not been demonstrated. **Waste:** Small amount of contaminated sulfonated detergents, synthetic wetting agents, coupling agents, rinse water, and drying cloth.	**Development:** Scale-up/development of the process to a size appropriate for Y-12 use. The technology itself is inexpensive, but development of the proper chemical and appropriate foam carrier and scale-up will probably require support. **Improvement:** Full control over the mean bubble dimensions and the volume swell factor are needed, indicating that some basic research will be necessary.	A waste treatment system is needed for the foam and wastewater. **Development cost:** ~$1M **Capital cost:** $50K **Operating cost:** $0.50-$2/ft²
	Chemical Gels DCON–9–OY *Ranking:** M *M-4-1 ($1M; $0.5-$2/ft^2)*	**Demonstration** The use of chemical gels is most suited to ex-situ decontamination of large surfaces. Gel is used as a carrier of chemical decontamination agents, not as the agent itself. It is sprayed on component walls; allowed to work; and then scrubbed, wiped, rinsed, or peeled off. Steps include scraping and vacuuming of solid waste material, preliminary hot water rinsing, and gel spraying. **Efficacy:** Expected to be effective only for smearable contamination. **Waste:** Wastes would be carboxymethylcellulose gelling agent, aluminum nitrate chelating agent, wash water, acidic chemical agent (possibly nitric-hydrofluoric-oxalic acid), and the removed contaminants. Wastes are reportedly 4-5 times less compared to chemical solutions.	**Development:** Complex gel formulation with a number of compounds may be required, depending on the objectives. Laboratory optimization will be necessary, with any change in variables.	Normal implementation needs: **Development cost:** ~$1M **Capital cost:** <$50K **Operating cost:** $0.50-$2.00/ft²
	Fluoboric Acid Treatment DCON–11–OY *Ranking:** M *M-3-1 ($1M; <$1/ft^2)*	**Demonstration** Technology was designed specifically for D&D. Has not been used to remove listed contaminants. **Efficacy:** Attacks nearly every metal surface and metallic oxide. Removes oxide and contaminated outer layer in controllable, uniform and efficient manner. High decontamination factor (DF); however, high corrosion. **Waste:** Acid can be regenerated electrolytically. Final quantity of cement-solidified waste is 20-50g/m^2 decontaminated metal with regeneration; 200-500g/m^2 for neutralization, precipitation and solidification; or 400-700g/m^2 for ion exchange with solidification of resin.	**Development:** Although the method has seen application at Chernobyl with good results, development work is needed to test applicability at Alpha-4.	Fluoboric acid exhibits low vapor pressure and requires only standard precautions for acid or base work The plant can be manufactured in modular form and installed in existing buildings.Hardware (equipment): Fabrication of all key plant parts from polypropylene or from Halar-coated metal. **Development cost:** ~$1M **Capital cost:** to set up a plant for decontaminating 5 tons/day of steel was $774K, excluding development, planning, and buildings. (1990 dollars) **Operating cost:** will be relatively low; this is a very simple process.

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
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EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods — M	Inorganic Acid Treatments DCON–12–OY *Ranking:** *M-4-0 ($0M; >$1/ft²)*	**Accepted** Nitric acid decontamination has been the preferred method at Y-12 for cleaning items in various facility operations since the 1940s. In addition, the technique has been widely used at ORNL, K-25 and Portsmouth. **Efficacy:** DFs are in the 100 range. **Waste:** Wastes consist of large quantities of corrosive wastes containing the removed contaminants.	**Improvements:** Adaptation of modifications to system (i.e., scrubbers, filters, treatment for nitrates and heavy metals) in order to meet regulatory requirements. Possible development of HNO^3/HF decontamination methods, with or without ultrasonic agitation. Continuing research and development on waste treatment, and volume reduction.	Nitrate treatment facility either on site or accessible to decontamination facility. **Operating cost:** (>$1/ft²) May be relatively high. Nitric acid decontamination was used extensively at most DOE plants, but data is not available regarding costs. Currently, Portsmouth plant is developing a data base to track costs, but it will not contain historical data **Development cost:** (improvements) $400K-1M (rough estimate) **Capital cost:** <$4M-$10M (rough estimate) **Available at X-10, K-25.**
M	Caustic Detergent Treatments DCON–13–OY *Ranking:** *M-4-0 ($0M; >$1/ft²)*	**Accepted** Surface smearable decontamination with caustic chemicals (soap and water) is accepted technology and is used extensively at Y-12. The caustic hand-scrubbing process was applied to cleaning small items. **Efficacy:** Caustic scrubbing is expected to only partially decontaminate the contaminated surfaces. **Waste:** Wastes would consist of used caustic solution containing the removed contaminants.	None for removal of smearable contamination with carbonates, soaps, etc.	This is an established process that could be implemented at Y-12 with no major changes. **Capital cost:** <$10K **Operating cost:** >$1/ft **Available at X-10, K-25.**
L	REDOX Treatments DCON–14–OY *Ranking:** *L-3-1 ($1M; >$1/ft²)*	**Demonstration** REDOX treatments have been demonstrated for nuclear power plant decontamination, but not for the contaminants of interest. **Efficacy:** DFs of 10-100 can be expected based on experience in nuclear power plants. **Waste:** With recycle, waste is spent sorption and ion exchange media containing removed contaminants. With neutralization and evaporation, waste is a solid waste containing the removed contaminants and chemicals from the REDOX reagents.	**Development:** All REDOX techniques will require demonstration to determine their usefulness to decontamination of Y-12 operations and applicability to Hg.	A system for treating the REDOX reagents to permit recycling these reagents will be needed to use this technology. **Development cost:** ~$1M to bring a REDOX decontamination development through bench-scale and demonstration phases. **Capital cost:** >$1M **Operating cost:** >$1/ft
L	Hypochlorite Oxidation DCON–202–OY *Ranking:** *Not Ranked*	**Accepted** Core process is commercially available and practiced on an industrial scale. Integrated process needs to be demonstrated. **Efficacy:** Dependant on solution flushing efficiency. Core process reduces Hg in water effluent to <2ppb. **Waste:** Cleanup debris, some salts, spent resin and carbon.	Core technology is ready to use.	Normal implementation requirements and a fluid delivery and cleanup system needs to be integrated with core technology

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	Electropolishing DCON–15–OY *Ranking:** M *M-4-3 ($1M; >$2/ft²)*	**Demonstration** Electropolishing is a surface removal technique and the amount of surface removed is proportional to factors such as current, time, and voltage. **Efficacy:** Electropolishing is essentially a "line of sight" process so cracks, crevices, areas out of sight of, or shadowed by, the electrode will not be decontaminated. Contaminated electrolyte must be removed for complete decontamination to be achieved. **Waste:** Waste would be removed contaminants along with the small amount of substrate removed.	**Development:** Primary and secondary waste treatment and solution recycle need to be developed. Cleanup principles (e.g., ion exchange and filtering) are well established, so that only design and demonstration are needed. **Improvement:** Better methods to remove the electrolyte and contaminant would be helpful.	Normal implementation needs. **Development cost:** $1M **Capital cost:** $1M **Operating cost:** >$2/ft²
	Amalgamation DCON-16-OY *Ranking:** H *H-5-1 ($0.5M; N)*	**Predemonstration** Although amalgamation of mercury with metals of interest is well known, application to Y-12 problems areas has not been demonstrated. Copper and zinc are main metals of interest for amalgamation. **Efficacy:** Method transforms liquid Hg into a solid that is often easy to recover. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** Resulting amalgam, which is unreactive, is chief waste. Zn amalgam is ~57wt% Hg. The Cu amalgam is <76wt% Hg.	**Development:** Laboratory and bench scale assessment is needed to determine the suitability of this process to the Y-12 problems.	The availability of a suitable facility to do development work is assumed. **Development cost:** $500K (mainly personnel costs) **Duration:** 8 months **Capital cost:** $100K **Operating cost:** NA
	Biological DCON–17–OY *Ranking:** L *L-5-2 ($0.5M; $0.1-$3/ft²)*	**Evolving Technology / Pre-conceptual** The knowledge base exists for biological treatments of various contaminants; however, there is not a data base for application of the technology for surface decontamination. **Efficacy:** This technology is quite likely to be successful for HNO_3 and perhaps, H_2SO_4. It could be successful for Hg and LiOH, but he Hg and Li would remain in the bacterial sludge. **Waste:** The waste generated would be the contaminated layer of microbes removed from the treated surface.	**Science:** Literature study and bench-scale tests of microbes on Hg, LiOH, and H_2SO_4. **Development:** Develop methods for applying a layer of microbes, supplying needed nutrients, and removing the microbe layer from the decontaminated item.	Facilities for cultivating the bacteria and disposing of the bacterial sludge would be needed. **Development cost:** $300K-$600K **Capital cost:** ~$200K **Operating cost:** $0.10-$3.00+/ft² **Available at X-10, K-25.**

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	M Ultraviolet Light/Ozone DCON-19-OY *Ranking:** *M-4-3 ($1M; $3/ft^2)*	**Prodemonstration** While commercial systems exist for producing ozone using ultraviolet light, there has been no identified application for Hg removal. **Efficacy:** Ozone will be very effective for removing surface oils and PCB from painted surfaces, and various other substrates such as steel. Mercury is very activated by UV. **Waste:** The process produces ozone which will have to be handled along with the existing waste which will be gasified and will be in modified chemical forms.	**Development:** Demonstration of process and waste collection system. Establishment of removal/decon rates.	Development, design, and construction of a unit for ex-situ demonstration. **Development cost:** $1M **Capital Coast:** $100K **Operating cost:** ~$3/ft²
	M Chelation DCON–21–OY *Ranking:** *M-4-2 ($1.5M; <$1/ft^2)*	**Demonstration** The technology has been employed at various facility operations and nuclear power plant sites. **Efficacy:** Excellent DFs achieving acceptable decontamination levels resulting in unconditional release. Easy to apply as agent acts at neutral pH and are non-hazardous, non-fuming, have no gas evolution and are biodegradable. **Waste:** Simple waste minimizing treatment and disposal as a non-RCRA waste. Minimizes waste through oxidative destruction of chelate agent, partitioning of organics (including PCBs) and concentration of radionuclides precipitated out in the flocculent sludge which can be further de-watered.	**Development:** Validation of updated chelating agents is needed and is currently underway at ORNL to confirm total efficacy and economic advantage.	Application equipment for ex-situ decontamination. Support personnel and equipment to sample, analyze, develop appropriate concentrations, ensure oxidation of organics and/or complete partitioning will be necessary. Spray booth or dipping tank facilities with heating capabilities desirable on-site or accessible by decontamination facility. **Development cost:** ~$1.5M **Capital Coast:** ~$1.5M **Operating cost:** <$1/ft²
Metal Refining Methods	M Sulfide Conversion DCON-22-OY *Ranking:** *M-3-1 ($0.5M; N)*	**Evolving Technology** Must evaluate the kinetics of the room temperature reaction of sulfur with elemental Hg to form Hg S, which is not water soluble and which is often easier to collect than elemental Hg. **Efficacy:** Method applicable only to elemental Hg. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** The chief waste is the recovered HgS which is about 84 wt% Hg.	**Science/Development:** Both lab and bench scale experiments are required to determine the kinetics of the S and Hg reaction at room temperature and to evaluate the suitability of the method to the Y-12 Hg problems.	The required lab and bench-scale experiments are expected to be relatively simple. Existing equipment and facilities will likely support these activities with slight modifications. **Development cost:** $500K (mainly personnel costs) Duration: ~ 6months **Capital cost:** $100K **Operating cost:** NA

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EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Metal Refining Methods	M Bases and Alkaline Salts DCON-23-OY *Ranking:** *M-4-1 ($0M; $1/ft²)*	**Accepted** Cleaning with caustic solutions has long been used at K-25, Portsmouth Gaseous Diffusion Plant, and other nuclear sites in the U.S. and abroad. **Efficacy:** This technology is only effective for smearable contamination. **Waste:** Waste will be contaminated sludges or filter cakes resulting form neutralization and treatment of waste decontamination solutions.	None	A waste treatment system would be needed to treat or recycle spent decontamination solutions from this technology. **Development cost:** none **Capital cost:** <$100K (excluding a recycle system or waste treatment facilities) **Operating cost:** ~$1/ft²
	M Smelt Purification DCON-31-OY *Ranking:** *M-4-3 ($3.5M; $0.93/lb)*	**Demonstration** Smelt purification of metals has been performed by a large number of investigators on a lab-scale and by some investigators on a large-scale. The metals include mild steel, stainless steel, nickel, copper, monel, aluminum, and others. **Efficacy:** Uncertain - has not been used to purify metals from Hg. **Waste:** Wastes are slags, scrubber solutions, chemical trap materials, sorbents and HEPA filters.	**Development:** Demonstrate fluxing agents and conditions for removing contaminants of interest in the laboratory and then on a larger scale.	Scientific Ecology Group (SEG) personnel estimate the costs of metal smelting at roughly $0.93/lb of metal in 1992 dollars, depending on the type metal and configuration of the metal. Kellogg et al. estimated that the capital and operating costs of smelting the 90,000 tons of DOE scrap metal presently on hand at K-25 could be recovered through sale of the metal if a *de minimus* were established. The quantity of metals at in Bldg. 9201-4 is probably not sufficient to be cost effective unless added to this. The technology development needs will require further lab and pilot-scale evaluation. The development costs are roughly estimated at $3.5M.
	L Electrorefining DCON-32-OY *Ranking:** *L-4-3 ($3M; $6/lb)*	**Predemonstration** Electrorefining is a well-established commercial technology. However, this technology cannot be considered mature concerning its use for decontaminating Hg-contaminated metal because this application has not been established. **Efficacy:** Technology is likely to be effective for the listed contaminants and substrates. **Waste:** Waste would be solid waste from assumed treatment of electrolyte solutions for recycle.	**Development:** Demonstrate (1) separation of Hg from substrates of interest and (2) recycle electrolyte solutions.	An electrorefining plant would also require a smelting and anode forming facility to form the impure metal into anodes of proper configuration. The capital costs altogether are estimated at $200M. The cost of an operating facility with a 10 million-pound/year capacity is estimated at $2M capital and $6/lb operating costs, which exceed the present value of virtually any metal because commercial companies operate on a much larger scale. **Development cost:** ~$3M.

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EM Goals	Y-12 Problem	Problem Areas.Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship				

EM Problems	Y-12 Problem	Problem Areas.Constituents	Reference Requirements	Subelements
• Facility Decontamination and Decommissioning (D&D)	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination
• Remedial Action (RA)—Soils, Groundwater and Surface Water				
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ination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
tal Refining Methods L	Leach/electrowinning DCON-34-OG *Ranking:** *L-4-2 ($1M; $4.lb)*	**Predemonstration** The method is similar to electrorefining except the metal is first dissolved into solution rather than formed into anodes. Although this process is a well established commercial process for producing nickel from ore, it has not been demonstrated on a large scale for purifying metals contaminated with Hg. **Efficacy:** Uncertain-process has not been used to purify metals contaminated with Hg. **Waste:** Recycle of electrolytic solutions will result in a solid waste bearing the contaminants and traces of the purified metal amounting to roughly 2% by weight of the metal purified.	**Science:** Evaluate process for purifying metals contaminated with Hg, etc. **Development:** Demonstrate techniques to recycle the electrolytic solutions.	A *de minimus* standard is needed to permit sale of the purified metal. **Development cost:** >$1M **Capital cost:** $200M (10M lb/yr plant) **Operating cost:** ~$4/lb
echanical Surface Removal ethods H	Ultra High-Pressure Water DCON-35-OY *Ranking:** *H-5-1 ($1.3M; $1/ft²)*	**Accepted** Technology has been used by industry. **Efficacy:** The decontamination efficiency should be essentially 100% unless the contamination has diffused into the substrate. **Waste:** Unless a recycle system is developed, waste would be 3-5 gal water/ft² cleaned that contains ~0.01 ft³ metal residue, plus the contaminants removed.	**Improvement:** To minimize waste generation, a system is needed to treat the water so that it can be recycled. **Improvement:** Automation, especially for vertical surfaces.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** $1.3M **Capital cost:** ~$500K **Operating cost:** ~$1/ft²
H	Shot Blasting DCON-36-OY *Ranking:** *H-4-0 ($0M; $1/ft²)*	**Accepted** Commercial iron shot blasters are in use. **Efficacy:** They are generally effective but leave some hot spots. **Waste:** Waste would be spent shot, abraded substrate, and removed contaminants in filters and charcoal sorbents.	**Improvement:** Automation, especially for walls and ceilings.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$50K **Operating cost:** ~$1/ft²

EM Goals

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- Prevent Future Insult
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EM Problems

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Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Mechanical Surface Removal Methods	Grit Blasting DCON–38–OY *Ranking:** *M-5-1 ($0.25M; $2.50/ft²)* M	**Accepted** Has been used successfully for many applications in the nuclear industry. **Efficacy:** Technology is generally effective. **Waste:** Waste would be used grit, abraded substrate, and removed contaminants on filters and charcoal sorbent.	**Improvement:** automation, especially for walls and ceilings. Better vacuum system demonstration. Needs system for handling waste.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$50K **Operating cost:** $~5/ft²
	Centrifugal Cryogenic CO_2 Blasting DCON–39–OY *Ranking:** *H-5-2 ($0.75M; <$1/ft²)* H	**Demonstration** Centrifuge pellet acceleration has been demonstrated in the DOE fusion energy program, as a decontamination tool in the Y-12 facility waste minimization effort, and more recently, as an aircraft depaint mechanism. **Efficacy:** Technology is likely to be successful with very high decontamination factors, for ex-situ decon of all listed contaminants and for all substrates except asbestos. **Waste:** The waste will be HEPA filters and sorbents containing the combination of contaminants and substrate material.	**Development:** Demonstration of mobile system with high velocity pellets delivered at a sufficient rate and adequate collection of removed contaminants. **Improvement:** 1) Demonstration of an on-line, real time contaminant sensor which would minimize the decontamination effort and limit the waste stream; 2) automation	Design and construction of a vacuum waste-handling system to handle the vaporized CO_2 containing the removed contaminants plus oxygen-depletion precautions. **Development cost:** <$1M **Capital cost:** $100K **Operating cost:** <$1/ft²
	Ice Blasting DCON–40–OY *Ranking:** *H-5-1 ($0.75M; $2/ft²)* H	**Demonstration** **Efficacy:** Efficacy of commercial system for this application needs demonstration. Should be effective for cleaning most contaminants from substrates other than asbestos. **Waste:** Waste would be about 14 to 18 gallons per hour waste water containing removed contaminants.	**Development:** Demonstration of efficacy of commercial system. **Improvement:** Automation/robotics, especially for curved surfaces. Waste handling improvements required.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** $750K **Capital cost:** $100K-$1M **Operating cost:** ~$2/ft²
	Supercritical CO_2 Blasting DCON–41–OY *Ranking:** *M-5-3 ($0.75M; >$1/ft²)* M	**Predemonstration** **Efficacy:** Likely to be effective with nearly infinite decontamination factors. **Waste:** Waste would be removed Hg, LiOH, HNO_3, and moderate amounts of metal substrate contained in a cyclone, sorbent and/or a HEPA filter.	**Development:** Investigate the effect of operating parameters on removal rates and removal and collection efficiencies for contaminants. Demonstrate efficacy for contaminants of interest.	Design and construction of a vacuum waste-handling system with HEPA filters and sorbents to handle the vaporized CO_2 containing the removed contaminants, plus oxygen depletion precautions. **Development cost:** $250K-1M **Capital cost:** ~$500K-$750K **Operating cost:** ~$1+/ft²

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EM Goals
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EM Problems
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• Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Tarjet Date 9/30/97. (Mil.stone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Mechanical Surface Removal Methods	M — Plastic Pellet Blasting DCON-42-OY *Ranking:** *M-4-1 (<\$0.2M; \$1/ft²)*	**Accepted** Plastic pellet blasting is a widely used alternate to sand blasting for applications in which it is desired to impart minimal damage to the substrate. **Efficacy:** Technology should remove Hg and smearable contamination, but not fixed contamination. **Waste:** Waste would be spent plastic pellets plus removed contamination.	**Improvement:** Develop and demonstrate system for processing waste. **Improvement:** Minimize blast media erosion to minimize waste; automation/robotics; improve containment of waste and removed contaminants.	A system for processing waste to an acceptable form is needed. **Development cost:** (Improvements) <\$0.2M **Capital cost:** ~\$100K **Operating cost:** >\$1/ft²
	H — Hand Grinding, Honing, Scraping DCON-43-OY *Ranking:** *H-5-0 (\$0M; \$1/ft²)*	**Accepted** Grinding with hand-held power grinders has been successfully used for small-scale decontamination. **Efficacy:** Is effective for surface contamination. **Waste:** Surface area of item being decontaminated, spent grinding media (such as emery paper), and the adsorption canisters and HEPA filters on the vacuum system.	None	A system to collect and remove dust and mercury vaporized by the heat generated during grinding will be needed. **Development cost:** None **Capital cost:** \$150 (\$10K with vacuum system) **Operating cost:** ~\$1/ft²
	M — Automated Grinding DCON-44-OY *Ranking:** *M-5-3 (\$1M; \$1/ft²)*	**Conceptual** Grinding has been successfully used for small-scale decontamination. This grinding was done with hand-held power grinders. Remotely-operated grinding equipment is available, but no reverences to its use for decontamination have been found. **Efficacy:** Is effective for surface contamination **Waste:** Surface area of item being decontaminated, spent grinding media (such as emery paper), and the adsorption canisters and HEPA filters on the vacuum system.	**Development:** The applicability of this technology for decontamination needs to be demonstrated.	A collection system for the dust and vaporized Hg would be needed to implement this technology. **Development cost:** ~\$1M **Capital cost:** \$250K **Operating cost:** \$1/ft²

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: <u>Steel Process Eq.</u> Hg <u>Steel Process Eq.</u> LiOH <u>Steel Process Eq.</u> H_2SO_4, HNO_3 <u>Steel Process Eq.</u> Asbestos <u>Steel Process Eq.</u> Hg, LiOH, H_2SO_4, HNO_3, Asbestos <u>Nickel Process Eq.</u> Hg <u>Nickel Process Eq.</u> LiOH <u>Nickel Process Eq.</u> H_2SO_4, HNO_3 <u>Nickel Process Eq.</u> Asbestos <u>Nickel Process Eq.</u> Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Mechanical Surface Removal Methods	Metal Milling DCON-45-OY M *Ranking:** *M-4-0 ($0M; $20/ft²)*	**Accepted** Milling has been used to decontaminate metal items. Additional Comments: This technology most suitable when there are many similar items to be decontaminated because there is a 1/2 to 3/4h set-up time required between differently shaped items. The heat generated by the milling process will vaporize mercury. **Efficacy:** This technology is 100% effective since as much surface metal as is desired can be removed. **Waste:** The top layers (up to 1/8 in.) of the metal would be chipped off. the canisters used to collect the mercury vapor would also have to be disposed of.	None	The contaminated equipment must be removed and dissembled before this technology can be used. **Development cost:** none **Capital cost:** ~$150K **Operating cost:** $20/ft²
	Slurry Blasting DCON-50-OY M *Ranking:** *M-5-2 ($0.5M; $1.75/ft²)*	**Demonstration** The use of a combination of grit and water is well known to effectively remove a variety of contaminants. It is a moderately aggressive removal process. **Efficacy:** Likely to improve the decontamination rate over the high pressure water process; however, this must be balanced against a slightly more complex process. **Waste:** Aqueous solution of spent grit and removed contaminants. The inclusion of volatiles in the solution is a major question.	**Development:** The characteristics of the specific contaminants must be matched to the increased removal rate for the grit blasting concept. Separation of the contaminants from the aqueous spent grit matrix must be accomplished satisfactorily. **Improvement:** The on-line recycling process may need improvement for satisfactory operations.	A variety of commercial engineered systems are available with considerable operating experience. **Development cost:** $750-1250K **Capital cost:** >$0.5M **Operating cost:** $1.75/ft²
Surface Cleaning Methods	Compressed Air Cryogenic CO² Pellet Blasting DCON–51–OY M *Ranking:** *M-5-1 ($0.25M; $2/ft²)*	**Demonstration** This technology is commercially available. It has been used at nuclear reactor sites to decontaminate hand tools and some equipment. **Efficacy:** The efficacy of this technology for removing the listed contaminants from various substrates has not been demonstrated. **Waste:** Wastes would be sorbents and HEPA filters filled with the removed contaminants.	**Development:** Evaluate technology that has recently been demonstrated in Department of Defense programs regarding automation and improvements in pellet delivery.	Design and construction of a vacuum waste-handling system with HEPA filters and sorbent to handle the vaporized CO_2 and large volumes of air containing the removed contaminants plus oxygen depletion precautions. **Development cost:** ~$0.25M **Capital cost:** ~$200K **Operating cost:** ~$2/ft²

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Surface Cleaning Methods H	High-Pressure Water Blasting DCON–52–OY *Ranking:** *H-5-1 ($1.2M; <$1/ft²)*	**Accepted** High pressure water blasting has been used very successfully to decontaminate various large and complex surfaces at nuclear power plants. **Efficacy:** Technique is expected to be effective with a DF of about 50 for loosely adhering contamination. DFs will be higher if chemical cleaning agents are also used. Technique is expected to be ineffective for fixed contamination. **Waste:** Waste is 4 to >100 gpm of contaminated waste water.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. **Improvement:** Remote operation will necessitate the adaptation of the high pressure water and vacuum collection systems to robotic system control.	A water treatment system is needed to minimize waste. **Development cost:** Water treatment system: About $1.2M Remote operation: $3-4M **Capital cost:** $50K-$75K (about $250K with remote operation) **Operating cost:** <$1.00/ft²
M	Superheated Water DCON–53–OY *Ranking:** *M-5-1 ($1.2M; <$2/ft²)*	**Accepted** Technology is available and has been used by industry. **Efficacy:** The removal of loosely bound Hg should be complete, but the removal of more tightly bound contaminants is likely to be slight. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. **Improvement:** Remote operation will necessitate the adaptation of the superheated water and vacuum collection systems to robotic system control.	A water treatment system is needed to minimize waste. **Development cost:** Water treatment system: About $1.2M **Capital cost:** About $175K (about $250K with remote operation) **Operating cost:** ~$2.0/ft²
M	Water Flushing DCON–54–OY *Ranking:** *M-5-1 ($1.2M; <$1/ft²)*	**Accepted** Flushing with hot water is often used following scrubbing. **Efficacy:** The technique may be effective for the listed contaminants (except asbestos). **Waste:** The waste generated is the contaminated water from the flushing operation.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the hot water cleaning operation.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** About $1.2M **Capital cost:** <$50K **Operating cost:** <$1/ft²
M	Steam Cleaning DCON–55–OY *Ranking:** *M-5-1 ($1.2M; $1-2/ft²)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology should be effective for Hg, but not for the more tightly bound contaminants. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. Remote operation will necessitate the adaptation of the steam and vacuum collection systems to robotic system control.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** Water treatment system: About $1.2M **Capital cost:** $50K-$75K (about $250K with remote operation) **Operating cost:** $1-2/ft²
H	Hand Brushing for Surface Contamination DCON-56-OY *Ranking:** *H-4-0 ($0M; $1/ft²)*	**Accepted** Brushing is a common decontamination technique. **Efficacy:** Brushing is effective for smearable contamination, and less effective for fixed contamination. **Waste:** HEPA filters and adsorption canisters on the vacuum cleaner used to pick up the particles generated by brushing and the worn brushes.	None	Normal implementation needs. **Development cost:** none **Capital cost:** Negligible **Operating cost:** $1.00/ft2

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Methods M	Automated Brushing DECON-57-OY *Ranking:** *M-3-2 ($1M; $300/ft²)*	**Demonstration** this technology has been used at Rocky flats to remove plutonium contamination from the inside of pipes. Tests would be needed to demonstrate its effectiveness for other contaminants on other substrates. **Efficacy:** Brushing is effective for smearable contamination and less effective for fixed contamination. The interior of the pipes at Rocky Flats was cleaned to shiny metal. **Waste:** HEPA filters and adsorption canisters on the vacuums used to pick up the particles of contamination and the worn bushes.	**Development:** Test to demonstrate that this technology is effective for the problems at Alpha 4.	Vacuum collection system. **Development cost:** $1000K **Capital cost:** $250K **Operating cost:** $300/ft of pipe
M	Sponge Blasting DCON–58–OY *Ranking:** *M-4-1.5 ($1.2M; $2/ft²)*	**Accepted** Although the technology is relatively new, it is currently being used by at least two sites including a nuclear power plant. **Efficacy:** Extensive data on decontamination factors are not available. With the aggressive sponges, which are impregnated with abrasives, this technology may be effective for the listed contaminants and substrates. **Waste:** Wastes consist of about 0.01 ft³ of blasting media and removed contaminants per ft² of area decontaminated degraded sponges plus any liquid cleaning agents that may have been added.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the sponge blasting operation.	A wastewater treatment / recycle system will be needed to use this technology. **Improvement cost:** About $1.2M **Capital cost:** Sponge blasting system: About $20K (with sifter system) **Operating cost:** About $2/ft²
H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-2 ($2M; $3/ft²)*	**Demonstration** The technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the warm air stream. Filters and sorbents should remove the contaminants and constitute the final waste stream.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of a hot air cleanup system is needed.	An air cleanup system is needed to use this technology. **Development cost:** ~$2M **Capital cost:** $250-500K **Operating cost:** $3/ft²

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Methods	M Dry Heat DCON-60-OY *Ranking:** *M-5-2 ($1M; >$1/ft²)*	**Conceptual** The use of heat to increase the vapor pressure of semi-volatile materials is well known, but the use of heat for surface removal of Hg, etc. is unproven. **Efficacy:** This process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other vaporized materials. The contaminants must normally be removed by scrubbing, sorption, or possibly filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system.	An air cleanup system is needed to use this technology. **Development cost:** $1M **Capital cost:**~$1M **Operating cost:** >$1.00/ft²
	M Solvent Washing to Remove Radiological Contamination DCON-61-OY *Ranking:** *M-5-1 (<$1M; $1/ft²)*	**Conceptual** Plutonium contaminated items at Richland, WA were rinsed with Freon. The vendor who supplied the equipment for Richland ten years ago no longer sells it. **Efficacy:** This technique is mainly applicable to smearable contamination. **Waste:** Waste would be spent solvent containing removed contaminants.	**Science:** Solvents that are less damaging to the environment need to be identified and demonstrated.	Vapor collection system **Development cost:** <$1M to identify and demonstrate the replacement solvent. **Capital cost:** $300K (1980 dollars) **Operating cost:** ~$1/ft² (An average of 7.5 minutes per item was required when decontaminating small items.) **Available in Private Sector.**
	M Solvent Washing to Remove PCBs DCON-62-OY *Ranking:** *M-4-1 (<$1M; $1/ft²)*	**Conceptual** Solvent degreasing was stopped to avoid exposing the workers and the environment to the hazardous solvents. This equipment is produced by a number of manufacturers and could be used with the proper solvent to remove PCBs. **Efficacy:** The technique is effective for most organics. Waste: Waste would be spent solvent containing removed contamination.	**Science:** Solvents that are less damaging to the environment and effective in removing PCBs need to be identified and demonstrated.	**Capital cost:** $400K (1992 dollars) for a 4,000-lb capacity unit. **Labor cost:** One operator for one hour to load, clean, and unload 4,000 lb of metal.
	M Strippable Coatings DCON-63-OY *Ranking:** *M-4-0($0M; >$1.50/ft²)*	**Accepted** Technology has been used for decontamination applications involving hazardous and radioactive contaminants. **Efficacy:** Decontamination factors of over 90% can be expected with two applications. **Waste:** Waste is a solid polymer containing the removed contaminants. The average thickness of the applied coating is a mm. This may be incinerated to reduce the final volume.	**Improvement:** Develop coating with lower material costs and greater ease of application.	Normal implementation needs. **Development cost:** none **Capital cost:** <20K **Operating cost:** $1.50/ft2

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #3 Ex situ decontamination of: Steel Process Eq. Hg Steel Process Eq. LiOH Steel Process Eq. H_2SO_4, HNO_3 Steel Process Eq. Asbestos Steel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos Nickel Process Eq. Hg Nickel Process Eq. LiOH Nickel Process Eq. H_2SO_4, HNO_3 Nickel Process Eq. Asbestos Nickel Process Eq. Hg, LiOH, H_2SO_4, HNO_3, Asbestos	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	• Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

mination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Methods	**M** Vacuum Cleaning DCON-64-OY *Ranking:** *M-2-0 (0M; < $0.75//ft²)*	**Accepted** Vacuum cleaners have long been used to clean up loose contamination. **Efficacy:** Any contaminants which are in a loose, solid form will be collected effectively in a HEPA filter vacuum system. **Waste:** A HEPA filter and/or sorbent with the collected contaminants.	None	Normal implementation needs. **Capital cost:** <$25K **Operating cost:** <$0.75/ft2
	M Ultrasonic Cleaning DCON-65-OY *Ranking:** *M-3-1 ($0.4M; $7//ft²)*	**Accepted** Ultrasonic cleaning has been used for many years in the private sector and in government installations for removing surface contamination from relatively small metal parts which can fit into an ultrasonic bath. **Efficacy:** Will not be effective on Hg amalgamates. May separate asbestos from metal and remove chemical contaminants. **Waste:** Spent ultrasonic bath solutions containing any removed contaminants.	**Improvement:** Definition of acceptable cleaning liquids which (1) are not hazardous, (2) can be separated from the contaminants, and (3) can be reused to minimize secondary wastes. **Improvement:** More aggressive cleaning action.	Requires removal, disassembly, and size reduction of contaminated equipment. **Improvements cost:** $400K **Capital cost:** $10K-$100K **Operating cost:** $5-10/ft² or more
	M Vibration Cleaning DCON-66-OY *Ranking:** *M-3-1 ($0.5M; $6//ft²)*	**Demonstration** **Efficacy:** Vibratory cleaning is likely to be effective for a variety of Y-12 problems. **Waste:** The problems of cross-contamination within the pellet medium and recycle of the pellets and solution remain.	**Development:** Methods for recycle of the pellets and solutions must be developed.	A bench scale demo lasting ~9 months is needed. **Development cost:** $0.5M **Capital cost:** $60K **Operating cost:** ~$6/ft²
Thermal Surface Removal Methods	**H** Plasma Torch DCON-72-OY *Ranking:** *H-5-2 ($0.5M; $2//ft²)*	**Evolving Technology Conceptual** Plasma torches exist commercially to weld and cut materials that have very high melting temperatures or require an inert atmosphere. **Efficacy:** Its efficacy in removing Hg or various organic contaminants or to remove layers of contaminated metal has not been investigated. **Waste:** Wastes would consist of materials used to trap reaction products from the decomposition of organics, and the listed contaminants.	**Science:** Laboratory tests are needed to evaluate the efficacy of vaporizing or decomposing organics and mercury and determine the decomposition reaction by-products and suitable trapping materials. Computer modeling of plasma-surface interactions and heat transfer are needed. **Development:** Plasma torches having geometries and conditions suitable for decontamination need to be developed along with suitable collection and gas treatment systems.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** ~$500K **Capital cost:** ~$100K **Operating cost:** $2/ft² **Available at Y-12.**
	M Laser Heating DCON-73-OY *Ranking:** *M-4-4 ($0.5M; <$1//ft²)*	**Demonstration** Currently being used to remove contamination form metal surfaces. **Efficacy:** Current prototype systems are capable of removing 2-mil-thick coating at the rate of 100 ft2/hr. Likely to be effective in removing Hg and inorganic acids. **Waste:** Waste will be sorbents and HEPA filters filled with contaminants.	**Development:** Current prototype needs to be evaluated for possible use on contaminated areas. **Science:** Systems with different operational parameters (e.g., wavelength, pulse durations) should be evaluated as well.	Normal implementation needs. **Development cost:** $0.5M **Capital cost:** $0.5M/machine **Operating cost:** <$1.00/ft²

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
hermal Surface Removal ethods	Laser Ablation DCON-74-OY *Ranking:** *M-4-4 ($1M; <$1/ft²)*	**Demonstration** Several research groups at university and government laboratories have used the technology to remove radiological and organic contaminants from various surfaces. **Efficacy:** The technique is slow to remove large deposits. **Waste:** Wastes would be removed deposits, some substrate material, and filters and sorbents from the off-gas treatment system.	**Development:** Existing lasers, delivery systems, and off-gas treatment systems need to be integrated into a prototype system for demonstration.	Prior removal and disassembly of contaminated equipment, a glove box in which the deposit removal is done, and a collection system with adequate off-gas treatment system would be needed to implement this technology. **Development cost:** $1M **Capital cost:** $0.5-1M/machine **Operating cost:** >$1.00/ft²
	Plasma Surface Cleaning DCON-75-OY *Ranking:** *M-5-3 ($1M; $1.75/ft²)*	**Predemonstration** Plasma surface cleaning by glow discharges are commonly and effectively utilized for cleaning high bonding energy contaminants from surfaces of metals prior to the operation of fusion devices. **Efficacy:** Technology is expected to be effective for removing deposits from listed substrates. **Waste:** Wastes would be sorbents and HEPA filters from the collection system.	**Science:** Data on cleaning rates for mercury and other contaminants and various substrates of interest are needed. **Development:** The capability of plasma generation and cleaning on complex internal surfaces of contaminated equipment with large surface areas needs to be established.	A collection system with appropriate sorbents and filters for the vaporized deposits would be needed to use this technology. **Development cost:** $1M **Capital cost:** $0.5-1M/machine **Operating cost:** >$1.75/ft² **Available at Y-12.**
	Plasma Etching DCON-76-OY *Ranking:** *M-5-3 ($1.3M; $3/ft²)*	**Predemonstration** Plasma etching processes are used in material processing and microelectronic manufacturing. **Efficacy:** Extrapolating these plasma processes for vaporizing and recovering Hg deposits is considered feasible. **Waste:** Wastes would be the vaporized deposits plus filters and sorbents from the collection system.	**Science:** Data on cleaning rates for contaminants and substrates of interest are needed. **Development:** The capability of plasma etching on deposits in complex equipment with large surface areas and curved surfaces needs to be established.	A collection system with appropriate filters and sorbents for the vaporized deposits would be needed to use this technology. An electric power supply would be needed. **Development cost:** ~$1.3M **Capital cost:** ~$1M **Operating cost:** $3/ft²
	Flashlamp Cleaning DCON-77-OY *Ranking:** *M-5-2 ($2M; $3/ft²)*	**Demonstration** Flashlamp systems are being used to remove organic contamination from metals, precious metals, and fragile substrates. Hanford-Westinghouse Laboratory is conducting tests of xenon flashlamp systems for removing radiological contamination from surfaces inside metal storage vessels. **Efficacy:** Technology is likely to be effective for surface mercury contamination. **Waste:** Wastes would be removed contaminants, some substrate material, and HEPA filters and sorbent from the off-gas collection system.	**Development:** Commercially available flashlamp systems need to be evaluated for mercury deposit removal.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** $2 M **Capital cost:** $50-100K/machine **Operating cost:** $3/ft²

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111) Initiate the design of pilot mercury roaster for the 9201-4 D&D project - Target Date 10/01/95. (Milestone No. OR270124) Complete the construction of the pilot mercury roaster for the 9201-4 D&D project - Target Date 9/30/98. (Milestone No. OR270123) Initiate the design of mercury roaster for the 9201-4 D&D project - Target Date 10/01/97. (Milestone No. OR270115) Complete Design of mercury roaster - Target Date 9/30/99. (Milestone No. OR270116) Begin construction of mercury roaster for 9201-4 D&D project - Target Date 4/01/2000. (Milestone No. OR270117) Complete construction of mercury roaster for 9201-4 D&D project - Target Date 3/31/2002. (Milestone No. OR270118)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Bulk Decontamination Methods	Incineration DCON–2–OY *Ranking:** *H-3-12 ($0M; $10/lb)* H	**Accepted** Incineration is being used at the -25 site. **Efficacy:** The K-1435 incinerator give 99.99 to 99.999% destruction and removal efficiency when burning toxic organics. Incineration should also be effective in removing mercury from concrete chunks. **Waste:** Incinerator ash will be concrete residue containing any uranium originally present. Mercury will be in the off-gas treatment system. During a test, the K-1435 incinerator generated 1.1 gallons of wastewater per 100 pounds of waste fed.	None	A new incinerator or modifications to the off-gas treatment system suitable for containing mercury would be necessary to use this technology. The K-1435 incinerator requires the services of about 30 maintenance workers (maintenance mechanics, welders, and instrument mechanics), their supervisors, 34 chemical operators, their supervisor, and 7 engineers. About 8-10 years is required for writing an environmental impact statement, holding public hearings, and obtaining the necessary permits, (RCRA, NESHAP, and Clean Air Act) **Development cost:** none **Capital cost:** $26M (1987 dollars) **Operating cost:** $10/lb (1992 dollars)
	Dry Heat (Thermal Desorption) DCON-4-OY *Ranking:** *H-4-2 ($0.5M; $12/lb)* H	**Demonstration** This is a common industrial process when the contaminated materials can be taken to the desorption process but has not been used for Hg-contaminated materials. **Efficacy:** This will handle almost any decontamination where heating will effectively volatilize the contaminants. **Waste:** Filtration or sorption can be utilized to clean the hot air stream before release. Contaminated HEPA filters and sorbents will be the final waste form.	**Development:** Engineering design data is needed.Improvement may be necessary in off-gas treatment for acceptance.	Existing furnace configurations should be applicable with a specific off-gas collection system for the contaminants removed. **Development cost:** $500K **Capital cost:** ~$0.5M **Operating cost:** $12/lb
	Chemical Leaching DCON-5-OY *Ranking:** *M-1-1.5 ($0.5M; <$1/ft²)* M	**Predemonstration** Chemical leaching is an accepted technique for some applications. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a waste treatment system for treatment or recycle of spent chemical leaching solution is needed. **Development cost:** Efficacy Demo: $250K Waste treatment: $250K **Capital cost:** $1.3-2M **Operating cost:** <$1/ft2 or $5-$50/lb

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Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Bulk Decontamination Methods M	Vacuum (Low Pressure with heat) DCON-7-OY *Ranking:** *M-5-1 ($1M; $1.20/ft^2)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of some contaminants, however, this must be balanced against its cost. **Waste:** Sorbent containing removed contaminants and other volatiles.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of decontamination by volatilization under vacuum conditions for the specific heating applied **Improvement:** In situ conditions need better designs to apply the vacuum heat combination efficiently.	An off-gas treatment system would be needed. **Development cost:** $500K **Capital cost:** $1M **Operating cost:** $1.2/ft^2 or 2/lb
Chemical Surface Cleaning Methods M	Chemical Foams DCON-8-OY *Ranking:** *M-5-1 ($1M; $0.5-2/ft^2)*	**Demonstration** Chemical foams have been widely used as carriers for decontamination agents. **Efficacy:** Foams should be effective in holding decontamination agents in contact with concrete floors and structures. **Waste:** Wastes would be contaminated sulfonated detergents, synthetic wetting agents, and coupling agents plus removed contaminants.	**Development:** A decontamination agent that removes mercury and is compatible with foam formulation must be found and demonstrated.	A waste treatment system is needed for the foam and wastewater. **Development cost:** ~$1M **Capital cost:** <$50K **Operating cost:** $0.5-$2.0/ft^2
M	Chemical Gels DCON-9-OY *Ranking:** *M-4-1 ($1M; $0.5-2/ft^2)*	**Demonstration** The use of chemical gels is most suited to decontamination of large surfaces. Gel is used as a carrier of chemical decontamination agents, not as the agent itself. It is sprayed on component walls; allowed to work; and then scrubbed, wiped, rinsed, or peeled off. **Efficacy:** Expected to be effective only for smearable contamination. **Waste:** Wastes would be carboxymethylcellulose gelling agent, aluminum nitrate chelating agent, waste water, acidic chemical agent (possibly nitric-hydrofluoric-oxalic acid), and the removed contaminants. Wastes are reportedly 4-5 times less compared to chemical solutions.	**Development:** Complex gel formulation with a number of compounds may be required depending on the objectives. Laboratory optimization will be necessary, with any change in variables.	Normal implementation needs: **Development cost:** ~$1M **Capital cost:** <$50K **Operating cost:** $0.5-$2.0/ft^2
M	Organic Acid Treatments DCON-10-OY *Ranking:** *M-3-1 ($1M; N)*	**Demonstration** In principal, organic acids can attack Hg, but organic acids have not been demonstrated to be effective on concrete or in removing Hg. **Efficacy:** Whether organic acids will be effective in removing Hg and the other listed contaminants from concrete is unproven and uncertain. **Waste:** After neutralization, waste would be filter cakes or sludges containing any removed contaminants.	**Development:** Effectiveness of candidate organic acids for removing Hg and other listed contaminants needs demonstration on a small scale. Waste treatment techniques should also be demonstrated on a small scale.	A suitable waste treatment system will be needed to implement this technology. **Development cost:** ~$1M **Capital cost:** <$50K for in situ treatment; $4-10M for an ex-situ treatment facility and new waste treatment facilities **Operating cost:** $300/metric ton for ex-situ treatment.

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	• Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods.	M Fluoboric Acid Treatment DCON-11-OY *Ranking:** *M-3-1 ($1M; <$1/ft²)*	**Demonstration** Technology was designed specifically for D&D. **Efficacy:** It is likely to be highly effective. I removes the outer layer in a controlled and effective manner. **Waste:** The acid can be electrolytically regenerated and recycled with radioactive waste plated out to the cathode and solidified in cement. Final quantity of cement-solidified waste is 20-50- grams/m2 of decontamination surface. Other waste treatment options are possible.	**Development:** Although the method has seen application at Chernobyl with good results, development work is needed to test applicability at Bldg. 9201-4.	A waste treatment plant is needed to treat the waste-water resulting from the decontamination operation. **Development cost:** $1000K (Rough estimate) **Capital cost:** $800K (1990 estimate for equipment only for 5T/day capacity of metal) **Operating cost:** <$1/ft²
	M Inorganic Acid Treatments DCON-12-OY *Ranking:** *M-4-0 ($0M; >$1/ft²)*	**Accepted** Nitric acid decontamination has been the preferred method at Y-12 for cleaning metal items in various facility operations, but not for concrete, since the 1940s. In addition, the technique has been widely used for metal decontamination at ORNL, K-25 and Portsmouth. **Efficacy:** DFs are in the 100 range. **Waste:** Wastes consist of large quantities of corrosive wastes containing the removed contaminants.	**Improvements:** Adaptation of modifications to system (i.e., scrubbers, filters, treatment for nitrates and heavy metals) in order to meet regulatory requirements. Possible development of HNO3/HF decontamination methods, with or without ultrasonic agitation. Continuing research and development on waste treatment, and volume reduction.	A treatment plant is needed to treat the wastewater resulting from the decontamination operation. **Development cost:** (improvements) $400K-1M (rough estimate) **Capital cost:** <$4-10M (rough estimate) **Operating cost:** <$1/ft² **Available at X-10, K-25.**
	M Caustic Detergent Treatment DCON-13-OY *Ranking:** *M-4-0 ($0M; >$1/ft²)*	**Accepted** Surface smearable decontamination with caustic chemicals (soap and water) is accepted technology and is used extensively for many years. Riding and power scrubbers are available for floors. **Efficacy:** Soaps, carbonates, etc., will remove smearable, but not fixed contamination. **Waste:** Waste would be spent detergent solution containing removed contaminants (normally treated by neutralization and precipitation)	None for removal of smearable contamination with carbonates, soaps, etc.	A waste treatment plant is needed to treat the waste-water resulting from the decontamination operation. **Development cost:** none **Capital cost:** <$10K **Operating cost:** >$1/ft2 (<$1ft2 with a riding scrubber) **Available at X-10, K-25.**
	Hypochlorite Oxidation DCON–202–OY *Ranking:** *Not Ranked*	**Accepted** Core process is commercially available and practiced on an industrial scale. Integrated process needs to be demonstrated. **Efficacy:** Dependant on solution flushing efficiency. Core process reduces Hg in water effluent to <2ppb. **Waste:** Cleanup debris, some salts, spent resin and carbon.	Core technology is ready to use.	Normal implementation requirements and a fluid delivery and cleanup system needs to be integrated with core technology

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EM Problems
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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	Amalgamation DCON-16-OY H *Ranking:** *H-5-1 ($0.5M; N)*	**Predemonstration:** Although amalgamation of mercury with metals of interest is well known, application to Y-12 problems areas has not been demonstrated. Copper and zinc are main metals of interest for amalgamation. **Efficacy:** Method transforms liquid Hg into a solid that is often easy to recover. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** Resulting amalgam, which is unreactive, is chief waste. Zn amalgam is ~57wt% Hg. The Cu amalgam is <76wt% Hg.	**Technology Development Needs:** Laboratory and bench scale assessment is needed to determine the suitability of this process to the Y-12 problems.	The availability of a suitable facility to do development work is assumed. **Development cost:** $500K (mainly personnel costs) **Duration:** 8 months **Capital cost:** $100K **Operating cost:** NA
	Biological Surface Cleaning DCON-17-OL L *Ranking:** *L-5-2 ($0.5M; $0.1-3/ft²)*	**Evolving Technology / Pre-conceptual** The knowledge base exists for biological treatments of mercury; however, there is not a data base for application of the technology for surface decontamination. **Efficacy:** This technology is quite likely to be successful for oil and PCBs. It could be successful for mercury, but would remain in the bacterial sludge. **Waste:** The waste generated would be the contaminated layer of microbes removed from the treated surface.	**Science:** Literature study and bench-scale tests of microbes on mercury. **Development:** Develop methods for applying a layer of microbes, supplying needed nutrients, and removing the microbe layer from the decontaminated area.	Facilities for cultivating the bacteria and disposing of the bacterial sludge would be needed. **Development cost:** $300K-$600K **Capital cost:** ~$200K **Operating cost:** $0.10-$3.00+/ft² **Available at X-10, K-25.**
	Chelation DCON-21-OY M *Ranking:** *M-4-2 ($1.5M; <$31/ft²)*	**Demonstration** The technology has been employed at various facility operations and nuclear power plant sites. **Efficacy:** Excellent DFs achieving acceptable decontamination levels resulting in unconditional release. Easy to apply in situ as agent acts at neutral pH and are non-hazardous, non-fuming, have no gas evolution and are biodegradable. **Waste:** Simple waste minimizing treatment and disposal as a non-RCRA waste. Minimizes waste through oxidative destruction of chelate agent, partitioning of organics (including PCBs) and concentration of radionuclides precipitated out in the flocculent sludge which can be further de-watered.	**Development:** Validation of updated chelating agents is needed and is currently underway at ORNL to confirm total efficacy and economic advantage.	Application equipment for in situ decontamination. Support personnel and equipment to sample, analyze, develop appropriate concentrations, ensure oxidation of organics and/or complete partitioning will be necessary. **Development cost:** ~$1.5M **Capital cost:** ~$1.5M **Operating cost:** <$1/ft²

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EM Problems

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Chemical Surface Cleaning Methods	Sulfide Conversion DCON-22-OY M *Ranking:* M-3-1 ($0.5M; N)*	**Evolving Technology** Must evaluate the kinetics of the room temperature reaction of sulfur with elemental Hg to form HgS, which is not water soluble and which is often easier to collect than elemental Hg. **Efficacy:** Method applicable only to elemental Hg. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** The chief waste is the recovered HgS which is about 84wt% Hg.	**Science/Development:** Both lab and bench scale experiments are required to determine the kinetics of the S and Hg reaction at room temperature and to evaluate the suitability of the method to the Y-12 Hg problems.	The required lab and bench-scale experiments are expected to be relatively simple. Existing equipment and facilities will likely support these activities with slight modifications. **Development cost:** $500K (mainly personnel costs) Duration: ~ 9months **Capital cost:** $100K **Operating cost:** NA
	Bases and Alkaline Salts DCON-23-OY M *Ranking:* M-4-1 ($0M; $1/ft²)*	**Accepted** Cleaning with caustic solutions has long been used at K-25, Portsmouth Gaseous Diffusion Plant, and other nuclear sites in the U.S. and abroad. **Efficacy:** This technology is only effective for smearable contamination. **Waste:** Waste will be contaminated sludges or filter cakes resulting from neutralization and treatment of waste decontamination solutions.	None	A waste treatment system would be needed to treat or recycle spent decontamination solutions from this technology. **Development cost:** none **Capital cost:** <$100K (excluding a recycle system or waste treatment facilities) **Operating cost:** ~$1/ft²
Mechanical Surface Cleaning Methods	Ultrahigh-Pressure Water DCON-35-OY H *Ranking:* H-5-1 ($1.3M; $1/ft²)*	**Accepted** Technology has been used by industry. **Efficacy:** Should work on concrete at 9201-4. **Waste:** Unless a recycle system is developed, waste would be 3-5 gal water/ft² concrete cleaned that contains ~0.01 ft³ concrete residue, plus the contaminants removed.	**Technology Improvement:** To minimize waste generation, a system is needed to treat the water so that it can be recycled. **Technology Improvement:** Automation, especially for walls and ceilings.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** $1300K **Capital cost:** ~$500K **Operating cost:** ~$1/ft²
	Shot Blasting DCON-36-OY H *Ranking:* H-4-0 ($0M; $1/ft²)*	**Accepted** Commercial iron shot blasters are in use at the K-25 site. **Efficacy:** They are generally effective but leave some hot spots. **Waste:** Waste is ~0.01 ft³ removed concrete (1/16" cut) containing removed contaminants plus 0.05lb spent shot per ft² of concrete decontaminated.	**Technology Improvement:** Automation, especially for walls and ceilings.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$50K **Operating cost:** ~$1/ft²

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Mechanical Surface Cleaning Methods	Scabblers/Scarifiers DCON-37-OL **M** *Ranking:** *M-3-0 ($0M; >$1/ft²)*	**Accepted** Mechanical scabblers are used commonly for concrete decontamination. **Efficacy:** They are generally effective, but leave some hot spots. Waste is ~0.01 ft³ removed substrate (1/16" cut) containing removed contaminants per ft² of substrate decontaminated	**Technology Improvement:** Automation, especially for walls and ceilings.	A collection system with adequate filtration and sorption. **Development cost:** None **Capital cost:** ~$500K (largest size) **Operating cost:** > $1/ft² (more than shot blasting)
	Grit Blasting DCON-38-OY **M** *Ranking:** *M-5-1 ($0.25M; $2.50/ft²)*	**Accepted** Has been used successfully for many applications in the nuclear industry. **Efficacy:** Technology is generally effective. **Waste:** Waste is ~0.01 ft³ removed concrete (1/16" cut) containing removed contaminants per ft² of concrete decontaminated plus spent grit.	**Technology Improvement:** automation, especially for walls and ceilings.	A collection system with adequate filtration and sorption. **Development cost:** $0.25M **Capital cost:** ~$500K (largest size) **Operating cost:** ~$2.5/ft²
	Centrifuge Cryogenic CO_2 Pellet Blasting DCON-39-OY **H** *Ranking:** *H-5-2 ($0.75M; <$1/ft²)*	**Predemonstration** Centrifuge pellet acceleration has been demonstrated in the DOE fusion energy program, as a decontamination tool in the Y-12 facility waste minimization effort, and more recently as an aircraft depaint mechanism. **Efficacy:** Technology is likely to be successful with very high decontamination factors. **Waste:** The waste will be HEPA filters and sorbents containing the combination of contaminants and substrate material.	**Development:** Demonstration of mobile system with high velocity pellets delivered at a sufficient rate and adequate collection of removed contaminants.	Design and construction of a vacuum waste-handling system to handle the vaporized CO_2 containing the removed contaminants plus oxygen-depletion precautions. **Development cost:** <$1M **Capital cost:** ~$100K **Operating cost:** <$1/ft² (200-2000 ft²/hr)
	Ice Blasting DCON-40-OY **H** *Ranking:** *H-5-1 ($0.75M; $2/ft²)*	**Demonstration** **Efficacy:** Efficacy of commercial system for this application needs demonstration. **Waste:** Waste would be about 14 to 18 gallons per hour waste water containing removed contaminants.	**Development:** Demonstration of efficacy of commercial system.Waste handling improvements required.	A water treatment system is needed to minimize liquid wastes from this technology. **Capital cost:** $100K-$1M **Operating cost:** ~$2/ft²
	Supercritical CO_2 Blasting DCON-41-OY **M** *Ranking:** *M-5-3 ($0.75 M; >$1/ft²)*	**Predemonstration** **Efficacy:** Likely to be effective with nearly infinite decontamination factors. **Waste:** Waste would be removed concrete and contaminants contained in a cyclone, sorbent, and/or a HEPA filter.	**Development:** Investigate the effect of operating parameters on removal rates and removal and collection efficiencies for contaminants. Demonstrate efficacy for contaminants of interest.	Design and construction of a vacuum waste-handling system with HEPA filters and sorbents to handle the vaporized CO_2 containing the removed contaminants, plus oxygen depletion precautions. **Development cost:** $250K-1M **Capital cost:** ~$500-750K **Operating cost:** $1+/ft²

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Mechanical Surface Cleaning Methods	Plastic Pellet Blasting DCON-42-OY M *Ranking:** *M-4-1 (<$0.2M; <$1/ft²)*	**Accepted** Plastic pellet blasting is a widely used alternate to sand blasting for applications in which it is desired to impart minimal damage to the substrate. **Efficacy:** Technology should remove Hg and smearable contamination, but not fixed contamination, from concrete. **Waste:** Waste would be spent plastic pellets plus removed contamination.	**Technology Improvement:** Develop and demonstrate system for processing waste. **Technology Improvement:** Minimize blast media erosion to minimize waste; automation/robotics, especially for walls, etc.; improve containment of waste and removed contaminants.	A system for processing waste to an acceptable form is needed. **Development cost:** <$0.2M **Capital cost:** $100K **Operating cost:** >$1/ft²
	Hand Grinding, Honing, Scraping DCON-43-OY H *Ranking:** *H-5-0 ($0M; $1/ft²)*	**Accepted** **Efficacy:** Grinding with hand-held power grinders has been successfully used for small-scale decontamination. **Waste:** Waste would be removed concrete plus contaminants and spent emery paper or dust.	None	A system to collect and remove dust and Hg vaporized by the heat generated during grinding will be needed. **Development cost:** None **Capital cost:** $150 ($5K with vacuum system) **Operating cost:** ~$1/ft² **Available at X-10, K-25.**
	Automated Grinding DCON-44-OY M *Ranking:** *M-5-3 ($1M; $1/ft²)*	**Conceptual** Grinding has been successfully used for small scale decontamination. This grinding was done with hand-held power grinders Remotely operated grinding equipment is available, but no references to its use for decontamination have been found. **Efficacy:** The decontamination efficiency should be essentially 100% unless the contamination has diffused deep into the concrete. **Waste:** Waste would be removed contaminants and substrate contained in filters and sorbent.	**Development:** The applicability of this technology to decontamination should be demonstrated.	A collection system for the dust and vaporized Hg deposits would be needed to implement this technology. **Development cost:** ~$1M **Capital cost:** $250K **Operating cost:** $1/ft²
	Electro-Hydraulic Scabbing DCON-46-OY M *Ranking:** *M-5-2 (<$1M; >$2/ft²)*	**Demonstration** EHS is an aggressive surface removal technique which controls the amount of material removed by the applied pulse energy and its frequency. Shock waves and cavitating bubbles are generated in water by pulses to crush and crack the concrete surface. **Efficacy:** The process is considered practical for concrete with application of robotic technology where necessary for operator protection. **Waste:** This is the removed substrate containing the contaminants.	**Development:** An effective waste handling and solution recycle system is needed. **Improvement:** The method to contain the water and removed material. The robotic capabilities should be improved where necessary.	Evaluate the prototype equipment for material removal effectiveness with the appropriate waste collection system. **Development cost:** >$750K **Operating cost:** $2/ft² including capital cost.

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Alternatives		Technologies	Status	Science/ Technology Needs	Implementation Needs
echanical Surface Cleaning ethods	M	Concrete Milling DCON-47-OL *Ranking:** *M-3-2 (<$3M; $2/ft²)*	**Conceptual** The equipment is commercially available, but no reference to its use for decontamination has been found. This technology is suited for horizontal surfaces only. **Efficacy:** The decontamination efficiency should be essentially 100% unless the contamination has diffused deep into the concrete. **Waste:** Waste would be removed concrete (6-25mm) contaminants.	**Development:** The technology to operate this equipment remotely needs to be developed and demonstrated.	Normal implementation needs. **Development cost:** <$3M **Capital cost:** $50K-$363K **Operating cost:** $2/ft²
	L	Explosive DCON-48-OY *Ranking:** *L-3-5 ($4M; $50/ft²)*	**Demonstration** Explosive scrabbling has been used to decontaminate nuclear reactors, but has not been demonstrated for Hg decontamination. **Efficacy:** Technology is expected to be successful. **Waste:** Waste would be rubble from removing 3-4" concrete plus removed contaminants.	**Development:** Safety concerns need to be resolved. Better contanment of dust is needed. **Improvement:** Better methods of applying the explosives and more uniform detonations that remove less concrete are needed.	A certified blasting technician and covers to contain the dust will be needed along with an air evacuation system with filters and sorbent. **Development cost:** $4M **Capital cost:** <$50KM **Operating cost:** $50/ft²
	H	Concrete Chipping DCON-49-OY *Ranking:** *H-3-0 ($0M; $5/ft²)*	**Accepted** Pavement breakers and chipping breakers have been successfully used to remove contaminated concrete in the nuclear industry. **Efficacy:** Technology is generally effective if concrete is removed to the depth that the contamination has penetrated and contamination is not spread by the dust produced. **Waste:** Waste is up to 20 yards³ removed concrete/day for a breaker and 27 ft³/day for a chipper containing removed contaminants plus work hammers and chippers.	**Improvement:** Automation, especially for walls and ceilings, and a collection system for chipped, contaminated concrete.	A dust collection system is needed for chipped, contaminated concrete. **Development cost:** none **Capital cost:** <$50K **Operating cost:** $5/ft²
	M	Slurry Blasting DCON-50-OY *Ranking:** *M-5-2 ($0.5M; $1.75/ft²)*	**Demonstration** The use of a combination of grit and water is well known to effectively remove a variety of contaminants. It is a moderately aggressive removal process. **Efficacy:** Likely to improve the decontamination rate over the high pressure water process; however, this must be balanced against a slightly more complex process. **Waste:** Aqueous solution of spent grit and removed contaminants. The inclusion of volatiles in the solution is a major question.	**Development:** The characteristics of the specific contaminants must be matched to the increased removal rate for the grit blasting concept. Separation of the contaminants from the aqueous spent grit matrix must be accomplished satisfactorily. **Improvement:** The on-line recycling process may need improvement for satisfactory operations.	A variety of commercial engineered systems are available with considerable operating experience. **Development cost:** $0.5M **Capital cost:** >$0.5M **Operating cost:** $1.75/ft²

Deconta

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Surface Cleaning Methods	Compressed-Air Cryogenic CO_2 Pellet Blasting DCON-51-OY *Ranking:** *M-5-1 ($0.25M; $2/ft²)* M	**Demonstration** This technology is commercially available. It has been used at nuclear reactor sites to decontaminate hand tools and some equipment. **Efficacy:** The efficacy of this technology for removing the listed contaminants from concrete has not been demonstrated and is doubtful. **Waste:** Wastes would be sorbents or HEPA filters filled with the removed contaminants.	**Development:** Automation required for cleaning high walls and ceilings. **Improvement:** Better waste handling.	Design and construction of a vacuum waste-handling system with sorbents or HEPA filters to handle the vaporized CO_2 containing the removed contaminants plus oxygen depletion precautions. **Development cost:** ~$0.25M **Capital cost:** ~$200K **Operating cost:** ~$2/ft²
	High-Pressure Water DCON-52-OY *Ranking:** *H-5-1 ($1.2M; <$1/ft²)* H	**Accepted** High pressure water blasting has been used very successfully to decontaminate various large and complex surfaces at nuclear power plants. **Efficacy:** Technique is expected to be effective with a DF of about 50 for loosely adhering contamination on concrete. DFs will be higher if chemical cleaning agents are also used. Technique is expected to be ineffective for fixed contamination on concrete. **Waste:** Waste is 4 to >100 gpm of contaminated waste water.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused.	A water treatment system is needed to minimize waste. **Development cost:** Water treatment system: About $1.2M **Capital cost:** $50-$175K **Operating cost:** <$1.00/ft²
	Superheated Water DCON-53-OY *Ranking:** *M-5-1 ($1.2M; <$2/ft²)* M	**Accepted** Technology is available and has been used by industry. **Efficacy:** Technology should be effective except for contamination that has soaked into the concrete. On finished concrete, technology may drive contamination deeper into substrate. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused.	A water treatment system is needed to minimize waste. **Development cost:** Water treatment system: About $1.2M **Capital cost:** About $175K **Operating cost:** ~$2.00/ft²
	Water Flushing DCON-54-OY *Ranking:** *M-5-1 ($1.2M; <$1/ft²)* M	**Accepted** Flushing with hot water is often used following scrubbing, especially on floors. **Efficacy:** The technique is not effective for the listed contaminants. On finished concrete, technology may drive contaminants deeper into substrate. **Waste:** The waste generated is the contaminated water from the flushing operation.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the hot water cleaning operation.	A water treatment system is needed to minimize liquid wastes from this technology. **Development cost:** About $1.2M **Capital cost:** <$50K **Operating cost:** <$1/ft²

Deconta

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship				

EM Problems

EM Problems	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Facility Decontamination and Decommissioning (D&D)	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination
• Remedial Action (RA)—Soils, Groundwater and Surface Water				
• Waste Management (WM)				

ination

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
urface Cleaning Methods	M	Steam Cleaning DCON-55-OL *Ranking:** *M-5-1 ($1.2M; $1-2/ft^2)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology should be effective for Hg, but not for more tightly bound contaminants or contamination that has soaked into the concrete. On finished concrete, technology may drive contaminants deeper into substrate. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Technology Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused.	A wastewater treatment / recycle system will be needed to use this technology. **Development cost:** Water treatment system: About $1.2M **Capital cost:** $50K-$75K **Operating cost:** ~ $1.00-2.00/ft^2
	H	Hand Brushing Used to Remove Surface Contamination DCON-56-OY *Ranking:** *H-4-0 ($0M; $1/ft^2)*	**Accepted** Manual brushing has been used to remove loose contamination for years. **Efficacy:** Since mercury is expected to be in loose form brushing is expected to be effective. **Waste:** Waste consists of HEPA filters or sorbents on the vacuum cleaner used to pick up the mercury.	None	Normal implementation needs. **Development cost:** none **Capital cost:** <$10K **Operating cost:** $1.00/ft^2 **Available at K-25.**
	M	Automated Brushing DCON-57-OY *Ranking:** *M-3-2 ($1M; $300/ft^2)*	**Demonstration** This technology has been used at Rocky Flats to remove plutonium contamination from the inside of pipes. **Efficacy:** Tests would be needed to demonstrate its effectiveness for other contaminants on other substrates. **Waste:** Waste would be removed contamination plus any other loose debris.	**Development:** Tests to demonstrate that this technology is effective for the problems at Bldg. 9201-4.	Vacuum collection system **Development cost:** $1M **Capital cost:** $250K(remotely operated system) **Operating cost:** >$1/ft^2
	M	Sponge Blasting DCON-58-OL *Ranking:** *M-4-1.5 ($1.2M; $2/ft^2)*	**Accepted** Although the technology is relatively new, it is currently being used by at least two sites including a nuclear power plant. **Efficacy:** Extensive data on decontamination factors are not available. With the aggressive sponges, which are impregnated with abrasives, this technology may be effective for decontaminating concrete. **Waste:** Wastes consist of about 0.01 ft^3 of blasting media and removed contaminants per ft^2 of area decontaminated, spent sponge plus any liquid cleaning agents that may have been added.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be recycled and reused in the sponge blasting operation.	A wastewater treatment / recycle system will be needed to use this technology. **Development cost:** About $1.2M **Capital cost:** Sponge blasting system: About $20K (with sifter system) **Operating cost:** About $2/ft^2

Deconta

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems
• Facility Decontamination and Decommissioning (D&D)
• Remedial Action (RA)—Soils, Groundwater and Surface Water
• Waste Management (WM)

mination

Alternatives		Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Methods	H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-2 ($2M; $3/ft²)*	**Demonstration** This technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the off-gas stream. HEPA filters and sorbents should remove the contaminants and constitute the final waste stream collection system matrix.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of a hot air cleanup system with HEPA filters and sorbents is needed.	An air cleanup system is needed to use this technology. **Development cost:** ~$2M **Capital cost:** $250-500K **Operating cost:** $3/ft²
	M	Dry Heat DCON-60-OY *Ranking:** *M-5-2 ($1M; >$1/ft²)*	**Accepted** The use of heat to increase the vapor pressure of semi-volatile materials is well known, but the use of heat for surface removal of Hg, etc. is unproven. **Efficacy:** This process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other vaporized materials. The contaminants must normally be removed by scrubbing, sorption, or possibly filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of and off-gas removal system.	An air cleanup system is needed to use this technology. **Development cost:** $1M **Capital cost:** $250-500K **Operating cost:** >$1/ft²
	M	Solvent Washing DCON-61&62-OY *Ranking:** *M-5-1 ($1M; $1/ft²)*	**Conceptual** Solvent cleaning of small items has been used at K-25, and the cleaning of larger areas has been demonstrated at Hanford. The use of solvent cleaning has been stopped at both sites to avoid exposing workers and the environment to the hazardous solvents. Other solvents may be available, but their effectiveness would have to be demonstrated. **Efficacy:** This technique is mainly applicable to smearable contamination. **Waste:** Waste would be spent solvent containing removed contaminants.	**Development:** Solvents that are less damaging to the environment need to be identified and demonstrated.	Solvent off-gas collection and treatment system would be needed. **Development cost:** <$1M **Capital cost:** <$100K **Operating cost:** ~$1.0/ft²

Deconta

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

mination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Methods	**M** Strippable Coatings DCON-63-OY *Ranking:** *M-4-0 ($0M; >$1.50/ft²)*	**Accepted** Technology has been used for decontamination applications involving hazardous and radioactive contaminants. **Efficacy:** Decontamination factors of over 90% can be expected with two applications. **Waste:** Waste is a solid polymer (volume = 1 mm x surface area decontaminated) containing the removed contaminants. This may be incinerated to reduce the final volume.	**Improvement:** Develop coatings with lower material costs and greater ease of application for the specific wall surfaces of interest.	Normal implementation needs. **Development cost:** None **Capital cost:** <20K **Operating cost:** >$1.50/ft²
	M Vacuum Cleaning DCON-64-OY *Ranking:** *M-2-0 ($0M; <$0.75/ft²)*	**Accepted** Vacuum cleaners have long been used to clean up loose contamination. **Efficacy:** Any contaminants which are in a loose, solid form will be collected effectively in a vacuum system. **Waste:** A HEPA filter and/or sorbent with the collected contaminants.	None	Normal implementation needs. **Capital cost:** <$25K **Operating cost:** <$0.75/ft²
	H Microwave Vaporization DCON-67-OY *Ranking:** *H-3-3 ($1.4M; $3/ft²)*	**Predemonstration** ORNL has fabricated and tested a prototype microwave concrete removal system. The mercury vaporization technique represents an extension of ongoing program. **Efficacy:** needs to be established., an the potential to leave floors and walls unscathed. **Waste:** The process has the potential to generate very little waste other than the volatile compounds extracted with the Hg vapor collected.	Requires proof of principle experiment and prototype development. Requires establishment of removal efficiency and cleaning rates.	Implementation of this system will require robot mounting and the addition of a Hg collection system. **Development cost:** $1.4M **Capitol cost:** $130K **Operating cost:** $3/ft² (including amortization of capital cost) **Cleaning rate:** ~25/ft²/hr

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

mination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Surface Cleaning Methods	**M** Microwave Scrabbling DCON-71-OY *Ranking:** *M-3-2 ($2.5M; >$1/ft²)*	**Predemonstration** In FY 1991 ORNL demonstrated reliable removal of noncontaminated concrete surfaces using a stationary microwave device. A mobile device is under development. **Efficacy:** Since microwave scrabbling removes the contaminated concrete surface, the decontamination efficiency should be essentially 100% unless the contamination has diffused deep into the concrete. **Waste:** The waste generated is concrete rubble with particle diameters lying primarily in the range of 1 to 10 mm plus the contaminants. For a removal depth of 10 mm, 0.03 ft³ of concrete rubble is generated per ft² of concrete decontaminated.	**Development:** The development and testing of a mobile prototype microwave concrete removal machine needs to be completed.	Normal implementation needs. **Development cost:** $2.5M **Capital cost:** ~$250K **Operating cost:** >$1/ft²
	H Plasma Torch DCON-72-OL *Ranking:** *H-5-2 ($0.5M; $2/ft²)*	**Evolving Technology Conceptual** Plasma torches exist commercially to weld and cut materials that have very high melting temperatures or require an inert atmosphere. **Efficacy:** Its efficacy in removing Hg or various organic contaminants or to spall off layers of contaminated concrete has not been investigated. **Waste:** Wastes would consist of materials used to trap reaction products from the decomposition of organics and spalled concrete with mercury contamination.	**Science:** Laboratory tests of thermal stress-induced spalling of concrete are needed. Computer modeling of plasma-surface interactions and heat transfer in concrete are needed. **Development:** Plasma torches having geometries and conditions suitable for decontamination need to be developed along with suitable collection and gas treatment systems.	Normal implementation needs. **Development cost:** ~$500K **Capital cost:** ~$200K **Operating cost:** $2.00/ft² **Available at Y-12.**
	M Laser Heating DCON-73-OY *Ranking:** *M-4-4 ($0.5M; <$1/ft²)*	**Demonstration** Currently being used to remove contamination from concrete surfaces. **Efficacy:** Current prototype systems are capable of removing 2-mil-thick coatings at the rate of 100 ft²/hr. Likely to be effective in removing Hg and inorganic acids. **Waste:** Waste will be prefilters or sorbents and HEPA filters filled with contaminants.	**Development:** Current prototype needs to be evaluated for possible use on contaminated areas.	A collection system for the vaporized contaminants would be needed to implement this technology. **Development cost:** $0.5M **Capital cost:** $500K/machine **Operating cost:** ~$1/ft²

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EM Goals
• Clean Up Legacy Waste
• Prevent Future Insult
• Develop Environmental Stewardship

EM Problems
• Facility Decontamination and Decommissioning (D&D)
• Remedial Action (RA)—Soils, Groundwater and Surface Water
• Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Ref Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #4 Painted concrete and clay tile contaminated with: PCB oil U, (and daughters) electrolytes Cd Pb Cr, and Hg.	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

nination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
hermal Surface Cleaning lethods M	Laser Ablation DCON-74-OY *Ranking:** *M-4-4 ($1M; >$1/ft^2)*	**Demonstration** Several research groups at university and government laboratories have used the technology to remove radiological and organic contaminants from various surfaces. **Efficacy:** The technique is slow to remove large deposits. **Waste:** Wastes would be removed contaminants, some substrate material, and HEPA filters and sorbents from the off-gas treatment system.	**Development:** Existing lasers, delivery systems, and filtration systems need to be integrated into a prototype system for demonstration.	A collection system for the vaporized contaminants would be needed to implement this technology. **Development cost: $1M** **Capital cost: $0.5-1M/machine** **Operating cost: >$1/ft²**
M	Flashlamp Cleaning DCON-77-OY *Ranking:** *M-5-2 ($2M; $3/ft^2)*	**Demonstration** Flashlamp systems are being used to remove organic contamination from metals, precious metals, and fragile substrates. Hanford-Westinghouse Laboratory is conducting tests of xenon flashlamp systems for removing radiological contamination from surfaces inside metal storage vessels. **Efficacy:** Efficacy for mercury on concrete is unknown. **Waste:** Wastes would be only the contaminants removed from the concrete contained in pre-filters or sorbents and HEPA filters.	**Science:** Existing flashlamps should be tested on a small scale for removing mercury from concrete. **Development:** A moderate-scale demonstration of flashlamp decontamination of concrete with the associated vacuum collection system is needed.	A collection system for the vaporized contaminants would be needed to implement this technology. **Development cost: $2 M** **Capital cost: $100-$150K** **Operating cost: $3.0/ft²**

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas.Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem # 5 Air Contaminated with Hg	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

mination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Air Cleaning Methods	Adsorption DCON-79-OY *Ranking:** **H** *H-4-0 ($1.3M; $200K/yr)*	**Accepted.** This is the accepted method for controlling mercury emissions. **Efficacy:** Over 99.5% efficiency. **Waste:** ~150 ft^3 Hg contaminated sorbent/yr	**Improvement:** System to recover mercury and spent adsorbent.	**Development (improvement) cost:** $1.3M **Capital cost:** ~$20K **Operating cost:** ~$200K/yr
	Condensation DCON-80-OY *Ranking:** **H** *H-4-0 ($0M; $6100K/yr)*	**Conceptual.** No references to the use of this technology for mercury on a large scale were found. **Efficacy:** Should be effective for recovering Hg. **Waste:** The mercury itself.	**Development:** Large scale demonstration.	Distillation may be required to purify the mercury. **Development cost:** $1.3M **Capital cost:** ~$100K **Operating cost:** ~$20,000/yr
	Electrostatic Precipitation DCON-81-OY *Ranking:** **L** *L-4-4 ($5M; $500K/yr)*	**Pre-conceptual.** No references to the use of electrostatic precipitation to remove of mercury to low levels was found. **Efficacy:** Very poor. Mercury is very volatile, and electrostatic precipitation is only effective on contaminants in condensed forms. **Waste:** The mercury itself.	**Science:** Tests to demonstrate the use of electrostatic precipitation to remove mercury from air. **Development:** Design and testing of full-scale system.	**Development cost:** $5M **Capital cost:** <$1M **Operating cost:** <500,000/yr
	Scrubbing DCON-82-OY *Ranking:** **H** *H-4-0 ($0; $10-20/ft^2)*	**Accepted** Scrubbing is often used to for air pollution control, but no references to its use for mercury were found. **Efficacy:** 90% (for most contaminants). **Waste:** ~1 gal/lb mercury None.	None	A system for treating the scrubber solution for release is needed to use this technology. **Capital cost:** $200-300K **Operating cost:** $10-20/AC
	Filtration DCON-83-OY *Ranking:** **H** *H-4-0 ($0; $12K/yr)*	**Accepted** HEPA filters are widely used to remove contaminated particles or droplets from air. **Efficacy:** Conventional HEPA filters remove only aerosols not gaseous contaminants. Because mercury has a high vapor pressure at ambient temperatures, HEPA filtration at ambient temperature can only reduce the concentration of mercury to about 12.5 mg/m^3. This is above the TLV (0.05 mg/m^3). The use of a HEPA filter upstream of an adsorbent trap might be economical. The HEPA filter would reduce the amount of spent sorbent that would be disposed of, and the adsorbent would reduce the mercury concentration to the desired value. **Waste:** ~150 ft^3/yr	None	**Development cost:** None **Capital cost:** $20K **Operating cost:** $12K/yr

Deconta

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #6 Insulation and building paper with Hg and U (and daughters) and Problem #9 Wood and sheet rock contaminated with: Hg LiOH H_2SO_4 HNO_3 U (and daughters) Asbestos and/or PCBs	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination
			Initiate the design of pilot mercury roaster for the 9201-4 D&D project - Target Date 10/01/95. (Milestone No. OR270124) Complete the construction of the pilot mercury roaster for the 9201-4 D&D project - Target Date 9/30/98. (Milestone No. OR270123) Initiate the design of mercury roaster for the 9201-4 D&D project - Target Date 10/01/97. (Milestone No. OR270115) Complete Design of mercury roaster - Target Date 9/30/99. (Milestone No. OR270116) Begin construction of mercury roaster for 9201-4 D & project - Target Date 4/01/2000. (Milestone No. OR270117) Complete construction of mercury roaster for 9201-4 D&D project - Target Date 3/31/2002. (Milestone No. OR270118)	

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

ination

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
ulk Decontamination ethods	**M** Solvent Extraction DCON-1-OY *Ranking:** *M-1-2 (<$1M;N)*	**Demonstration** Solvent extraction is a mature technical field but specific extractants have not been identified for PCB extraction. **Efficacy:** An attractive solvent, triethylamine, has been evaluated for organic extraction from sludge and found to be a very effective solvent and one for which industrial processing equipment is available commercially. Not expected to be effective for Hg, U, asbestos, or inorganic acids. **Waste:** Wastes would be spent solvent with removed contaminants. Solvent recycle equipment and off-gas treatment equipment could be easily adapted for use here. Difficult to apply in situ.	**Development:** Survey and tests of specific extractants applicable to PCB-contaminated materials are needed. A portable "spot" remover can be developed or adapted from commercial devices. Applicability of rotary contractor, solvent recycle and, if appropriate because of solvent selection, should be demonstrated. An off-gas treatment system.	**Development cost:** <$1M assuming availability of lab scale and pilot-scale extraction units from ORNL, and industrial participation in demo. No unusual costs for deployment, since development (pilot-scale) equipment may be used in production. **Operating cost:** NA
	H Incineration DCON-2-OY *Ranking:** *H-3-12 ($0M; $10/lb)*	**Accepted** The incineration of contaminated combustible materials is common in the nuclear industry. **Efficacy:** Hg & volatile contaminants will go into the off-gas. PCBs can be destroyed. Non-volatile materials will go into the ash. **Waste:** This will depend on the designs of the incinerator and the ash content of the waste being fed.	None	The system will have to be designed to prevent mercury emissions. **Development cost:** none **Capital cost:** $26M **Operating cost:** $10/lb About 8-10 years will be required for writing an environmental impact statement; holding public hearings, and obtaining the necessary permits- TSCA permit, RCRA permit, NESHAP permit, and Clean Air Act permit.
	H Dry Heat (Thermal Desorption) DCON-4-OY *Ranking:** *H-4-2 ($0.5M; $12/lb)*	**Demonstration** This is a common industrial process when the contaminated materials can be taken to the process, but has not been used for Hg-contaminated materials. **Efficacy:** The thermal desorption process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other combustion products. The contaminants must normally be removed by sorption and filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system. Engineering design data is needed.	Existing furnace designs can be used with a specific off-gas collection system for the contaminants removed. **Development cost:** $500K **Capital cost:**~$1M **Operating cost:** $12/lb

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #6 Insulation and building paper with Hg and U (and daughters) and Problem #9 Wood and sheet rock contaminated with: Hg LiOH H_2SO_4 HNO_3 U (and daughters) Asbestos and/or PCBs	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111).	Decontamination

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Alternatives		Technologies	Status	Science/ Technology Needs	Implementation Needs
Bulk Decontamination Methods	M	Chemical Leaching DCON-5-OY *Ranking:** *M-1-1.5 ($0.5M; <$1/ft²)*	**Predemonstration** Chemical Leaching is an accepted technique for some applications, but has not been used for Hg-contaminated materials. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a system for treatment or recycle of spent chemical leaching solution. **Development cost:** Efficacy demo: $500K **Capital cost:** $150K **Operating cost:** <$1/ft² or $5-$50/lb
	M	Catalytic Extraction Process DCON-6-OY *Ranking:** *M-4-4 ($5M; $0.90/lb)*	**Predemonstration** Has not been used to process material bearing Hg contamination. **Efficacy:** Effectiveness for separation of Hg is unknown. **Waste:** Slag containing contaminants plus contaminants in a scrubber solution and/or sorbents.	**Science:** Find a suitable fluxing agent to remove Hg and asbestos from the melt **Development:** Demonstrate the ability to remove Hg and asbestos.	"Off the shelf" induction of arc furnace. **Development cost:** $5 million **Capital cost:** ~$16 million **Operating cost:** $0.9/lb
	M	Vacuum (Low Pressure with Heat) DCON-7-OY *Ranking:** *M-5-1 ($1M; $1.20/ft2)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of some contaminants, however, this must be balanced against its cost. **Waste:** Sorbent containing removed contaminants and other volatiles.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of volatilization under vacuum conditions for the specific heating applied.	An off-gas treatment system would be needed. **Development cost:** ~$500K **Capital cost:** $1M **Operating cost:** $2/lb
Surface Cleaning Methods	H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-2 ($2M; $3/ft²)*	**Demonstration** The technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the warm air stream. Sorbents should remove the contaminants and constitute the final waste stream.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of a hot air cleanup system with sorbents is needed.	An off-gas treatment system would be needed. **Development cost:** ~$2M **Capital cost:** $250-500K **Operating cost:** $3/ft²

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4- Target Date 9/30/97. (Milestone No. OR270111) Complete removal of drainable residual mercury from process equipment/piping - Target Date 6/30/94. (Milestone No. OR270114) Initiate the design of pilot mercury roaster for the 9201-4 D&D project - Target DAte 10/01/95. (Milestone No. OR270124) Complete the construction of the pilot mercury roaster for the 9201-4 D&D project - Target Date 9/30/98. (Milestone No. OR270123) Initiate the design of mercury roaster for the 9201-4 D&D project - Target Date 10/01/97. (Milestone No. OR270115) Complete Design of mercury roaster - Target Date 930/99. (Milestone No. OR270116) Begin construction of mercury roaster for 9201-4 D7D project - Target Date 4/01/2000. (Milestone No. OR270117) Complete construction of mercury roaster for 9201-4 D&D project - Target DAte 3/31/2002. (Milestone No. OR270118)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Bulk Decontamination Methods				
H	Dry Heat (Thermal Desorption Roasting) DCON-4-OY *Ranking:** *H-4-2 ($0.5M; $12/lb)*	**Demonstration** This is a common industrial process when the contaminated materials can be taken to the desorption process, but has not been used for Hg-contaminated materials. **Efficacy:** The roasting process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other combustion products. The contaminants must normally be removed by sorption before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system. Engineering design data is needed.	Existing furnace designs can be used with a specific off-gas collection system for the contaminants removed. **Development cost:** $500K **Capital cost:**~$1M **Operating cost:** $12/lb
M	Chemical Leaching DCON-5-OY *Ranking:** *M-1-1.5 ($0.5M; <$1/ft²)*	**Predemonstration** Chemical Leaching is an accepted technique for some applications but has not been used for Hg-contaminated materials. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective. **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a system for treatment or recycle of spent chemical leaching solution. **Development cost:** Efficacy demo: $500K **Capital cost:** $150K **Operating cost:** <$1/ft2 or $5-$50/lb
M	Catalytic Extraction Process DCON-6-OY *Ranking:** *M-4-4 ($5M; $0.90/lb)*	**Predemonstration** Has not been used to smelt process material bearing Hg contamination. **Efficacy:** Effectiveness for separation of Hg is unknown. **Waste:** Slag containing contaminants plus contaminants in a scrubber solution.	**Science:** Find a suitable fluxing agent to remove Hg and asbestos from the smelt. Development demonstrate the ability to remove Hg and asbestos.	"Off the shelf" induction of arc furnace. **Development cost:** $5 million **Capital cost:** ~$16 million **Operating cost:** $0.9/lb
M	Vacuum (Low Pressure with Heat) DCON-7-OY *Ranking:** *M-5-1 ($1M; $1.20/ft²)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of some contaminants, however, this must be balanced against its cost. **Waste:** Sorbent containing removed contaminants and other volatiles.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of decontamination by volatilization under vacuum conditions for the specific heating applied.	An off-gas treatment system would be needed. **Development cost:** ~$1M **Capital cost:** $1M **Operating cost:** $2/lb

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EM Goals

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EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
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Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	Electropolishing DCON–15–OY M *Ranking:* M-4-3 ($1M; >$2/ft²)*	**Demonstration** Electropolishing is a surface removal technique and the amount of surface removed is proportional to factors such as current, time, and voltage. **Efficacy:** Electropolishing is essentially a "line of sight" process so cracks, crevices, areas out of sight of, or shadowed by, the electrode will not be decontaminated. Contaminated electrolyte must be removed for complete decontamination to be achieved. **Waste:** Waste would be removed contaminants along with the small amount of substrate removed.	**Development:** Primary and secondary waste treatment and solution recycle need to be developed. Cleanup principles (e.g., ion exchange and filtering) are well established, so that only design and demonstration are needed. **Improvement:** Better methods to remove the electrolyte and contaminant would be helpful.	Normal implementation needs. **Development cost: $1M** **Capital cost: $1M** **Operating cost: >$2/ft²**
	Amalgamation DCON-16-OY H *Ranking:* H-5-1 ($0.5M;N)*	**Predemonstration** Although amalgamation of mercury with metals of interest is well known, application to Y-12 problems areas has not been demonstrated. Copper and zinc are main metals of interest for amalgamation. **Efficacy:** Method transforms liquid Hg into a solid that is often easy to recover. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** Resulting amalgam, which is unreactive, is chief waste. Zn amalgam is ~57wt% Hg. The Cu amalgam is <76wt% Hg.	**Technology Development Needs:** Laboratory and bench scale assessment is needed to determine the suitability of this process to the Y-12 problems.	The availability of a suitable facility to do development work is assumed. **Development cost: $500K** (mainly personnel costs) **Duration: 8 months** **Capital cost: $100K** **Operating cost: NA**
	Biological DCON–17–OY L *Ranking:* L-5-2 ($0.5M; $0.1-3/ft²)*	**Evolving Technology / Pre-conceptual** The knowledge base exists for biological treatments of various contaminants; however, there is not a data base for application of the technology for surface decontamination. **Efficacy:** This technology is quite likely to be successful for HNO3 and perhaps, H2SO4. It could be successful for Hg and LiOH, but he Hg and Li would remain in the bacterial sludge. **Waste:** The waste generated would be the contaminated layer of microbes removed from the treated surface.	**Science:** Literature study and bench-scale tests of microbes on Hg, LiOH, and H2SO4. **Development:** Develop methods for applying a layer of microbes, supplying needed nutrients, and removing the microbe layer from the decontaminated item.	Facilities for cultivating the bacteria and disposing of the bacterial sludge would be needed. **Development cost: $300K-$600K** **Capital cost: ~$200K** **Operating cost: $0.10-$3.00+/ft²** **Available at X-10, K-25.**

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Surface Cleaning Methods	Chelation DCON–21–OY M *Ranking:* M-4-2 ($1.5M; <$1/ft²)*	**Demonstration** The technology has been employed at various facility operations and nuclear power plant sites. **Efficacy:** Excellent DFs achieving acceptable decontamination levels resulting in unconditional release. Easy to apply in situ as agent acts at neutral pH and are non-hazardous, non-fuming, have no gas evolution and are biodegradable. **Waste:** Simple waste minimizing treatment and disposal as a non-RCRA waste. Minimizes waste through oxidative destruction of chelate agent, partitioning of organics (including PCBs) and concentration of radionuclides precipitated out in the flocculent sludge which can be further de-watered.	**Development:** Validation of updated chelating agents is needed and is currently underway at ORNL to confirm total efficacy and economic advantage.	Application equipment for in situ decontamination. Support personnel and equipment to sample, analyze, develop appropriate concentrations, ensure oxidation of organics and/or complete partitioning will be necessary. **Development cost:** ~$1.5M **Capital cost:** ~$1.5M **Operating cost:** <$1/ft²
	Sulfide Conversion DCON-22-OY M *Ranking:* M-3-1 ($0.5M;N)*	**Evolving Technology** Must evaluate the kinetics of the room temperature reaction of sulfur with elemental Hg to form HgS, which is not water soluble and which is often easier to collect than elemental Hg. **Efficacy:** Method applicable only to elemental Hg. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** The chief waste is the recovered HgS which is about 84wt% Hg.	**Science/Development:** Both lab and bench scale experiments are required to determine the kinetics of the S and Hg reaction at room temperature and to evaluate the suitability of the method to the Y-12 Hg problems.	The required lab and bench-scale experiments are expected to be relatively simple. Existing equipment and facilities will likely support these activities with slight modifications. **Development cost:** $500K (mainly personnel costs) Duration: ~ 8months **Capital cost:** $100K **Operating cost:** NA
...urface Cleaning Methods	Steam Cleaning DCON–55–OY M *Ranking:* M-5-1 ($1.2M; $1-2/ft²)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology is expected to be effective for Hg but not for the more tightly bound contaminants. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. Remote operation will necessitate the adaptation of the steam and vacuum collection systems to robotic system control.	A glove box or a work room that is easily decontaminated in which the decontamination will be accomplished plus design and construction of a water recycle system are needed to use this technology. **Development cost:** about $1.2M **Capital cost:** Steam system: $50-75K Glove box: <$50K Work room: ~$250K **Operating cost:** $1-2/ft²
	Hypochlorite Oxidation DCON–202–OY *Ranking:* Not Ranked*	**Accepted** Core process is commercially available and practiced on an industrial scale. Integrated process needs to be demonstrated. **Efficacy:** Dependant on solution flushing efficiency. Core process reduces Hg in water effluent to <2ppb. **Waste:** Cleanup debris, some salts, spent resin and carbon.	Core technology is ready to use.	Normal implementation requirements and a fluid delivery and cleanup system needs to be integrated with core technology

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Surface Cleaning Methods	H	Hot Air Stripping DCON-59-OY *Ranking:** *H-5-3 ($2M; $3/ft²)*	**Demonstration** The technology is readily available but needs to be demonstrated for the specific site conditions. **Efficacy:** Has a good chance of working for the volatile contaminants if a viable collection method is available. **Waste:** The volatile contaminants will be in the warm air stream. Filters and Sorbents should remove the contaminants and constitute the final waste stream.	**Development:** Investigation of the conditions and removal efficiency for the removal of Hg and other volatile contaminants is required. Development of hot air cleanup system is needed.	An air cleanup system is needed to use this technology. **Development cost:** ~ $2M **Capital cost:** $2M **Operating cost:** $3/ft²
	M	Dry Heat DCON-60-OY *Ranking:** *M-5-2 ($1M; >$1/ft²)*	**Conceptual** The use of heat to increase the vapor pressure of semi-volatile materials is well known, but the use of heat for surface removal of Hg, etc. is unproven. **Efficacy:** This process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other vaporized materials. The contaminants must normally be removed by scrubbing, sorption, or possibly filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system.	An air cleanup system is needed to use this technology. **Development cost:** $1M **Capital cost:**~$1M **Operating cost:** >$1.00/ft²
	M	Ultrasonic Cleaning DCON-65-OY *Ranking:** *M-3-1 ($0.4M; $7/ft²)*	**Accepted.** Ultrasonic cleaning has been used for many years in the private sector and in government installations for removing surface contamination from relatively small metal parts which can fit into an ultrasonic bath. **Efficacy:** Will not be effective on Hg amalgamates. May separate Hg from metal and remove chemical contaminants. **Waste:** Spent ultrasonic baths containing removed contaminants.	**Improvement:** Definition of acceptable cleaning liquids which (1) are not hazardous, (2) can be separated from the contaminants, and (3) can be reused to minimize secondary waste. More aggressive cleaning action.	Requires removal and disassembly of contaminated equipment. **Improvement cost:** $400K **Capital cost:** $10K-$100K **Operating cost:** $5-$10/ft² or more
	M	Vibratory Cleaning DCON-66-OY *Ranking:** *M-3-1 ($0.5M; $6/ft²)*	**Demonstration** **Efficacy:** Vibratory cleaning is likely to be effective for a variety of Y-12 problems. **Waste** The problems of cross-contamination within the pellet medium and recycle of the pellets and solution	**Development:** Methods for recycle of the pellets and solution must be developed.	A bench scale demo lasting ~9 months is needed **Development cost:** $0.5M **Capital cost:** $60K **Operating cost:** ~$6/ft²

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	• Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Metal Refining Methods M	Smelt Purification DCON–31–OY *Ranking:** *M-4-3 ($3.5M; $0.93/lb)*	**Demonstration** Smelt purification of metals has been performed by a large number of investigators on a lab-scale and by some investigators on a large-scale. The metals include mild steel, stainless steel, nickel, copper, monel, aluminum, and others. **Efficacy:** Uncertain - has not been used to purify metals from Hg. **Waste:** Wastes are slags, scrubber solutions, chemical trap materials, and HEPA filters.	**Development:** Demonstrate fluxing agents and conditions for removing contaminants of interest in the laboratory and then on a larger scale.	Scientific Ecology Group (SEG) personnel estimate the costs of metal smelting at roughly $0.93/lb of metal in 1992 dollars, depending on the type metal and configuration of the metal. Kellogg et al. estimated that the capital and operating costs of smelting the 90,000 tons of DOE scrap metal presently on hand at K-25 could be recovered through sale of the metal if a *de minimus* were established. The quantity of metals in Bldg. 9201-4 is probably not sufficient to be cost effective unless added to this. The technology development needs will require further lab and pilot-scale evaluation. The development costs are roughly estimated at $3.5M.
L	Electrorefining DCON–32–OY *Ranking:** *L-4-3 ($3M; $6/lb)*	**Predemonstration** Electrorefining is a well-established commercial technology. However, this technology cannot be considered mature concerning its use for decontaminating Hg-contaminated metal because this application has not been established. **Efficacy:** Technology is likely to be effective for the listed contaminants and substrates. **Waste:** Waste would be solid waste from assumed treatment of electrolyte solutions for recycle.	**Development:** Demonstrate (1) separation of Hg from substrates of interest and (2) recycle of electrolyte solutions.	An electrorefining plant would also require a smelting and anode forming facility to form the impure metal into anodes of proper configuration. The capital costs altogether are estimated at $200M. The operating cost 10 million-pound/year capacity is estimated at $6/lb which exceeds the present value of virtually any metal because commercial companies operate on a much larger scale. **Development cost:** ~$3M.
L	Leach/electrowinning DCON-34-OG *Ranking:** *L-4-2 ($>1M; $4/lb)*	**Predemonstration** The method is similar to electrorefining except the metal is first dissolved into solution rather than formed into anodes. Although this process is a well established commercial process for producing nickel from ore, it has not been demonstrated on a large scale for purifying metals contaminated with Hg. **Efficacy:** Uncertain-process has not been used to purify metals contaminated with Hg. **Waste:** Recycle of electrolytic solutions will result in a solid mixed waste bearing the contaminants and traces of the purified metal amounting to roughly 2% by weight of the metal purified.	**Science:** Evaluate process for purifying metals contaminated with Hg, etc. **Development:** Demonstrate techniques to recycle the electrolytic solutions.	A *de minimus* standard is needed to permit sale of the purified metal. **Development cost:** >$1M **Capital cost:** $200M (10M lb/yr plant) **Operating cost:** ~$4/lb

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #7 Packing Hg LiOH H_2SO_4 HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards; DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Thermal Surface Removal Methods	Plasma Surface Cleaning DCON–75–OY M *Ranking:** *M-5-3 ($1M; $1.75/ft²)*	**Predemonstration** Plasma surface cleaning by glow discharges are commonly and effectively utilized for cleaning high bonding energy contaminants from surfaces of metals prior to the operation of fusion devices. **Efficacy:** Technology is expected to be effective for removing deposits from listed substrates, but whether the plasma can follow the irregular shapes involved in the packing material is uncertain. **Waste:** Wastes would be sorbents and HEPA filters from the collection system.	**Science:** Data on cleaning rates for mercury and other contaminants and various substrates of interest are needed. **Development:** The capability of plasma generation and cleaning on complex internal surfaces of contaminated equipment with large surface areas needs to be established.	A collection system with appropriate sorbents and filters for the vaporized deposits would be needed to use this technology. An electric power supply would be needed. **Development cost:** About $1M **Capital cost:** $0.5-1M /machine **Operating cost:** > $1/ft² **Available at Y-12.**
	Plasma Etching DCON–76–OY M *Ranking:** *M-5-3 ($1.3M; $3/ft²)*	**Predemonstration** Plasma etching processes are used in material processing and microelectronic manufacturing. **Efficacy:** Extrapolating these plasma processes for vaporizing and recovering mercury deposits is considered feasible. The ability of the plasma to etch the inside of packing material needs to be demonstrated. **Waste:** Wastes would be collected in sorbents and HEPA filters.	**Science:** Data on cleaning rates for contaminants and substrates of interest are needed. **Development:** The capability of plasma etching of the packing needs to be established.	A collection system with sorbents and appropriate filters for the vaporized deposits would be needed to use this technology. An electric power supply would be needed. **Development cost:** $1.3M **Capital cost:** ~$1M **Operating cost:** $3/ft²
	Flashlamp Cleaning DCON–77–OY M *Ranking:** *M-5-2 ($2M; $3/ft²)*	**Demonstration** Flashlamp systems are being used to remove organic contamination from metals, precious metals, and fragile substrates. Hanford-Westinghouse Laboratory is conducting tests of xenon flashlamp systems for removing radiological contamination from surfaces inside metal storage vessels. **Efficacy:** Technology is likely to be effective for surface-mercury contamination. **Waste:** Wastes would be removed contaminants, some substrate material, and HEPA filtersand sorbent from the off-gas collection system.	**Development:** Commercially available flashlamp systems need to be evaluated for mercury deposit removal. Also demonstration of removal of contaminants from inside packing surfaces needs to be demonstrated.	A collection system for the vaporized deposits would be needed to implement this technology. **Development cost:** ~$2 M **Capital cost:** $50-100K/machine **Operating cost:** ~3.00/ft²

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EM Goals

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EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem

Alpha 4 Building (9201-4)

Problem Areas/Constituents

Problem #8

<u>Carbon Chunks</u>
Hg

<u>Carbon Chunks</u>
LiOH

<u>Carbon Chunks</u>
H_2SO_4, HNO_3

Reference Requirements

Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards; DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.

Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)

Initiate the design of pilot mercury roaster for the 9201-4 D&D project - Target DAte 10/01/95. (Milestone No. OR270124)

Complete the construction of the pilot mercury roaster for the 9201-4 D&D project - Target Date 9/30/98. (Milestone No. OR270123)

Initiate the design of mercury roaster for the 9201-4 D&D project - Target Date 10/01/97. (Milestone No. OR270115)

Complete Design of mercury roaster - Target Date 930/99. (Milestone No. OR270116)

Begin construction of mercury roaster for 9201-4 D7D project - Target Date 4/01/2000. (Milestone No. OR270117)

Complete construction of mercury roaster for 9201-4 D&D project - Target DAte 3/31/2002. (Milestone No. OR270118)

Subelements

Decontamination

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
ulk Decontamination ethods	**H** Incineration DCON-2-OY *Ranking:** *H-3-12 ($0M; $10/lb)*	**Accepted** The incineration of contaminated combustible materials is common in the nuclear industry. **Waste:** This will depend on the designs of the incinerator and the ash content of the waste being fed.	None	**Capital cost:** $26M **Operating cost:** $10/lb About 8-10 years will be required for writing an environmental impact statement, holding public hearings, and obtaining the necessary permits- TSCA permit, RCRA permit, NESHAP permit, and Clean Air Act permit.
	H Dry Heat (Thermal Desorption or Roasting) DCON-4-OY *Ranking:** *H-4-2 ($0.5M; $12/lb)*	**Demonstration** This is a common industrial process when the contaminated materials can be taken to the thermal desorption process, but has not been used for Hg-contaminated materials. **Efficacy:** This process should work for contaminants which can be volatilized. **Waste:** This will initially consist of volatilized contaminants along with hot air and other combustion products. The contaminants must normally be removed by sorption and filtration before atmospheric release is allowed.	**Development:** Demonstration of the efficacy of the process and design and demonstration of an off-gas removal system. Engineering design data is needed.	Existing furnace designs can be used with a specific off-gas collection system for the contaminants removed. **Development cost:** $500K **Capital cost:**~$0.5M **Operating cost:** $8-12/lb
	M Chemical Leaching DCON-5-OY *Ranking:** *M-1-1.5 ($0.5M; <$1/ft2)*	**Predemonstration** Chemical leaching is an accepted technique for some applications but has not been used for Hg-contaminated materials.. **Efficacy:** Bench scale tests are needed to determine which chemical would be effective **Waste:** Waste would be original materials contaminated with chemical leachates plus chemical leachates containing removed contaminants or sludges, filter cakes, and ion exchange resin from recycle system containing removed contaminants.	**Development:** Bench scale tests are needed to determine which chemicals would be effective and what secondary waste treatment would be necessary to recycle chemicals.	Extensive chemical processing system for chemical leaching with a waste treatment system for treatment or recycle of spent chemical leaching solution.. **Development cost:** Efficacy Demo: $350K **Capital cost:** $150K **Operating cost:** <$1/ft2 or $5-$50/lb
	M Catalytic Extraction Process DCON-6-OY *Ranking:** *M-L-4 ($5M; $0.90/lb)*	**Predemonstration** Has not been used to process material bearing Hg contamination. **Efficacy:** Effectiveness for separation of Hg is unknown. **Waste:** Slag containing contaminants plus contaminants in a scrubber solution and/or sorbents.	Science: Find a suitable fluxing agent to remove Hg and asbestos from the melt. **Development:** Demonstrate the ability to remove Hg and asbestos.	"Off the shelf" induction or arc furnace. **Development cost:** $3-5 million **Capital cost:** ~$16 million **Operating cost:** $1/lb

Deconta

EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #8 Carbon Chunks Hg Carbon Chunks LiOH Carbon Chunks H_2SO_4, HNO_3	Refer to the Regulatory Compliance chapter for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems
• Facility Decontamination and Decommissioning (D&D)
• Remedial Action (RA)—Soils, Groundwater and Surface Water
• Waste Management (WM)

mination

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Bulk Decontamination Methods	Vacuum (Low Pressure with Heat) DCON-7-OY *Ranking:** **M** *M-5-1 ($1M; $1.20/ft²)*	**Demonstration** The use of vacuum with heat is well known to improve the removal rate for many contaminants. **Efficacy:** Likely to improve the rate of removal of Hg and some contaminants, however, this must be balanced against its cost. **Waste:** Sorbent containing removed contaminants and other volatiles.	**Development:** The characteristics of the specific contaminants must be matched to the rate advantage of decontamination by volatilization under vacuum conditions for the specific heating applied. **Improvement:** In-situ conditions need more streamlined designs to apply the vacuum and heat combination efficiently.	**Development cost:** ~$1M **Operating cost:** $2/lb **Capital cost:** $1M
Chemical Surface Cleaning Methods	Amalgamation DCON-16-OY *Ranking:** **H** *H-5-1 ($0.5M;N)*	**Predemonstration** Although amalgamation of mercury with metals of interest is well known, application to Y-12 problems areas has not been demonstrated. Copper and zinc are main metals of interest for amalgamation. **Efficacy:** Method transforms liquid Hg into a solid that is often easy to recover. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** Resulting amalgam, which is unreactive, is chief waste. Zn amalgam is ~57wt% Hg. The Cu amalgam is <76wt% Hg.	**Technology Development Needs:** Laboratory and bench scale assessment is needed to determine the suitability of this process to the Y-12 problems.	The availability of a suitable facility to do development work is assumed. **Development cost:** $500K (mainly personnel costs) **Duration:** 8 months **Capital cost:** $100K **Operating cost:** NA
	Sulfide Conversion DCON-22-OY *Ranking:** **M** *M-3-1 ($0.5M;N)*	**Evolving Technology** Must evaluate the kinetics of the room temperature reaction of sulfur with elemental Hg to form Hg S, which is not water soluble and which is often easier to collect than elemental Hg. **Efficacy:** Method applicable only to elemental Hg. Method must be used with a second method such as vacuuming. May actually be a disadvantage in cases where Hg could be recovered for reuse. **Waste:** The chief waste is the recovered HgS which is about 84wt% Hg.	**Science/Development:** Both lab and bench scale experiments are required to determine the kinetics of the S and Hg reaction at room temperature and to evaluate the suitability of the method to the Y-12 Hg problems.	The required lab and bench-scale experiments are expected to be relatively simple. Existing equipment and facilities will likely support these activities with slight modifications. **Development cost:** $500K (mainly personnel costs) Duration: ~ 8months **Capital cost:** $100K **Operating cost:** NA
	Hypochlorite Oxidation DCON-202-OY *Ranking:** *Not Ranked*	**Accepted** Core process is commercially available and practiced on an industrial scale. Integrated process needs to be demonstrated. **Efficacy:** Dependant on solution flushing efficiency. Core process reduces Hg in water effluent to <2ppb. **Waste:** Cleanup debris, some salts, spent resin and carbon.	Core technology is ready to use.	Normal implementation requirements and a fluid delivery and cleanup system needs to be integrated with core technology

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha 4 Building (9201-4)	Problem #8 Carbon Chunks Hg Carbon Chunks LiOH Carbon Chunks H_2SO_4, HNO_3	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. Removal of all asbestos insulation in Building 9201-4-Target Date 9/30/97. (Milestone No. OR270111)	Decontamination

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Surface Cleaning Method — M	Steam Cleaning DCON–55–OY *Ranking:** *M-5-1 ($1.2M; $1-2/ft^2)*	**Accepted** The technique has proven useful, especially on complex shapes and large surfaces. **Efficacy:** Technology should be effective for Hg; but not for the more tightly bound contaminants. **Waste:** Waste will be 0.4 to 2.0 gpm wastewater containing removed contaminants.	**Improvement:** To minimize waste generation, a water treatment system is needed for decontamination of the wastewater so that the water can be reused. Remote operation will necessitate the adaptation of the steam and vacuum collection systems to robotic system control.	A water recycle system is needed to use this technology. **Development cost:** None **Capital costs:** $50-75K **Operating cost:** $2/ft^2

Dismai

The Dismantlement section is written to address the Y-1; concrete, structural steel, asbestos materials, major disman and the need for other "enabling technologies." Basic to thi; general, depend upon the type of contamination as long as section will explain the relationship of the subject to the disn to follow a sequence similar to the current ongoing D&D eff

There are some basic assumptions for dismantlement ir decontaminated as much as practical, (2) remaining, or ve characterized before dismantlement is initiated, (3) the proc suitable for disposal as recyclable scrap or waste or for disp materials will be desirable and/or required.

tlement

Plant problems specific to dismantlement: massive
ement (removal of equipment), disassembly of equipment,
approach is the assumption that dismantlement will not, in
ontainment and worker protection are provided. Each
antlement problem list. Dismantlement has been assumed
ts elsewhere.
luding: (1) equipment exteriors will have been
igial, contamination will have been located and
cts of dismantlement will be sorted materials in forms
sition to complete decontamination, and (4) recycle of

Dismai

EM Goals	Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development Laboratories • Machining Facilities	Massive Concrete with Hg, Pb, Cr, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

tlement

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Cutting	H	High-Pressure Abrasive Water Jet (Massive Concrete) DISM-11-OY *Ranking:** *H-4-2 ($250K;$700/yd³)*	**Demonstration** DOE-sponsored development. Not demonstrated at Y-12. **Efficacy:** High; useful in Mercury contaminated areas. **Waste:** Contaminated water slurry. Amount would be minimal.	**Science development:** None. **Technology improvement needs:** Need to develop a high-efficiency fluid recovery system.	**Unusual needs:** Research operational techniques. **Development cost:** $2.5M **Capital cost:** $1M **Operating cost:** $100/hour
	H	Diamond Wire Cutting DISM-12-OY *Ranking:** *H-4-1 ($.5M;$600/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** High: industry expected standard. **Waste:** Contaminated water slurry. Amount would be minimal.	**Science development:** None **Technology improvement:** Method of cutting large rebar must be developed. High-efficiency fluid recovery system must be developed	**Unusual needs:** Need vacuum system. **Development cost:** $.5M **Capital cost:** $1M **Operating cost:** $600/yd³
	L	Explosive Cutting DISM-13-OY *Ranking:** *L-4-2 ($2M;$400/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** Low; not well suited for these types of structures. **Waste:** Contaminated water slurry used to hold down dust possible.	**Science development:** None **Technology Improvements Needs:** Crane system to remove large sections of concrete. Remote method of cutting rebar in large amounts of debris is needed.	**Unusual needs:** Need to witness an actual site being demolished. **Development cost:** $2.0M **Capital cost:** $0.75M **Operating cost:** $400/yd³
	M	Mechanical Saws DISM-14-OY *Ranking:** *M-4-0* (None;*$810/yd³)*	**Accepted** **Efficacy:** Medium; industry-accepted standard. **Waste:** Saw blades, chains,coolant, etc.	**Science development:** None **Technology improvement:** Vacuum system to handle the dust and/or mercury vaporization must be created. Remote-controlled manipulator to maneuver saw blade and large sections of concrete.	**Unusual needs:** Personnel training. **Development cost:** None. **Capital cost:** $350K/system **Operating cost:** $30/ft³
Removal	M	High-Pressure Abrasive Water Jet Scarification DISM-121-OY *Ranking:** *M-4-2 ($2M;$400/yd³)*	**Demonstrated** **Efficacy:** Medium; can remove portions of the concrete's surface. **Waste:** Contaminated water slurry.	**Science development:** None. **Technology improvement:** Develop high-efficienc y recovery system.	**Unusual needs:** Automated manipulator. **Development cost:** $2M **Capital cost:** $1M **Operating cost:** $400/yd³
Demolition	M	Microwave Demolition DISM-15-OY *Ranking:** *M-4-5 ($5M;$460/yd³)*	**Predemonstration** In final stage of development. **Efficacy:** Medium; will remove moderate amounts of material. **Waste:** No additional waste will be generated as a result of utilizing this technology.	**Science development:** None **Technology improvement:** Final phase of development.	**Unusual needs:** Need to develop track system. **Development cost:** $5M **Capital cost:** $2M **Operating cost:** $17/ft³
	M	Demolition Compounds DISM-16-OY *Ranking:** *M-4-1 ($250K;$400/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** Medium; can be used on lightly reinforced concrete only. **Waste:** No additional waste will be generated as a result of the use of this technology.	**Science development:** None **Technology improvement:** Demonstration is required using a lightly reinforced building. Hole geometry needs to be determined.	**Unusual needs:** Method of cutting rebar must be developed. **Development cost:** $250K **Capital cost:** $0.5M **Operating cost:** $400/yd³

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Massive Concrete with Hg, Pb, Cr, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement
EM Problems • Facility Decontamination and Decommissioning (D&D) • Remedial Action (RA)—Soils, Groundwater and Surface Water • Waste Management (WM)		Walls with Hg, Pb, Cr, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Demolition	H	Conventional Demolition DISM-17-OY *Ranking:** *H-4-0 ($1M;$400/ft²)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** High; industry-accepted standard. **Waste:** No additional waste will be generated as a result of utilizing this technology.	**Science development:** None **Technology Improvement:** Vacuum system to handle dust must be created. Crusher to downsize concrete sections must be developed.	**Unusual needs:** None. **Development cost:** $1M **Capital cost:** $0.5M **Operating cost:** $400/ft²
	H	Grappler and Massive Shearing DISM-18-OY *Ranking:** *H-4-1* (None;*$100/yd³)*	**Demonstrated** **Efficacy:** High; can shear and maneuver most any material or component. Cutting is independent of geometry. Does not alloy contaminants to the process material. **Waste:** None. Decontamination of manipulator and associated equipment.	None	**Unusual Needs:** N/A. **Development cost:** NA. **Capital cost:** $400K/system **Operating cost:** $100/yd³
Cutting	H	High Pressure Abrasive Water Jet (Walls) DISM-19-OY *Ranking:** *H-3-2 ($250KM;$100/hr)*	**Demonstration** DOE-sponsored development. Not demonstrated at Y-12. **Efficacy:** High; useful in Mercury contaminated areas. **Waste:** Contaminated water slurry. Amount would be minimal.	**Science development:** None **Technology Improvement:** Need to develop a high-efficiency fluid recovery system. Need to address contaminated cracks in concrete.	**Unusual needs:** Research operational techniques. **Development cost:** $.25M **Capital cost:** $1M **Operating cost:** $100/hr
	H	Diamond Wire Cutting DISM-20-OY *Ranking:** *H-3-1 ($.5M;$600/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** High; industry-expected standard. **Waste:** Contaminated water slurry. Amount would be minimal.	**Science development:** None **Technology Improvement:** Method of cutting large rebar must be developed. high-efficiency fluid recovery system must be developed	**Unusual needs:** Need vacuum system. **Development cost:** $.5M **Capital cost:** $1M **Operating cost:** $600/yd³
	M	Mechanical Saws DISM-21-OY *Ranking:** *M-3-0* (None;*$30/ft³)*	**Accepted** **Efficacy:** Medium; industry-accepted standard. **Waste:** Saw blades, chains,coolant, etc.	**Science development:** None **Technology Improvement:** Vacuum system to handle the dust and/or mercury vaporization must be created. Remote-controlled manipulator to maneuver saw blade and large sections of concrete.	**Unusual needs:** Personnel training **Development cost:** None **Capital cost:** $350K/system **Operating cost:** $30/ft³
	L	Explosive Cutting DISM-22-OY *Ranking:** *L-3-2 ($2M;$400/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** Low; not practical for clay tile walls. **Waste:** Contaminated water slurry used to hold down dust is possible.	**Science development:** None **Technology Improvement:** Remote method of cutting rebar in large amounts of debris	**Unusual needs:** To witness a site being demolished. **Development cost:** $2.0M **Capital cost:** $0.75M **Operating cost:** $400/yd³
Demolition	M	Demolition Compounds DISM-23-OY *Ranking:** *M-3-1 ($250K;$400/yd³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** Medium; can be used on lightly reinforced concrete only. **Waste:** No additional waste will be generated as a result of the use of this technology.	**Science development:** None **Technology Improvement:** Demonstration is required using a lightly reinforced building. Hole geometry needs to be determined.	**Unusual needs:** Method of cutting rebar must be developed. **Development cost:** $2.0M **Capital cost:** $0.5M **Operating cost:** $400/yd³

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

Y-12 Problems

Alpha-4 Building (9201-4)
- Colex Facilities
- Uranium Processing Facilities
- Process Support Facilities
- Electrical and Electrical Switch Gear
- Development laboratories
- Machining Facilities

Problem Areas Constituents	Reference Requirements	Subelements
Walls with Hg, Pb, Cr, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement
Hg, PCBs, U on Structural Steel	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
emolition	H Conventional Demolition DISM-24-OY *Ranking:** *H-3-0 ($1M;$400/ft^2)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** High; industry-accepted standard. **Waste:** No additional waste will be generated as a result of utilizing this technology.	**Science development:** None **Technology improvement:** Vacuum system to handle dust must be created. Crusher to down-size clay tile sections must be developed.	**Unusual needs:** None. **Development cost:** $1M **Capital cost:** $0.5M **Operating cost:** $400/ft^2
	H Grappler and Massive Shearing DISM-25-OY *Ranking:** *H-3-1 (None;$100/yd^3)*	**Accepted** **Efficacy:** High; can shear and maneuver most any material or component. Cutting is independent of geometry. Does not alloy contaminants to the process material. **Waste:** None. Decontamination of manipulator and associated equipment.	None	**Unusual needs:** None. **Development cost:** None. **Capital cost:** $400K/system **Operating cost:** $100/yd^3
	M Microwave Demolition DISM-26-OY *Ranking:** *M-3-6 ($5M;$17/ft^3)*	**Predemonstration** In final stage of development. **Efficacy:** Medium; will remove moderate amounts of material. **Waste:** No additional waste will be generated as a result of utilizing this technology.	**Science development:** None **Technology improvement:** Final phase of development.	**Unusual needs:** Need to develop track system. **Development cost:** $5M **Capital cost:** $2M **Operating cost:** $17/ft^3
itting	L Laser Cutting (Structural Steel) DISM-27-OY *Ranking:** *L-2-4 ($2.5M;$900/cut)*	**Predemonstration** **Efficacy:** Low; can cut any known material. Contamination will be alloyed to the process material. **Waste:** None; no waste generated by the process. Equipment will be decontaminated after use.	**Science development:** The appropriate power level for the laser. A fiber-optic delivery system	**Unusual needs:** Personnel training **Development cost:** $2M–$2.5M **Capital cost:** $1.5M/system **Operating cost:** $900/cut of 6 inch in diameter steel pipe.
	H High-Pressure Abrasive Water jet DISM-28-OY *Ranking:** *H-2-2 ($.25M;$100/hr)*	**Demonstration** **Efficacy:** High; can cut any known material, steel up to 9-in. thick. Does not alloy contaminants to the process material. **Waste:** 2 lb/min of garnet is used; 1.5 gal/min of liquid waste is generated. The water can be recycled, therefore, reducing waste. Decontamination of manipulator.	**Science Development** Recyclable abrasives A recovery system for the abrasives and water **Technology Improvement:** Longer lasting nozzles, hoses, and intensifier pumps.	**Unusual needs:** Personnel training. **Development cost:** $250K **Capital cost:** $700K/system **Operating cost:** $100/hour of cutting.
	L Plasma Arc Cutting DISM-29-OY *Ranking:** *L-2-4 ($.25M;$600/cut)*	**Demonstration** **Efficacy:** Low; can cut only conductive materials. Alloys contaminants to the process material. **Waste:** Water at 1/2 gal/hr is used to cool the nozzle. Particulate generation occurs at 4–6 lb/hr. Decontamination of manipulator.	None	Normal implementation needs. **Development cost:** $250K **Capital cost:** $50K/system **Operating cost:** $600/cut
	L Oxyacetylene Cutting DISM-30-OY *Ranking:** *L-2-0 ($0;$150/cut)*	**Accepted** **Efficacy:** Low; cuts mostly ferrous metals. Alloys contaminants to the process material. **Waste:** None. Decontamination of manipulator.	None	Normal implementation needs. **Development cost:** None **Capital cost:** $2000/system **Operating cost:** $150/cut

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EM Goals	Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Structural Steel with Hg, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Cutting L	Thermite Lance DISM-31-OY *Ranking:** *L-2-3 ($75K;$150/cut)*	**Predemonstrated.** **Efficacy:** Low; can cut steel in normal surroundings or under water. **Waste:** None. Decontamination of manipulator.	**Science development:** A method to contain the contamination	Personnel training. **Development cost:** $75K **Capital cost:** $1000/system **Operating cost:** $150/cut
L	Plasma Arc Saw DISM-32-OY *Ranking:* *L-2-2 ($1.5M;$1100/cut)*	**Demonstration** **Efficacy:** Low; can cut any type of steel. Can cut geometrically complicated components. Alloys contaminants to the process material. **Waste:** Dust and aerosol from the process; the saw blade. Decontamination of manipulator.	**Science development:** Computer-aided process. **Technology Improvement:** A remote-controlled manipulator. Different sizes of saw blades that are interchangeable	Personnel training. **Development cost:** $1M–$1.5M **Capital cost:** $1.2M–1.4M/system **Operating cost:** $1100/cut
L	Thermal Arc Water Jet DISM-33-OY *Ranking:** *L-2-2 ($1.5M;$1000/cut)*	**Demonstration** **Efficacy:** Low; can cut any type of steel. Can cut geometrically complicated components. Alloys contaminants to the process material. **Waste:** Dust and aerosol from the process and the water used to wash the material from the kerf. Decontamination of manipulator.	**Science development:** Computer-aided process. **Technology Improvement:** A remote-controlled manipulator.	Personnel training. **Development Cost** $1M–$1.5M **Capital cost:** $1M–$1.2M/system **Operating cost:** $1000/cut
M	Explosive Cutting DISM-34-OY *Ranking:** *M-2-3 ($.2M;$10K/cut)*	**Demonstrated** **Efficacy:** Medium; can cut any known material in normal surroundings or under water. Used where other mechanical cutting methods are impractical. **Waste:** None. Decontamination of manipulator.	**Science development:** A method of buttering the shock wave and its noise. A method to contain the contamination that explodes of the material.	Personnel training. **Development cost:** $200K **Capital cost:** $175K/system **Operating cost:** $10,000/cut
H	Liquified Cryogenic Gas Cutting DISM-35-OY *Ranking:** *H-2-4 ($10M;$2000/cut)*	**Evolving Technology** **Efficacy:** High; can cut any known material. Does not alloy contaminants to the process material. Effective on hazardous materials having a low-vaporization temperature. **Waste:** None. Decontamination of manipulator.	**Science development:** Cryogenic liquid cutting. **Technology Improvement:** A remote-controlled manipulator. Long lasting nozzles and hoses.	Personnel training. **Development cost:** $10M **Capital cost:** $3.5M/system **Operating cost:** $2000/cut
Demolition L	Conventional Disassembly DISM-36-OY *Ranking:** *E-2-1 ($.2M;$300/cut)*	**Accepted** **Efficacy:** Essential; can cut or dismantle any material or component. Cutting is independent of geometry. Does not alloy contaminants to the process material. **Waste:** Airborne contaminants. Decontamination of manipulator and associated equipment.	**Science development:** The capability to capture the contaminants exiting the kerf.	**Unusual needs:** Personnel training. **Development cost:** $200K. **Capital cost:** $100K/system. **Operating cost:** $10/bolt and $300/cut.

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Structural Steel with Hg, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- & waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement
	Asbestos with Hg, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

Alternatives		Technologies	Status	Science/ Technology Needs	Implementation Needs
Demolition	E	Grapple and Massive Shearing DISM-37-OY *Ranking:** *E-2-1 ($.2M;$150/cut)*	**Accepted** **Efficacy:** Essential; can shear and maneuver most any material or component. Cutting is independent of geometry. Does not alloy contaminants to the process material. **Waste:** None. Decontamination of manipulator and associated equipment.	None	Normal implementation needs. **Development cost:** None. **Capital cost:** $400K/system **Operating cost:** $150/cut
Removal		Conventional Removal DISM-38-OY *Ranking:** *L-3-0 ($0;$200/ft^2)*	**Accepted** **Efficacy:** Low; labor intensive **Waste:** Protective clothing and plastic bags. Large volume.	None required	**Unusual needs:** None required. **Development cost:** None required. **Capital cost:** None required **Operating cost:** $20.00 ft^2
	M	Conventional/Automated Removal with Vacuum System DISM-39-OY *Ranking:** *M-3-1 ($.2M;$60/ft^2)*	**Accepted** **Efficacy:** medium; industry accepted. **Waste:** Plastic bags and protective clothing. Amounts would decrease by 70% over conventional method.	None required	**Unusual needs:** None required. **Development cost:** $200K **Capital cost:** $100K **Operating cost:** $2.00 ft^2
	H	CO_2 Blasting DISM-40-OY *Ranking:** *H-3-4 ($3.5M;$20/ft^2)*	**Demonstration** Not demonstrated at Y-12 **Efficacy:** High; industry accepted **Waste:** Plastic bags. Amount would be minimal compared to conventional method.	**Technology Improvements:** Pipe hangers close to walls. Pipes close to walls.	**Unusual needs:** Determine robotics available. **Development cost:** $3.5M **Capital cost:** $1.2M **Operating cost:** $.20 ft^2
	M	Sodium Bicarbonate Blasting DISM-41-OY *Ranking:** *M-3-3 ($.3M;$100/hr)*	**Demonstration** **Efficacy:** Medium; will remove asbestos from a surface and not damage the surface of the material. Production rate is 2 ft^2/min. **Waste:** 100 lbs/hour of sodium bicarbonate and 0.5 gpm of water	**Science development:** Recyclable blast media. A recovery system for the abrasives and water. **Technology improvement:** Longer lasting nozzles, hoses and pumps.	**Unusual needs:** Personnel training. Implementation of a remote-controlled manipulator. **Development cost:** $300K **Capital cost:** $200K/system **Operating cost:**$ 100/hour
	H	Ice Blasting DISM-42-OY *Ranking:** *H-3-1 ($.1M;$100/hr)*	**Demonstration** **Efficacy:** High; will remove asbestos from a surface and minimize the airborne contaminants. **Waste:** 0.5 gpm of water.	**Science development:** A recovery system for the ice. **Technology Improvement:** Longer lasting nozzles, hoses and pumps.	Personnel training Implementation of a remote-controlled manipulator **Development cost:** $100K **Capital cost:** $25K/system **Operating cost:**$ 100/hour

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Asbestos with Hg, PCBs, and/or U contamination	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement
		Equipment Removal	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Removal

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

lement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Cutting H	High-Pressure Water Jet DISM-43-OY *Ranking:** *H-3-3 ($.3M;$110/hr)*	**Demonstration** **Efficacy:** High; will remove asbestos from a surface and minimize the airborne contaminants. **Waste:** 1.0 gpm of water.	**Science development:** A recovery system for the water. **Technology improvement:** Longer lasting nozzles, hoses and pumps/	Personnel training. Implementation of a remote-controlled manipulator. **Development cost:** $300K **Capital cost:** $350K/system **Operating cost:**$ 110/hour
M	Laser Cutting DISM-44-OY *Ranking:** *M-3-6 ($3.5M;$900/cut)*	**Predemonstration** **Efficacy:** Medium; potentially useful in cutting other hazardous materials such as PCBs,s volatile organic compounds, etc. **Waste:** disposal bags. Waste would be minimal	**Technology improvement:** Confirmation of negligible dispersion Confirmation of cut cauterization.	**Unusual needs:** Determine beam containment, laser safety, and optics protection from flaming. **Development cost:** $3.5M **Capital cost:** $1.5M **Operating cost:** $900/cut
H	High-Pressure Abrasive Water Jet DISM-45-OY *Ranking:** *H-3-3 ($3.5M;$1.25/ft²)*	**Demonstration.** Not demonstrated at Y-12 **Efficacy:** High; industry accepted **Waste:** Contaminated water slurry. Could be substantial without recovery system.	**Technology improvement:** High-efficiency water recovery and recycle system must be developed. Improvement of wear on nozzles, hoses, and pumps when abrasive are used.	**Unusual needs:** Determine robotics technology available. **Development cost:** $3.5M **Capital cost:** $1.1M **Operating cost:** $1.25 sq/ft
M	Liquified Cryogenic Gas Cutting DISM-46-OY *Ranking:** *M-3-10 ($10M;$60/ft³)*	**Evolving Technology** **Efficacy:** Medium. **Waste:** Large volumes of gas.	**Science development:** Significant development and demonstration required.	**Unusual needs:** Means of collecting and treatment of gase generated. **Development cost:** $10M **Capital cost:** None **Operating cost:** $60/ft³
Cutting H	High-Pressure Abrasive Water Jet DISM-47-OY *Ranking:** *H-5-4 ($2.5M;$40/ft³)*	**Demonstration** Not demonstrated at Y-12. **Efficacy:** High; industry accepted **Waste:** Contaminated water slurry. Could be substantial without recovery system.	**Technology improvement:** Development of flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	**Unusual needs:** Determine robotics technology available. **Development cost:** $2.5M **Capital cost:** $1.1M **Operating cost:** $40 sq/ft³
M	Oxyacetylene Cutting DISM-48-OY *Ranking:** *M-5-3 ($.5M;$5/ft³)*	**Accepted** **Efficacy:** Medium; commonly used in normal environments, could be easily adapted to remote operations, limited material cutting capability. **Waste:** Metals alloyed with radiative contaminates possible.	**Technology improvement:** Development of flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None.	Incorporate remote operations capability. **Development cost:** $500K **Capital cost:** $10K not including. remote manipulation provisions **Operating cost:** $5/ft³ of waste generated
M	Diamond Wire Cutting DISM-49-OY *Ranking:** *M-3-1 ($.5M;$40/ft³)*	**Accepted** **Efficacy:** Medium; proven method in general industry. Could be adapted to remote operations. **Waste:** Water is required to wash away sines from cut.	**Technology improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $500K. **Capital cost:** 10K not including remote op. equip. **Operating cost:** $40/ft³.
H	Mechanical Saws DISM-50-OY *Ranking:** *H-5-1 ($.25M;$20/ft³)*	**Accepted** **Efficacy:** High; commonly used in normal environments, could be easily adapted to remote operations, slow process. **Waste:** None	**Technology improvement:** Development of flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $250K. **Capital cost:** $10K not including remote manipulation provisions. **Operating cost:** $20/ft³ of waste generated.

** See the Explanation and Understanding Key in the front of this document for a description of the ranking code/scheme.*

Dismar

EM Goals	Y-12 Problems	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Equipment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Removal

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

lement

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
utting H	Advanced Automatic Fixtures, BUG-O, etc. DISM-51-OY *Ranking:** *H-5-4 ($2M;$30/ft^3)*	**Accepted** **Efficacy:** High; commonly used in normal environments, readily adaptable to remote operations. **Waste:** None	**Technology Improvement:** None **Science development:** None	Incorporate rémote operations capability. **Development cost:** $1–2M. **Capital cost:** $200K not including remote manipulation provisions. **Opering cost:** $30/ft^3 of waste generated.
H	Split-Frame Cutoff Machine DISM-52-OY *Ranking:** *H-5-3 ($1.5M;$100/cut)*	**Demonstration** **Efficacy:** High; commonly used in normal environments, readily adaptable to remote operations. **Waste:** None	**Technology Improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $1.5M. **Capital cost:** $200K not including remote manipulation provisions. **Operating cost:** $100/cut.
L	Laser Cutting DISM-53-OY *Ranking:** *L-5-6 ($4M;$50/ft^3)*	**Predemonstration** **Efficacy:** Low; commonly used in normal environments, probably expensive to adapt to remote operations. **Waste:** Metals alloyed with contaminates possible.	**Technology Improvement:** Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $3M–$5M. **Capital cost:** $200K not including remote manipulation provisions. **Operating cost:** $50/ft^3 of waste generated.
M	Plasma Arc Cutting DISM-54-OY *Ranking:** *M-5-6 ($2.5M;$50/ft^3)*	**Demonstration** **Efficacy:** Medium; commonly used in normal environments, readily adaptable to remote operations. Cutting complex geometries is difficult. Limited material cutting capability. **Waste:** Metals alloyed with contaminants possible.	**Technology Improvement:** Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $2M–$3.5M. **Capital cost:** $200K not including remote manipulation provisions. **Operating cost:** $50/ft^3 of waste generated.
L	Advanced Laser Cutting DISM-55-OY *Ranking:** *L-5-8 ($2.5M;$50/ft^3)*	**Predemonstration** **Efficacy:** Low; under-development for use in normal environments, probably expensive to adapt to remote operations. **Waste:** Metals alloyed with contaminants possible.	**Technology Improvement:** Scaling laser system to required levels. Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $2–3M **Capital cost:** $250K not including. remote manipulation provisions **Operating cost:** $50/ft^3 of waste generated.
L	Explosive Cutting DISM-56-OY *Ranking:** *L-5-2 ($1.5M;$8K/cut*	**Demonstration** **Efficacy:** Low; difficult to contain, not recommended for contaminated material. **Waste:** None	**Technology Improvement:** A means of buffering the associated shock wave.	Incorporate remote operations capability. **Development cost:** $1.5M **Capital cost:** <$100K not including. remote manipulation provisions. **Operating cost:** $8K/cut

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Equipment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Removal

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

tlement

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Cutting L	Plasma Arc Saw DISM-57-OY *Ranking:** *L-5-6 ($3.5M;$50/ft^3)*	**Demonstration** **Efficacy:** Low; commonly used in normal environments, readily adaptable to remote operations. **Waste:** Metals alloyed with contaminants possible.	**Technology Improvement:** Saw design for material thicknesses >100mm will require development. Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $3–4M **Capital cost:** $250K not including remote manipulation provisions. **Operating cost:** $50/ft^3 of waste generated.
L	Thermal Arc Water Jet Cutting DISM-58-OY *Ranking:** *L-5-4 ($2.5M;$40/ft^3)*	**Demonstration** **Efficacy:** Low; primarily an under water tool; may be difficult to adapt for out-of-water operation. **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $2–3M **Capital cost:** $1M not including remote manipulation provisions. **Operating cost:** $40/ft^3 of waste generated.
L	Thermite Lance Cutting DISM-59-OY *Ranking:** *L-5-2 ($0.5M;$10/ft^3)*	**Predemonstration** **Efficacy:** Low; Messy operation, may cause alloying of contaminants with metals, gross cutting tool. **Waste:** Metals alloyed with radioactive contaminants.	**Technology Improvement:** Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $500K **Capital cost:** $10K not including remote manipulation provisions. **Operating cost:** $10/ft^3 of waste generated.
H	Liquefied Cryogenic Gas Cutting DISM-60-OY *Ranking:** *H-5-10 ($2.5M;$60/ft^3)*	**Evolving Technology** **Efficacy:** High; currently not ready for use. **Waste:** None	**Technology Improvement:** Significant development effort required. **Science development:** None	Incorporate remote operations capability. **Development cost:** $2-3M **Capital cost:** ~ $10M not including remote manipulation provisions. **Operating cost:** $60/ft^3 of waste generated.
M	High-Pressure Water Jet DISM-61-OY *Ranking:** *M-5-4 ($1.5M;$30/ft^3)*	**Accepted** **Efficacy:** Medium; Commonly used in normal environments, effective on thin-gauge metals, readily adaptable to remote operations.	**Technology Improvement:** Development of a flexible shroud/enclosure for ventilation of the immediate work zone. **Science development:** None	Incorporate remote operations capability. **Development cost:** $1.5M **Capital cost:** $200K not including remote manipulation provisions. **Operating cost:** $30/ft^3
Conventional H	Conventional Disassembly DISM-62-OY *Ranking:** *H-5-3 ($0.75M;$40/ft^3)*	**Accepted** **Efficacy:** High; proven methods for remote environments, slow **Waste:** None	**Technology Improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $0.5M–$1M. **Capital cost:** $250 not including remote manipulation provisions. **Operating cost:** $40/ft^3 of waste generated.
Automated Conventional M	Grapple and Massive Shearing DISM-63-OY *Ranking:** *M-5-4 ($1.5M;$30/ft^3)*	**Demonstration** **Efficacy:** Medium; commonly used in normal environments, readily adaptable to remote operations **Waste:** None	**Technology Improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $1–2M. **Capital cost:** $250K not including remote manipulation provisions. **Operating cost:** $30/ft^3 of waste generated.

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EM Goals	Y-12 Problems	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Equipment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and non-regulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Dissasembly

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

lement

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
utting H	High-Pressure Abrasive Water Jet DISM-64-OY *Ranking:** *H-4-4 ($2M;$40/ft³)*	**Demonstration** Site specific demo needed with remote manipulation and water/fines recovery system. **Efficacy:** High; industry accepted **Waste:** Contaminated water slurry recovery system.	**Technology Improvement:** High-efficiency water recovery and recycle system with Hobil containment system for site specific must be developed. Improvement of wear on nozzles, hoses, and pumps when abrasive are used	**Unusual needs:** Determine robotics technology available. **Development cost:** $2M. **Capital cost:** $1.1M. **Operating cost:** $40/ft^3 of waste generated.
M	Diamond Wire Cutting DISM-65-OY *Ranking:** *M-4-2 ($2M;$40/ft³)*	**Demonstration** Site specific demo needed with remote manipulation and water/fines recovery system. **Efficacy:** medium; Potential in most areas **Waste:** Water recycled; fines decontaminated or handled as low level waste.	high-efficiency water cleaning/recycling system developed. Method of decontamination fines.	**Unusual needs:** Remote manipulators. **Development cost:** $2M. **Capital cost:** 50K not including remote manipulators. **Operating cost:** $40/ft^3 of waste generated.
L	Oxyacetylene Cutting DISM-66-OY *Ranking:** *L-4-1 ($.5M;$5/ft³)*	**Accepted** Industry proven. **Efficacy:** Low, commonly used in normal environments, could be easily adapted to remote operations, limited material cutting capability and used on non-mercury contaminated material. **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability. **Development cost:** $500K. **Capital cost:** $10K not including remote manipulation provisions. **Operating cost:** $5/ft^3 of waste generated.
H	Mechanical Saws DISM-67-OY *Ranking:** *H-4-1 ($.25M;$20/ft³)*	**Accepted** Industry proven. **Efficacy:** High; commonly used in normal environments, could be easily adapted to remote operations, slow process **Waste:** Fines decontaminated or handled as low level waste.	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability. **Development cost:** $250K. **Capital cost:** $10K not including remote manipulation provisions. **Operating cost:** $20/ft^3 of waste generated.
H	Advanced Automatic Fixtures DISM-68-OY *Ranking:** *H-4-4 ($2M;$30/ft³)*	**Accepted** Industry proven. **Efficacy:** High; commonly used in normal environments, readily adaptable to remote operations **Waste:** None	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability. **Development cost:** $1-2M **Capital cost:** $200K not including. remote manipulation provisions. **Operating cost:** $30/ft^3 of waste.generated.
H	Split Frame Cutoff Machine DISM-69-OY *Ranking:** *H-4-4 ($1M;$100/cut)*	**Demonstration** Site specific demo needed with remote manipulation. **Efficacy:** High; commonly used in normal environments, readily adaptable to remote operations **Waste:** None	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability. **Development cost:** $1M **Capital cost:** $200K not including. remote manipulation provisions **Operating cost:** $100/cut

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Equipment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Disassembly

tlement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Cutting M	Laser Cutting DISM-70-OY *Ranking:** *M-4-6 ($5M;$50/ft^3)*	**Predemonstration** Technology under laboratory tests. **Efficacy:** Medium; commonly used in normal environments, probably expensive to adapt to remote operations, can't be used on mercury contaminated material. **Waste:** Metals alloyed with contaminants possible.	**Technology Improvement:** Remote manipulators. **Science development:** Fiber-optic or ther wave guide delivery system.	Incorporate remote operations capability **Development cost:** $3-5M **Capital cost:** $200K not including, remote manipulation provisions **Operating cost:** $50/ft^3 of waste generated
L	Plasma Arc Cutting DISM-71-OY *Ranking:** *L-4-6 ($3M;$50/ft^3)*	**Demonstration** Site specific demo needed with remote manipulation. **Efficacy:** Low; commonly used in normal environments, readily adaptable to remote operations can't be used on mercury contaminated material. **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability **Development cost:** $2-4M **Capital cost:** $200K not including, remote manipulation provisions **Operating cost:** $50/ft^3 of waste generated
L	Advanced Laser Cutting DISM-72-OY *Ranking:** *L-4-8 ($3M;$50/ft^3)*	**Predemonstration-** Technology under laboratory tests. **Efficacy:** Low; Under development for use in normal environments, probably expensive to adapt to remote operations can't be used on mercury contaminated material. **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** Scaling laser system to required levels Remote manipulators **Science development:** Fiber-optic or other wave guide delivery system.	Incorporate remote operations capability **Development cost:** $2-3M **Capital cost:** $250K not including, remote manipulation provisions **Operating cost:** $50/ft^3 of waste generated
M	Plasma Arc Saw DISM-73-OY *Ranking:** *M-4-6 ($4M;$50/ft^3)*	**Demonstration-** Site specific demo needed with remote manipulation. **Efficacy:** High; commonly used in normal environments, readily adaptable to remote operations can't be used on mercury contaminated material. **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** Saw Design for material thicknesses >100mm will require development. Remote manipulators **Science development:** None	Incorporate remote operations capability **Development cost:** $3-4M **Capital cost:** $250K not including, remote manipulation provisions **Operating cost:** $50/ft^3 of waste generated
L	Thermal Arc Water Jet DISM-74-OY *Ranking:** *L-4-5 ($3M;$40/ft^3)*	**Demonstration-** Site specific demo needed with remote manipulation and water/fines recovery system. **Efficacy:** Low; primarily an under water tool, may be difficult to adapt for out of water operation **Waste:** Metals alloyed with contaminants possible	**Technology Improvement:** Remote manipulators **Science development:** Design	Incorporate remote operations capability. **Development cost:** $2M–$3M. **Capital cost:** $1M not including remote manipulation provisions. **Operating cost:** $40/ft^3 of waste generated.
M	Thermite Lance Cutting DISM-75-OY *Ranking:** *M-4-2 ($.5M;$10/ft^3)*	**Predemonstration-** Technology under laboratory tests. **Efficacy:** Medium. Messy operation, may cause alloying of contaminants with metals, gross cutting tool. **Waste:** Metals alloyed with radioactive contaminants	**Technology Improvement:** Remote manipulators **Science development:** None	Incorporate remote operations capability. **Development cost:** $500K. **Capital cost:** $10K not including remote manipulation provisions. **Operating cost:** $10/ft^3 of waste generated.
L	High-Pressure Water Jet DISM-76-OY *Ranking:** *L-4-4 ($4M;$40/ft^3)*	**Predemonstration** Technology under laboratory tests. **Efficacy:** Low; DOE Developed **Waste:** Water recycled with 95% space recovery.	**Technology Improvement:** high-efficiency water recovery and recycle system with modil containment system for site specific must be developed.	Incorporate remote operations capability. **Development cost:** $4M. **Capital cost:** $1.1M. **Operating cost:** $40/ft^3.

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Disman

EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Ground Water and Surface Water
- Waste Management (WM)

Y-12 Problems	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Equipment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement/Disassembly
	Entombment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
...utting	H	Liquified Cryogenic Gas Cutting DISM-77-OY *Ranking:** *H-4-10 ($10M;$60/ft³)*	**Evolving Technology** **Efficacy:** High; currently not ready for use. **Waste:** None	**Technology improvement:** Significant development effort required. **Science development:**	Incorporate remote operations capability. **Development cost:** $10M. **Capital cost:** not known. **Operating cost:** $60/ft³ of waste generated.
	H	Shear Cutting DISM-78-OY *Ranking:** *H-4-1 ($250K;$50/cut)*	**Demonstration**-Visit similar installation and evaluate site specific problems. **Efficacy:** High; shearing will minimize the vaporization of mercury **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $250K. **Capital cost:** $750K plus foundaton, building and installation. **Operating cost:** $50/cut.
...isassembly	H	Conventional Disassembly DISM-79-OY *Ranking:** *H-4-3 ($1M;$40/ft³)*	**Accepted** Technology being used. Demo use of remote manipulation. **Efficacy:** High; proven methods for remote environments; slow **Waste:** None	**Technology improvement:** None **Science development:** None	Incorporate remote operations capability. **Development cost:** $0.5M–$1M. **Capital cost:** $1K not including remote manipulation provisions. **Operating cost:** $40/ft³ of waste generated.
...ntombment	L	Thermoset Polymer/Thermal Plastic Stabilization (Entombment) DISM-80-OY *Ranking:** *L-3-4 ($1M;$30—100K)*	**Demonstration** **Efficacy:** Leachability index of 11-12 (very low & impervious). **Waste:** None	**Technology improvement:** A Test for the presence of promoter remaining after polymerization. **Science development:** None	**Development cost:** $1M **Capital cost:** $125K **Operating cost:** 10% of material cost.
	M	Groundwater Diversion DISM-81-OY *Ranking:** *M-3-3 ($1M;None)*	**Accepted** **Efficacy:** This technology's use is based on the need to divert groundwater away from the entombed area. **Waste:** None	Commercially available French drains are presumed to be adequate if designed properly. The cost of this technology is low, and the amount of waste generated is also low. Prototype testing of groundwater diversion techniques at the DOE X-10 Site will be required before acceptance by site D&D officials.	**Development cost:** $1M **Capital cost:** $203K **Operating cost:** Site specific
	M	Temporary Entombment/Clay Fill DISM-82-OY *Ranking:** *M-3-2 ($500K;$200/ft³)*	**Demonstration.** This technology has been used at other sites and is proposed for the X-10 graphite reactor transfer trench for the purpose of temporary entombment. If portions of building 9201-4 basement is left in place temporarily this technology would be useful. Efficacy considered high. The biggest limitation of this technology is leaching of contaminants because hydrologic isolation beneath the basement level is not addressed and hydrologic isolation.	**Technology improvement:** Hydrologic isolation methods for specific sites. **Science development:** Detection and collection of leachate methods or system of sensors if used.	Prototype testing at the DOE Y-12 Plant will be required prior to acceptance by site D&D officials. **Development cost:** $500K **Capital cost:** $1M **Operating cost:** $200/ft³
	M	Permanent Entombment DISM-83-OY *Ranking:** *M-3-2 ($2M;$500/ft³)*	**Evolving Technology** **Efficacy:** Low; the technology depends upon the hydrological isolation of the remaining basement area.	**Technology improvement:** Demonstration of capping, hydrological isolation, containment mintoring, waste leachate detecting, solidification/stabilization processes, and micro tunneling. **Science development:** None	Incorporate remote operations capability. **Development cost:** $2M **Capital cost:** Site specific **Operating cost:** $500/ft³.

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EM Goals	Y-12 Problem	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Entombment	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

tlement

Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Entombment				
L	Hydraulic Isolation DISM-84-OY *Ranking:** *L-3-4 ($3M;Site Specific)*	**Demonstration** **Efficacy:** Medium; The success of this technology is the ability to bottom seal basement floors, since some of the basement floor of 9201-4 rest on bed-rock.	**Technology improvement:** Y-12 plant demonstration of grout formulations for the specific geology.	**Development cost:** $3M **Capital cost:** $1M **Operating cost:** None
M	Capping—Aboveground Environmental Barrier DISM-85-OY *Ranking:** *M-3-2 (None;$50/ft²)*	**Demonstration** **Efficacy:** High Y-12 has utilized the technology in the past, e.g. S-4 ponds.	**Technology improvement:** Aging test on various liners to determine their longevity. **Science development:** None	**Development cost:** none **Capital cost:** $50K **Operating cost:** $50/ft²
M	Encasement—Subsurface Waste Storage with Void Reduction DISM-86-OY *Ranking:** *M-3-3 ($2M;$200/ft³)*	**Evolving Technology** **Efficacy:** Low; the technology depends upon hydraulic isolation implementation. **Waste:** None	**Science development:** **Technology improvement:** Same as hydraulic isolation, capping, solidification stabilization process, water diversion and sensor monitoring technologies.	**Development cost:** $2M **Capital cost:** $1—2M/building **Operating cost:** $200/ft³
M	Rubblization Via Crushing and/or Shredding DISM-87-OY *Ranking:** *M-3-2 (None;$100/ft³)*	**Evolving Technology** **Efficacy:** High; very high for suitable waste streams.	**Technology improvement:** None **Science development:** None	**Development cost:** None **Capital cost:** $5—500K **Operating cost:** $100/ft³
H	Engineered Storage For Future Disposal DISM-88-OY *Ranking:** *H-3-3 ($1M;$200/ft³)*	**Demonstration** **Efficacy:** High; This technology is certain to work and could be used as the final storage cask. **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $1M **Capital cost:** $100K/ storage container **Operating cost:** $200/ft³
M	Modular Entombment with Provisions for Future Removal DISM-89-OY *Ranking:** *M-3-3 ($500K;$100/ft³)*	**Demonstration** **Efficacy:** Medium; this technology will store stabilized waste in metal or polyurethane containers. **Waste:** None	**Technology improvement:** Improve embedded sensors for in situ testing and verification. **Science development:** A method of ensuring uniform mixing and proper stabilization of the composite mixture.	**Development cost:** $500K **Capital cost:** $500K—$2M **Operating cost:** $100/ft³
H	Concrete-Based Solidification/Stabilization DISM-90-OY *Ranking:** *H-3-4 (None;$200/yd³)*	**Accepted** **Efficacy:** High; very effective for suitable wastes, cannot handle mixed wastes unconditionally, compressive strength of 200—300 psi and can be less expensive than thermoset polymers. **Waste:** The volume of waste would increase by 60%, but no new waste is generated.	**Technology improvement:** Waste characterization **Science development:** Grout development and complete performance assessment including verification of solidification stabilization.	**Development cost:** none **Capital cost:** $250K—$3.8M based on basement volume of 100,000 ft³ **Operating cost:** $200/yd³
H	Sensors for Monitoring Entombment Integrity DISM-91-OY *Ranking:** *H-3-5 ($150K;$2000/yr)*	**Demonstration** **Efficacy:** High; this technology will determine the overall stability of entombed structures. **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $150K **Capital cost:** $400K **Operating cost:** $2000/yr

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Disma

EM Goals

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EM Problems

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Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities		Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement
	Enabling Technologies	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
redisposal Staging — H	Shredding, Sorting, Compaction DISM-92-OY *Ranking:** *H-2-1 ($.75M;$100/yd³)*	**Demonstration** **Efficacy:** This technology will volume reduce waste and sort waste. **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $.75M **Capital cost:** $1M plus foundation, building, and installation **Operating cost:** $100/yd³
H	Engineered Storage for Future Disposal DISM-93-OY *Ranking:** *H-2-4 ($.5M;$200/FT³)*	**Demonstration** **Efficacy:** This technology is certain to work and could be used as the final storage cask. **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $.5M **Capital cost:** $100K/ storage container style **Operating cost:** $200/ft³
H	Concrete Crushing DISM-94-OY *Ranking:** *H-2-2 ($1M;$50/ft³)*	**Demonstration** **Efficacy:** Huge cost savings in disposal **Waste:** Very minimal.	**Technology improvement:** Study to determine size capacity for disposal System to process material into workable size	**Development cost:** $1M **Capital cost:** $1.5M **Operating cost:** $50/ft³
M	Glassification DISM-95-OY *Ranking:** *M-2-5 ($5M;$100/ft²)*	**Predemonstration** Technology under laboratory tests. **Efficacy:** Medium; huge cost savings in disposal of contaminated asbestos. **Waste:** very minimal.	Study to determine size capacity for disposal System to process material into workable size	**Unusual needs:** determine available robotics implementations **Development cost:** $5M **Capital cost:** $1.2M **Operating cost:** $100 sq/ft
ield Assistance — L	Bar Code/Laser Tooling Location (Enabling Technologies) DISM-96-OY *Ranking:** *L-3-2 ($1.75M;None)*	**Demonstration** Need site specific demo. **Efficacy:** Low; it will precisely locate tooling using a laser or bar code, therefore, minimizing worker exposure. **Waste:** None	**Technology improvement:** None **Science development:** None	**Development cost:** $1.75M **Capital cost:** $750K **Operating cost:** None
H	Zoning for Containment-three Zones DISM-97-OY *Ranking:** *H-3-3 ($2.7M;None)*	**Accepted** Demonstrated technology exists for use at site. **Efficacy:** This technology will reduce the spread of contamination. **Waste:** None	**Technology improvement:** None **Science development:** Lighter-weight materials for panels, or inflatable panels	**Development cost:** $2.7M **Capital cost:** $1M—1.5M **Operating cost:** not known
L	Laser Triangular Mapping of Facilities DISM-98-OY *Ranking:** *L-3-2 ($3M;$150/hr))*	**Demonstration** Need site specific demo. **Efficacy:** Low; it will confirm or deny the true as-built status **Waste:** None	**Technology improvement:** Detailed software that integrates 3-D mapping into an existing data base **Science development:** None	**Development cost:** $3M **Capital cost:** $1.5M **Operating cost:** $150/hour
H	Video Mapping DISM-99-OY *Ranking:** *H-3-2 ($1.5M;$150/hr)*	**Demonstration** Need site specific demo. **Efficacy:** It will establish configuration layouts to be used through the D&D effort. **Waste:** None	**Technology improvement:** Assembly of an imaging/computer system, software development, procedure development **Science development:** None	**Development cost:** $1.5M **Capital cost:** $1M **Operating cost:** $150/hour
M	Computer-Based Training Systems DISM-100-OY *Ranking:** *M-3-3 ($2M;None)*	**Demonstration** Need site specific demo. **Efficacy:** Application software is available that permits rapid development of courses using many media (visual, audio), including support for a variety of testing strategies. **Waste:** None	Further development is needed in the area of authoring support.	A well-defined course development life cycle does not yet exist. Currently used software engineering development life cycle methods should work well. **Development cost:** $2M **Capital cost:** $600K **Operating cost:** None

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Y-12 Problem	Problem Areas Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Enabling Technologies	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Field Assistance	**H** Enclosed Utility System DISM-101-OY *Ranking:** *H-3-0 (None;$11,000/ft)*	**Accepted.** Demonstrated technology exists for use at site. **Efficacy:** High; it will reduce the volume and potential spread of contaminated soils. **Waste:** Contaminated soils.	**Technology Improvement:** None.C **Science development:** None.	**Development cost:** None **Capital cost:** None **Operating Cost:** $11K/ft.
	H Improved Protective Clothing and Equipment DISM-120-OY *Ranking:** *H-3-3 ($3M;None)*	**Evolving/Conceptual** **Efficacy:** High; it would maximize protection. **Waste:** Contaminated equipment and clothing.	**Technology Improvement:** Design of enclosures and personnel protective equipment should be per the specific requirements of Building 9201-4. **Science development:**	None
Engineering Assistance	**H** Point-and-Direct Tooling Positioning DISM-102-OY *Ranking:** *H-3-2 ($1.5M;$100/hr)*	**Evolving/Conceptual -** Technology at conceptual stage. Pre-proof of principle stage. **Efficacy:** High; Reduced contact of worker with materials, low cost, easily adapted to multiple uses. **Waste:** None	Develop prototype and demonstrate efficacy.	**Development cost:** $1.5M **Capital cost:** $500K **Operating Cost:** $100/hour
	M Computer-Based D&D Information Retrieval System DISM-103-OY *Ranking:** *M-3-2 ($2M;$150/hr)*	**Demonstration** **Efficacy:** Medium; ability to access automatically necessary **Waste:** None	**Technology Improvement:** An extensive enhancement of the FDDI network which exists within Energy Systems **Science development:** None	**Development cost:** $2M **Capital cost:** $1.3M **Operating Cost:** $150/hour
	H GIF Images to Enhance As-Built Documentation DISM-104-OY *Ranking:** *H-3-2 ($2.15M;$150/hr)*	**Predemonstration** Technology under laboratory tests; Need site specific demo. **Efficacy:** High; Images from cameras and video cameras will be used for specific designs. **Waste:** None	**Technology Improvement:** Assembly of an imaging/computer system, software development, procedure development and requirements **Science development:** None	**Development cost:** $2.15M **Capital cost:** $1M **Operating Cost:** $150/hour
	H Project Information Access Services DISM-105-OY *Ranking:** *H-3-1 ($1.5M;$150/hr)*	**Demonstration** Need site specific demo. **Efficacy:** High; the technology needs to be demonstrated because of the degree of integration of different host computers required to support effective information access across wide area networks.	**Technology Improvement:** Technology to implement such a system is commercially available and is found typically in financial services companies and some large corporations. **Science development:** None	Computer networks, especially Ethernet (cable, fiber), need to be extended throughout the Y-12 Plant to provide a basic foundation for information access and file transfersare in place. **Development cost:** $1.5M **Capital cost:** $150K **Operating Cost:** $150/hour
	M Network Architecture with integrated Workstations DISM-106-OY *Ranking:** *M-3-2 ($1.5M;None)*	**Demonstration** Need site specific demo. **Efficacy:** Medium; Reduced time and cost to obtain or transfer information. **Waste:** None	**Technology Development:** Software acquisition; user training. **Science development:** None	**Development cost:** $1.5M **Capital cost:** $1.1M **Operating Cost:** None
	M Client/Server Access to Standards and Regulatory Guidelines DISM-107-OY *Ranking:** *M-3-2 ($.55M;$100/hr)*	**Demonstration** Need site specific demo. **Efficacy:** Medium; Component technologies are well-established, commercially available, and affordable. They have not yet been integrated for use in a client/server environment.	**Technology Improvement:** A product is needed that provides network access to the databases on CD-ROM using the TCP/IP communications protocols between client and server. **Science development:** None	Automated, on-line access to basic reference documents is essential to reducing costs and increasing reliability of operations in a highly regulated work environment. **Development cost:** $.55M **Capital cost:** $200K **Operating Cost:** $100/hr.

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Y-12 Problems	Problem Areas, Constituents	Reference Requirements	Subelements
Alpha-4 Building (9201-4) • Colex Facilities • Uranium Processing Facilities • Process Support Facilities • Electrical and Electrical Switch Gear • Development laboratories • Machining Facilities	Enabling Technologies	Refer to the Regulatory Compliance chapter of Vol. 1 for potential applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Dismantlement

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Engineering Assistance				
L	Data Access Services DISM-108-OY *Ranking:** *L-3-1 ($.6M;$100/hr)*	**Demonstration** Need site specific demo. The particular network and communications configurations needed to support restoration activities may not exist, so would have to set up and their successful operation demonstrated. **Efficacy:** Low; data access service essential to meeting services.	**Technology Improvement:** Some software will be available commercially; some will have to be developed locally. **Science development:** None	Requirements and specifications for such services must be identified and documented to serve as a common reference so that data can be accessed using a single set of services, regardless of the type of computer at each node on the network. **Development cost:** $.6M **Capital cost:** $450K **Operating Cost:** $100/hr.
H	Automated Scanning and Conversion of Engineering Drawings DISM-109-OY *Ranking:** *H-3-3 ($.9M;$200/hr)*	**Demonstration** Need site specific demo. The basic technology is well established. Whether the current state of the art can adequately process the large number of drawings needed for reference and how effectively the technology can be integrated with other aspects of automated support needs to be demonstrated. **Efficacy:** High; electronic storage of drawings. Greatly improve availibility and reliability.	**Technology Improvement:** Improvements are needed in the speed and accuracy of converting scanned images to graphical representations that will meet the needs (e.g., ability to change scale to show more detail) of the environmental restoration program. **Science development:** None	Considerable human intervention may be required to handle large drawings or drawings that cannot easily be laid flat on a scanning bed. **Development Cost:** $.9M **Capital Cost:** $360K **Operating Cost:** $200/hr
H	3-D CAD DATA Base of Buildings and Structures DISM-110-OY *Ranking:** *H-3-3 ($2M;$150/hr)*	**Accepted** Demonstrated technology exists for use at site; The basic technology is in wide use. A variety of commercial products is available for use on systems ranging from desktop. Computers to large mainframes. **Efficacy:** High; Industry accepted technology.	**Technology Improvement:** Integration of this technology with the other supporting technologies to provide the high level of automation needed to ensure proper compliance with environmental legislation governing restoration activities	Identification of all possible uses (e.g., "training" robots, visual "walkthroughs", tags for tracking activities) of this technology and development of database requirements to support them are very important foundations for effective use of this technology. **Development Cost:** $2M **Capital Cost:** $1.5M **Operating Cost:** $150/hr
M	Client/Server Architecture for Data Base Access DISM-111-OY *Ranking:** *M-3-1 ($1.75M;$150/hr)*	**Demonstration** Need site specific demo. **Efficacy:** the effectiveness and appropriateness of a particular architecture design to meet the requirements of the restoration activities needs to be demonstrated.	**Technology Improvement:** This technology will benefit most from improvements in network technology (higher transmission speeds, improved transmission protocols, and data access services) needed to support it. **Science development:** None	Data dictionaries, data directories and data models are the essential foundation for use of this technology. **Development cost:** $1.75M **Capital Cost:** $1.3M **Operating Cost:** $150/hr
H	Hypertext Information Systems DISM-112-OY *Ranking:** *H-3-2 ($.6M;$200/hr)*	**Demonstration** Need site specific demo; a range of products exists to support development of hypertext information systems having many capabilities such as mechanisms for linking related items, for starting execution and controlling other applications, and for navigating documents for faster access to information. (Authoring and design tools are needed.) **Efficacy:** Hypertext technology very effective and powerful.	**Technology Improvement:** New technology that needs improvment.	Hypertext information systems must be designed with great care to avoid problems with maintenance (e.g., modifying or replacing blocks of text from which or to which many links have been made to selected text strings within the block). **Development cost:** $.6M **Capital cost:** $400K **Operating Cost:** $200/hr

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Disma

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Alternatives	Technologies	Status	Science/ Technology Needs	Implementation Needs
Engineering Assistance H	Electronic Catalog Descriptions and Source Locations of Site Historical Data DISM-113-OY *Ranking:** *H-3-3 ($.4M;$150/hr)*	**Accepted** Demonstrated technology exists for use at site. **Efficacy:** High; Standard database products can be used to create and maintain the inventory database.	**Technology Improvement:** Methods will be needed to evaluate and sort historical records according to their likely usefulness. **Science development:** None	Initial implementation efforts must focus on locating the collections of records and documents of historical value. **Development cost:** $375K **Capital cost:** $30K **Operating cost:** $150/hr
M	Simulated Walk-through Facility for Robotics Task Sequence Analysis DISM-114-OY *Ranking:** *M-3-3 ($.55M;$100/hr)*	**Demonstration** Need site specific demo. **Efficacy:** Medium; It can actually show the simulated method of the dismantlement of a specific item **Waste:** None	**Technology Improvement:** None **Science development:** None	**Development cost:** $.55M **Capital cost:** $350K **Operating cost:** $100/hr
M	Computer-Aided Task Analysis and Procedure Preparation DISM-115-OY *Ranking:** *M-3-2 ($.3M;None)*	**Demonstration** Need site specific demo. **Efficacy:** Medium; This technology is used extensively in planning by various federal agencies, most notably the Department of Defense in military operations planning.	**Technology Improvement:** More natural language analysis tools are needed to assist with analysis of information used for planning, much of which is provided in text form. **Science development:** None	Knowledge-base development will require the largest effort, followed by development of expert systems and decision aids needed to make effective use of the information in the knowledge bases. **Development cost:** $300K **Capital cost:** $50K **Operating cost:** None
M	Generalized Object-Oriented Simulation Software DISM-116-OY *Ranking:** *M-3-4 ($.5M;$150/hr)*	**Demonstration** Need site specific demo. **Efficacy:** Medium; The simulation environment is being used currently in ongoing studies associated with several different nuclear reactor design concepts. Modules would have to be written to model other types of systems.	**Technology Improvement:** Improvements are needed most in graphical display support systems. **Science development:** None	Successful deployment depends on availability of applications programmers who understand object-oriented design and programming principles and have experience applying this understanding to models of physical systems. **Development cost:** $500K **Capital cost:** $150K **Operating cost:** $150/hr.
M	Automated Engineering System Life Cycle Planning DISM-117-OY *Ranking:** *M-3-2 ($.4M;$150/hr)*	**Accepted** Demonstrated technology exists for use at site. **Efficacy:** Medium; A variety of commercial products developed to assist with managing large software development processes can be adapted for effective use in other engineering disciplines.	**Technology Improvement:** Improvements are needed to provide new types of support in order to satisfy regulatory requirements.	The usual life-cycle planning methods must be modified to accommodate requirements of applicable environmental legislation which imposes constraints and requires additional elements to augment common practice. **Development cost:** $.4M **Capital cost:** $50K **Operating cost:** $150/hr.
M	Automated System Reliability and Safety Analysis DISM-118-OY *Ranking:** *M-3-3 ($.5M;$150/hr)*	**Accepted/Demonstration** Need site specific demo. **Efficacy:** Medium; Tools for some types of analysis are in common use in engineering development environments for things like software, aircraft; communications satellites, and medical diagnostic equipment.	**Technology Improvement:** Few automated analysis tools exist since much of the effort for these analyses requires checking for consistency, correctness, completeness, tolerance of designs to various kinds of system failures, and unintended function.	Detailed knowledge of the system being analyzed (its behavior and attributes), its intended use, operation, and constraints that apply is essential to being able to automate any such analysis. **Development cost:** $.5M **Capital cost:** $50K **Operating cost:** $150/hr.
H	Geographic Information Systems for DOE Sites DISM-119-OY *Ranking:** *H-3-1 ($.3M;$150/hr)*	**Accepted** Need site specific demo. **Efficacy:** High; Most information, data, and computer system components for a basic geographic information system (GIS) for each DOE site already exists but must be integrated to meet the needs of the environmental restoration program.	**Technology Improvement:** Existing technology must be enhanced by adding a tagging mechanism to permit the system to be used for tracking activities and to link information in databases associated with a physical location to appropriate map and drawing displays on desktop computers.	A large initial effort may be required to scan and digitize diagrams and drawings for electronic storage and quick retrieval or transfer across networks. **Development cost:** $300K **Capital cost:** $100K **Operating cost:** $150/hr.

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Robotics/

The identification of the technologies required to use rob and waste management at Y-12 was based upon the premis provide support for other necessary activities such as chara this section of the diagram the problem areas are identified to differentiate between activities was made. For example a equally applicable to deploy dismantlement tools.

The robotics/ automation technologies were grouped into Sensors; with various sub-groups identified under each of th the basis of the following considerations: speed and econom automated equipment to repetitive tasks, ability to minimize requirements, and reliability and efficiency in handling redun

utomation

ics/ automation in the decommissioning, remedial action,
that the primary purpose of these technologies is to
erization, decontamination, and dismantlement. Hence, in
these "other" decommissioning activities and no attempt
obotic platform used to deploy a sensor was assumed to be

hree main categories: (1) Mechanical, (2) Control, and (3)
categories. Technologies were selected for this section on
in the deployment of tools and sensors, adaptability of
aste by reduction or elimination of clothing exchange
nt tasks.

Robotics/

EM Goals	Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	D&D of Alpha 4 building (9201-4) • characterization • mercury decontamination • process equipment removal • building intervals and outside process equipment D&D • above-grade building demolition • building foundation removal • RA contaminated soil	Robotics/automation (R/A) is a crosscutting technology that provides support to characterization, decontamination, and dismantlement activities. Specifically, support is provided for the following tasks: **Characterization** R/A provides methods of deploying sensors and instruments required for in situ characterization, monitoring, and surveying as described by the characterization data sheets contained in Vol. 3. R/A provides methods for deploying tools to collect and prepare samples for subsequent analysis in analytical laboratories. These technologies are described in ROBA-57 and -59-OY. R/A provides the technologies required for the automation of analytical laboratories as described in ROBA-55 and -56-OY. **Decontamination** Provides methods of deploying decontamination tools and/or performing tasks in areas sufficiently hazardous to preclude human access. R/A will also be required for those tasks that generate secondary environmental hazards, e.g., grinding, carbon dioxide blasting. **Dismantlement** Provides methods of deploying dismantlement tools and/or performing tasks in areas within buildings or structures that are sufficiently hazardous to preclude human access. **Waste Retrieval** R/A provides the vehicles, mobile platforms, or excavation systems necessary to retrieve radiologically or chemically hazardous wastes or soils. Mobile platforms suitable for these tasks are described in ROBA-1-OY. **Waste Sorting and Packaging** R/A provides the manipulation systems (ROBA-16-OY) and the End-of-Arm Tooling (ROBA-23 through -26-OY) required for the sorting and repackaging of RH-TRU waste.		Robotics/Automation

EM Problems
• Facility Decontamination and Decommissioning (D&D)
• Remedial Action (RA)—Soils, Groundwater and Surface Water
• Waste Management (WM)

utomation

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
echanical—Mobility	E	Wheeled/Tracked Vehicle ROBA-I-OY *Ranking:* *E-5-2 ($3M;N)*	**Accepted** **Efficacy:** An essential technology. Agility may be restricted for larger systems. Normal deployment method for characterization, decontamination dismantlement. **Waste:** Possible emissions. Decontamination of system after use. **TTP Match**	**Development:** Improved controls to allow more autonomy of operation. Improved design for decontamination after use.	Training of operators in advanced control stations. **Development costs:** $3.0M.
	M	Internal Duct/Pipe Crawler ROBA-5-OY *Ranking:** *M-3-2 ($1M;N)*	**Predemonstration** **Efficacy:** High for straight runs of pipe without obstacles; low if obstacles are present. **Waste:** Decontamination of system after use. **TTP Match**	**Development:** Miniaturization of sensors/tooling. Ability to negotiate around obstructions. Cable management system for tethered equipment.	No unusual needs **Development costs:** $1.0M.
	M	External Duct/Pipe Crawlers ROBA-6-OY *Ranking:** *M-3-4 ($5M;N)*	**Predemonstration** **Efficacy:** High if obstacles are not present; low if obstacles are present. **Waste:** Decontamination of system after use. **TTP Match**	**Development:** Robotic compatibility of tooling. Ability to negotiate around obstructions.	No unusual needs **Development costs:** $5.0M.
	M	Specialized Robotic Deployment Platforms ROBA-7-OY *Ranking:** *M-4-3 ($5M;N)*	**Demonstration** **Efficacy:** Low for most applications in D&D. Unique applications may require extensive development. **Waste:** Frequent decontamination with resulting waste fluids may be necessary. **TTP Match**	**Development:** Specialized controls and sensors. Improved vision systems.	Cold test beds and operator training. **Development costs:** $5.0M.
	M	Long-Arm Deployed Robotic Platforms ROBA-9-OY *Ranking:** *M-4-3 ($5M;N)*	**Accepted** **Efficacy:** Medium. Accurate positioning may be a problem. **Waste:** Hydraulic fluid during operation. Decontamination fluids after use.	**Development:** Flexible body control. End-point sensing. Collision avoidance. Weight-to-payload ratio reduction.	Cold test beds. Extensive operator training. **Development costs:** $5.0M.
	E	Power Sources for Mobile Platforms ROBA-10-OY *Ranking:** *E-5-1 ($0.5M;N)*	**Accepted** **Efficacy:** An essential technology. Accepted status means high efficacy. **Waste:** Batteries, and exhaust emissions.	**Improvement:** Energy storage capacity. Duty cycle availability. Current capacity/discharge. rate. Emission control.	No unusual needs. **Development costs:** included in costs for mobility system
	E	Failure Recovery Systems for Mobile Platforms ROBA-11-OY *Ranking:** *E-5-1 ($0..5M;N)*	**Accepted** **Efficacy:** High. This is an essential technology that is well established. **Waste:** Little or no waste.	None	No unusual needs. **Development costs:** $0.5M.

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EM Goals	Y-12 Problems	Problem Areas/Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	D&D if Alpha-4 Bldg. • characterization • mercury decontamination • process equipment removal • building intervals and outside process equipment • above-grade building demolition • building foundation removal • RA contaminated soil	Robotics/automation (R/A) is a cross cutting technology that provides support to characterization, decontamination, and dismantlement activities. Specifically, support is provided for the following tasks: **Characterization** R/A provides methods of deploying sensors and instruments required for in situ characterization, monitoring, and surveying as described by the characterization data sheets contained in Vol. 3. R/A provides methods for deploying tools to collect and prepare samples for subsequent analysis in analytical laboratories. These technologies are described in ROBA-57 and -59-OY. R/A provides the technologies required for the automation of analytical laboratories as described in ROBA-55 and -56-OY. **Decontamination** Provides methods of deploying decontamination tools and/or performing tasks in areas sufficiently hazardous to preclude human access. R/A will also be required for those tasks that generate secondary environmental hazards, e.g., grinding, carbon dioxide blasting. **Dismantlement** Provides methods of deploying dismantlement tools and/or performing tasks in areas within buildings or structures that are sufficiently hazardous to preclude human access. **Waste Retrieval** R/A provides the vehicles, mobile platforms, or excavation systems necessary to retrieve radiologically or chemically hazard our wastes or soils. Mobile platforms suitable for these tasks are described in ROBA-1-OY. **Waste Sorting and Packaging** R/A provides the manipulation systems (ROBA-16-OY) and the End-of-Arm Tooling (ROBA-23 through -26-OY) required for the sorting and repackaging of RH-TRU waste.		Robotics/Automation

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

utomation

Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Mechanical—Mobility	**M** Transportation Systems for Mobile Platforms ROBA-12-OY *Ranking:* * *M-3-1 ($0.5M;N)*	**Accepted** for small robotic platforms **Predemonstration** for large platforms or unique devices **Efficacy:** Low. **Waste:** No waste. The purpose of the technology is to minimize decontamination waste. **TTP Match**	**Development:** Light-weight containers for medium- and heavy-duty mobile platform. Containers that can be easily decontaminated.	No unusual needs **Development costs:** $0.5M.
	E Data/Signal Transmission ROBA-13-OY *Ranking:* * *E-5-1 ($1M;N)*	**Accepted** **Efficacy:** High. An essential technology. Specific application may determine type of system required. **Waste:** None. **TTP Match**	None	Testing in representative environments. **Development costs:** $1.0M.
Mechanical—Manipulation	**H** Long-Reach Manipulator—Light Duty ROBA-14-OY *Ranking:* * *H-4-2 ($2M;N)*	**Predemonstration** **Efficacy:** Medium. Positioning accuracy and control may be problems. **Waste:** Hydraulic fluid during operation; decon fluid after use. **TTP Match**	**Development:** Flexible body control. End-point sensing. Collision avoidance. Light-weight, small cross section design.	Cold test beds, extensive operator training. **Development costs:** $2.0M.
	M Long-Reach Manipulator—Heavy Duty ROBA-15-OY *Ranking:* * *M-4-3 ($5M;N)*	**Predemonstration** **Efficacy:** Low. Positioning accuracy and control may be problems. **Waste:** Hydraulic fluid during operation; decon fluid after use. **TTP Match**	**Development:** Flexible body control. End-point sensing. Collision avoidance. Weight-to-payload ratio reduction.	Cold test beds, extensive operator training. **Development costs:** $5.0M.
	E Dexterous Manipulators ROBA-16-OY *Ranking:* * *E-5-1 ($1M;N)*	**Demonstration** **Efficacy:** High. An essential technology. **Waste:** Possible hydraulic fluid during use and decon fluid after use. **TTP Match**	**Development:** Redundant manipulator planning and control. Modular design. Nonreplica master/slave operation. Cooperating and coordinated dual-arm control.	Operator training on nonreplica master controllers. **Development costs:** $1.0M.
	H Compact, High-Capacity Manipulators ROBA-19-OY *Ranking:* * *H-5-1 ($1M;N)*	**Evolving** **Efficacy:** High. Constrained access may require this technology.	**Development:** Compact, high-output, electrical motors. Design/fabrication/testing of compact arms.	No unusual needs. **Development costs:** $1.0M.
Mechanical—Mechanisms	**H** Precise Programmable Motions ROBA-20-OY *Ranking:* * *H-5-1 ($0.5M;N)*	**Demonstration** **Efficacy:** High. Particularly useful in analytical laboratory. **Waste:** None. **TTP Match**	**Improvement:** Standardization of mechanical interfaces.	No unusual needs. **Development costs:** $0.5M.
	H Tool Caddies ROBA-21-OY *Ranking:* * *H-4-1 ($0.5M;N)*	**Demonstration** **Efficacy:** High. Will increase efficiency of operations and minimize waste. **Waste:** Decontamination after use.	None	No unusual needs. **Development costs:** $0.5M.
	M Stabilization/Support Mechanisms or Booms ROBA-22-OY *Ranking:* * *M-3-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Some applications may require secondary support due to long reach or load balancing requirements. **Waste:** Minimal. Some decon waste.	**Improvement:** Use of high-strength advanced materials.	No unusual needs. **Development costs:** $0.5M.

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Robotics/

EM Goals	Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	D&D of Alpha-4 building (9201-4) • characterization • mercury decontamination • process equipment removal • building intervals and outside process equipment • above-grade building demolition • building foundation removal • RA contaminated soil	Robotics/automation (R/A) is a cross-cutting technology that provides support to characterization, decontamination, and dismantlement activities. Specifically support is provided for the following tasks: **Characterization** R/A provides methods of deploying sensors and instruments required for in situ characterization, monitoring, and surveying as described by the characterization data sheets contained in Vol. 3. R/A provides methods for deploying tools to collect and prepare samples for subsequent analysis in analytical laboratories. These technologies are described in ROBA-57 and -59-OY. R/A provides the technologies required for the automation of analytical laboratories as described in ROBA-55 and -56-OY. **Decontamination** Provides methods of deploying decontamination tools and/or performing tasks in areas sufficiently hazardous to preclude human access. R/A will also be required for those tasks that generate secondary environmental hazards, e.g., grinding, carbon dioxide blasting. **Dismantlement** Provides methods of deploying dismantlement tools and/or performing tasks in areas within buildings or structures that are sufficiently hazardous to preclude human access. **Waste Retrieval** R/A provides the vehicles, mobile platforms, or excavation systems necessary to retrieve radiologically or chemically hazard our wastes or soils. Mobile platforms suitable for these tasks are described in ROBA-1-OY. **Waste Sorting and Packaging** R/A provides the manipulation systems (ROBA-16-OY) and the End-of-Arm Tooling (ROBA-23 through -26-OY) required for the sorting and repackaging of RH-TRU waste.		Robotics/Automation

EM Problems

• Facility Decontamination and Decommissioning (D&D)

• Remedial Action (RA)—Soils, Groundwater and Surface Water

• Waste Management (WM)

utomation

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
lechanical—End-of-Arm-ooling	E	End Effectors/Alternatives ROBA-23-OY *Ranking:** *E-5-2 ($1M;N)*	**Demonstration** **Predemonstration** for multi-fingered grippers. **Efficacy:** High. An essential technology. Primary interface with tools. **Waste:** Minimal. **TTP Match**	**Improvement:** Robotic compatibility of tooling.	Extensive operator training. **Development costs:** $1.0M.
	M	End-Effector Changeout Mechanisms ROBA-24-OY *Ranking:** *M-3-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Particularly useful if tool resource interfaces are provided (power, data, etc.) **Waste:** Minimal decon waste. **TTP Match**	None	Integration and testing with specific robotic systems. **Development costs:** $0.5M.
	H	General Gripper/Tool Interface ROBA-25-OY *Ranking:** *H-4-1 ($0.5M;N)*	**Accepted** **Efficacy:** High. Many potential applications for tool/sensor gripping. **Waste:** Minimal decon waste.	None	No unusual needs. **Development costs:** $0.5M.
	M	Force-Limiting/Compliant Mechanisms ROBA-26-OY *Ranking:** *M-3-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. **Waste:** Minimal	None	No unusual needs. **Development costs:** $0.5M.
ontrols—Algorithms	E	Control Modes ROBA-27-OY *Ranking:** *E-5-N ($N;N)*	**Accepted** for Teleoperation **Demonstration** for Preprogramming **Predemonstration** for other modes **Efficacy:** High. An essential technology. Type of control mode will depend on application. **Waste:** None.	**Development:** Operator assistance technologies. Sensor interpretation. Task planning. **Improvement:** Better human-machine interfaces.	University-level research. **Development costs:** $N.
	E	Vehicle/Mobility—Driving ROBA-28-OY *Ranking:** *E-5-1 ($0.5M;N)*	**Accepted** **Efficacy:** High. An essential technology. Many potential applications. **Waste:** None.	**Development:** Integration of driving algorithms with human-machine interface. Fuzzy-logic-driving algorithms.	Operator training. **Development costs:** $0.5M.
	M	Vehicle/Mobility—Navigation ROBA-29-OY *Ranking:** *M-4-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Primarily required in characterization to specify exact system location. **Waste:** None. **TTP Match**	**Development:** Path planning with nonholonomic constraints. Real-time sensor feedback.	Operator training. **Development costs:** $0.5M.
	H	Manipulation—Joint Control ROBA-30-OY *Ranking:** *H-4-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Applications may be limited. Usage assumes desired trajectory is known. **Waste:** None. **TTP Match**	**Development:** Special purpose control algorithms.	University level research. **Development costs:** $0.5M.
	H	Manipulation—Cartesian Control ROBA-31-OY *Ranking:** *H-4-1($1M;N)*	**Demonstration** **Efficacy:** Medium. Operator interaction is more intuitive than other control schemes. **Waste:** None	None	No unusual needs. **Development costs:** $1.0M.

EM Goals	Y-12 Problems	Problem Areas Constituents	Reference Requirements	Subelements
• Clean Up Legacy Waste • Prevent Future Insult • Develop Environmental Stewardship	D&D If Alph-4 Bldg. • characterization • mercury decontamination • process equipment removal • building intervals and outside process equipment • above-grade building demolition • building foundation removal • RA contaminated soil	Robotics/automation (R/A) is a crosscutting technology that provides support to characterization, decontamination, and dismantlement activities. Specifically support is provided for the following tasks: **Characterization** R/A provides methods of deploying sensors and instruments required for in situ characterization, monitoring, and surveying as described by the characterization data sheets contained in Vol. 3. R/A provides methods for deploying tools to collect and prepare samples for subsequent analysis in analytical laboratories. These technologies are described in ROBA-57 and -59-OY. R/A provides the technologies required for the automation of analytical laboratories as described in ROBA-55 and -56-OY. **Decontamination** Provides methods of deploying decontamination tools and/or performing tasks in areas sufficiently hazardous to preclude human access. R/A will also be required for those tasks that generate secondary environmental hazards, e.g., grinding, carbon dioxide blasting. **Dismantlement** Provides methods of deploying dismantlement tools and/or performing tasks in areas within buildings or structures that are sufficiently hazardous to preclude human access. **Waste Retrieval** R/A provides the vehicles, mobile platforms, or excavation systems necessary to retrieve radiologically or chemically hazard our wastes or soils. Mobile platforms suitable for these tasks are described in ROBA-1-OY. **Waste Sorting and Packaging** R/A provides the manipulation systems, ROBA-16-OY, and the End-of-Arm Tooling (ROBA-23 through -26-OY) required for the sorting and repackaging of RH-TRU waste.		Robotics/Automation

EM Problems
• Facility Decontamination and Decommissioning (D&D)
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utomation

Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Control—Alogorithms	H Manipulation (Special-Purpose Control) ROBA-32-OY *Ranking:** *H-4-2 ($1.5M;N)*	**Predemonstration** **Efficacy:** Medium. Will lead to higher efficiency and safety. **Waste:** None. **TTP Match**	**Development:** Advanced test-beds for testing and evaluating candidate algorithms.	Software development. **Development cost:** $1.5M.
	M Manipulation (Redundancy Control) ROBA-33-OY *Ranking:** *M-3-2 ($2M;N)*	**Predemonstration** **Efficacy:** Medium. Arms with greater than 6 D.O.F. may be required for constrained areas. **Waste:** None. **TTP Match**	**Development:** Advanced test-beds for testing and evaluating candidate algorithms.	Software development. **Development cost:** $2.0M.
	M Combined Mobility/Manipulation ROBA-34-OY *Ranking:** *M-2-2 ($1M;N)*	**Evolving** **Efficacy:** Low. Improvements in efficiency could be realized. **Waste:** None.	**Development:** Redundancy resolution. Real-time task planning.	Software development. **Development cost:** $1.0M.
	H Safety (Collision Avoidance) ROBA-35-OY *Ranking:** *H-4-1 ($1M;N)*	**Accepted** **Efficacy:** Medium. An increase in efficiency would be realized and potential damage to equipment minimized. **Waste:** None. **TTP Match**	None	Use of customized sensors. **Development cost:** $1.0M.
	H Safety (Load/Rate Limiting) ROBA-36-OY *Ranking:** *H-3-1 ($0.5M;N)*	**Accepted** **Efficacy:** Medium. Potential damage to equipment minimized. **Waste:** None.	**Improvement:** Testing of load- and rate-limiting algorithms.	Software development. **Development cost:** $0.5M.
	E Emergency Shutdown ROBA-37-OY *Ranking:** *E-4-1 ($0.5M;N)*	**Accepted** for Teleoperation **Predemonstration** for automated shutdown **Efficacy:** High. An essential technology to prevent catastrophic damage to equipment. **Waste:** None.	None	Software Development. **Development cost:** $0.5M.
Controls—Human/Machine Interface	E Console (Fixed/ Mobile/Suitcase) ROBA-38-OY *Ranking:** *E-5-1 ($0.5M;N)*	**Demonstrated** for fixed or mobile stations. **Evolving** for suitcase-control stations. **Efficacy:** High. An essential technology for use of robotics/automation. **Waste:** None.	**Improvement:** Reliability and capacity of data links requires improvements.	Improved human-machine interfaces. **Development cost:** $0.5M.
	M Console (Data Handling Methods) ROBA-39-OY *Ranking:** *M-3-1 ($1M;N)*	**Evolving** **Efficacy:** Medium. The need to process, store, and retrieve data is required for planning and control functions. **Waste:** None. **TTP Match**	**Development:** Design of heterogeneous data base management systems. Integration of heterogeneous data sources. Data fusion.	Software development **Development cost:** $1.0M.
	H Operator Interface (Command Input) ROBA-40-OY *Ranking:** *H-3-1 ($0.5M;N)*	**Evolving** **Efficacy:** High. Minimizes human error and increases operational efficiency. **Waste:** None. **TTP Match**	**Development:** Language expansion. Validation of eye-gaze measures/parameters. Head tracking.	Specialized operator training. **Development cost:** $0.5M.

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Robotics/

EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

- Facility Decontamination and Decommissioning (D&D)
- Remedial Action (RA)—Soils, Groundwater and Surface Water
- Waste Management (WM)

Y-12 Problems

D&D of Alpha-4 building (9201-4)
- characterization
- mercury decontamination
- process equipment removal
- building intervals and outside process equipment
- above-grade building demolition
- building foundation removal
- RA contaminated soil

Problem Areas/Constituents

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Reference Requirements

Subelements

Robotics/Automation

utomation

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
ontrols—Human/Machine terface	H	Operator Interface (Operator Assistance) ROBA-41-OY *Ranking:** *H-3-2 ($1.5M;N)*	**Demonstration** for most functions **Evolving** for other functions **Efficacy:** High. Will allow most efficient operation of "telerobotic" equipment. **Waste:** None. **TTP Match**	**Development:** Establish validity and completeness of knowledge bases. Conflict resolution. Hybrid artificial intelligence architectures. Dynamic allocation of functions.	Software development **Development costs:** $1.5M.
	E	Operator Interface (Status/Alert System) ROBA-42-OY *Ranking:** *E-5-1 ($0.5M;N)*	**Demonstration** for most functions **Evolving** for other functions **Efficacy:** High. An essential technology to prevent damage to equipment/tools/sensors. **Waste:** None. **TTP Match**	**Development:** Display navigation. Sensor/data fusion.	Software development **Development costs:** $0.5M.
ensors—Perception	E	Vision/Aural Systems ROBA-43-OY *Ranking:** *E-5-1 ($1M;N)*	**Demonstration** for 3-D and HDTV **Predemonstration** for directional aural **Efficacy:** High. An essential technology for Robotics/Automation. **Waste:** None.	**Development:** Sensor fusion. Increased processing speed. Advanced visualization.	No unusual needs **Development costs:** $1.0M.
	M	Range Finders ROBA-44-OY *Ranking:** *M-3-2 ($1.5M;N)*	**Accepted** **Efficacy:** Medium. Applications are limited. **Waste:** None. **TTP Match**	**Improvement:** Speed/accuracy improvement. Processing speed. Presentation to operator.	No unusual needs. **Development costs:** $1.5M.
	M	Proximity Probes ROBA-45-OY *Ranking:** *M-2-2 ($1M;N)*	**Predemonstration** **Efficacy:** Medium. Used in collision avoidance sensing systems, especially for large manipulators. **Waste:** None. **TTP Match**	**Improvement:** Increased range and improved presentation to operator.	No unusual needs. **Development costs:** $1.0M.
	M	Force/Torque ROBA-46-OY *Ranking:** *M-2-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Provides force reflection to the operator. **Waste:** None **TTP Match**	**Improvement:** Testing of force-sensing systems.	No unusual needs. **Development costs:** $0.5M.
ensors—Control	E	Position/Velocity Sensors ROBA-48-OY *Ranking:** *E-5-1 ($0.5M;N)*	**Accepted** **Efficacy:** High for analytical laboratory applications or sensor sweeps. **Waste:** None.	None	No unusual needs. **Development costs:** $0.5M.
	H	Force/Torque Sensors ROBA-50-OY *Ranking:** *H-3-1 ($0.5M;N)*	**Demonstration** **Efficacy:** Medium. Force or torque control is used to prevent damage to equipment. **Waste:** None. **TTP Match**	**Improvement:** Impulse force resolution. Stability.	No unusual needs. **Development costs:** $0.5M.
	H	Proximity Sensors ROBA-51-OY *Ranking:** *H-3-1 ($0.5M;N)*	**Accepted** for small volumes. **Predemonstration** for large volumes. **Efficacy:** Medium. **Waste:** None.	**Improvement:** Increased range and better signal quality.	No unusual needs. **Development costs:** $1.0M.

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EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
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EM Problems

- Facility Decontamination and Decommissioning (D&D)
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Y-12 Problems

D&D If Alpha 4 Bldg.
- characterization
- mercury decontamination
- process equipment removal
- building intervals and outside process equipment D&D
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- building foundation removal
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Problem Areas Constituents

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Reference Requirements

Subelements

Robotics/Automation

utomation

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Sensors—Control	H	Tooling Sensors ROBA-52-OY *Ranking:** *H-3-1 ($0.5; N)*	**Predemonstration** **Efficacy:** High. This technology is required to prevent damage to tools or sensors. **Waste:** None. **TTP Match**	**Development:** Development/testing of tactile-sensing sensors, force sensors, and proximity sensors.	Operator training. **Development costs:** $0.5M.
Other Technologies	M	Field Hardening ROBA-53-OY *Ranking:** *M-3-1 ($0.5M; N)*	**Demonstration** **Efficacy:** Medium. The ability to be decontaminated is essential for mechanical devices. **Waste:** None **TTP Match**	None	Testing of hardened systems. **Development costs:** $0.5M.
	E	Integrated Automated Analytical Laboratory ROBA-55-OY *Ranking:** *E-5-2 ($3M; N)*	**Predemonstration** for hardware systems. **Evolving** for data interpretation. **Efficacy:** High. High-sample loading in analytical laboratories require maximum use of automation **Waste:** None. **TTP Match**	**Development:** Development of Standard Laboratory Modules (SLM) for sample preparation, analytical instruments, and data interpretation.	Extensive testing of SLM's. EPA approval of SLM. **Development costs:** $3.0M.
	E	Information Management for Sample Handling ROBA-56-OY *Ranking:** *E-5-1 ($1M; N)*	**Demonstration** **Efficacy:** High. **Waste:** None. **TTP Match**	**Development:** Automatic data entry systems. Improved reliability and auditabilty.	No unusual needs **Development costs:** $1.0M.
	E	Sample Collection ROBA-57-OY *Ranking:** *E-5-1 ($1.5M; N)*	**Evolving** **Efficacy:** Medium. Alternative, but slower methods of physical sample collection are available and may be more cost effective. **Waste:** None. **TTP Match**	**Development:** Mobile platforms to deploy and manipulate sample collection tools. Suitable robotic end effectors.	No unusual needs **Development costs:** $1.5M.
	M	Characterization Sensor Integration ROBA-58-OY *Ranking:** *M-3-2 ($1M; N)*	**Demonstration** **Efficacy:** High for non-contact sensing. Medium for physical sample collection/analysis. **Waste:** None. **TTP Match**	**Development:** Signal conditioning. Data/Signal transmission.	No unusual needs. **Development costs:** $1.0M.
	E	Sample Preparation ROBA-59-OY *Ranking:** *E-5-1 ($1M; N)*	**Evolving** **Efficacy:** High. Will minimize work to be performed in analytical laboratory. **Waste:** Usual amount of waste normally generated in sample preparation operations. **TTP Match**	None	Adaptation of current sample preparation tools to robotic devices. **Development costs:** $1.0M.

** See the Explanation and Understanding*

Waste Ma

The Waste Management (WM) section address likely to be generated as a result of the decontamin ations at the Alpha-4 building. The objectives of the WM options and to rank these options in managing address the following "EM Problem" areas as they r waste processing, waste stabilization, waste packa waste minimization.

It should be noted that waste stabilization, as us residual solid wastes and does not include pretreatr tions.

nagement

the technologies for processing the waste streams on and decommissioning (D&D) and current WM oper- /M wiring diagrams are to list and evaluate the likely astes. The WM wiring diagrams were developed to ate to the Y-12 Site D&D activities: waste retrieval, g, handling, & transportation, waste disposal, and

here, consists of processes for the final treatment of nt of the wastes to stabilize them before WM opera-

Waste Ma

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 D&D	• RAD • Scrap Wood • Scrap Metals • Asbestos • PCBs • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR); radiation protection standards; DOE Orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Retrieval
			Refer to the appropriate Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

agement

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
echanical Retrieval		**Wheeled/Tracked Vehicles** – Front-end Loader – Backhoe – Fork Lift	*See* Robotics/Automation		
		Demolition – Jackhammers – Controlled Blasting	*See* Dismantlement		
ydraulic Retrieval		**Fluid Systems**	*See* Dismantlement		

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha -4 Contaminated Concrete Rubble Clay Tiles	• Rubble • RAD • PCBs • Organics • Inorganics • Mercury MTC 5210	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation; radiation protection standards; DOE orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

nagement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Waste Stabilization	See Waste Stabilization			
Thermal Treatment	**H** Thermal Desorption WPRO-106-OY *Ranking: H-2-2 ($1M; $1/lb)*	**Accepted** This technology has been used by industry to remove and recover volatiles from contaminated media such as soils. The process is claimed to have a >99% removal efficiency for recovering volatile organic compounds (VOCs) from soil. The application of the process to treat other contaminated media (such as concrete rubble) needs to be	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application, funding, and regulatory approval.
	M Plasma Arc Furnace WPRO-107-OY *Ranking: M-2-3 ($2M;N)*	**Demonstration** This is a developmental technology proposed for the destruction of organics and the immobilization of non-volatile radionuclides and toxic metals in a glassy slag matrix. The attractive features of the technology are that it can be used to treat almost any solid waste and it does not require extensive pre-treatment of the waste feed. The negative aspect of the process is that it is very energy intensive thus, it is likely to be expensive.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. RD&D is required on the process to determine for example, waste destruction and removal efficiencies (DREs), electrode life, materials of construction, power efficiency, effluent characteristics for different waste feeds, and the viability of the process.	The RD&D effort is estimated to require 3 years and $ 10 million.
Chemical Treatment	**H** Solvent Washing WPRO-211/212-OY *Ranking: H-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.

Waste Ma

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Concrete Rubble	• Rubble MTC 5210 • RAD • PCBs • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
	Alpha-4 Scrap Transite Alpha-4 Scrap Asbestos Pipe & Insulation	• Asbestos MTC 5290 • PCB • Oils • RAD • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water (RA)
- Waste Management (WM)

agement

Alternatives	Technologies	Status	Science.Technology Needs	Implementation Needs
hemical Treatment — M	Gamma-Radiolysis WPRO-100-OY *Ranking:* *M-2-5 ($2M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic byproducts.	The RD&D effort is estimated to require $ 1.25-2.5 million.
M	Leaching & Stripping WPRO-213-OY *Rankng:* *M-2-3 ($1M;N)*	**Accepted** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
L	Electro Osmosis/Migration DCON-20-OY *Rankng:* *L-3-4 ($2M;N)*	**Evolving Technology** Initial data indicate 90+% removal of uranium and technetium from concrete. The process could also be used to remove oils and organics however, this application needs additional RD&D.	Some development work is required to apply the method to treat the site wastes.	Normal implementation needs. Development costs are estimated to be $ 400-1000K. Capital costs: Not available. Operating costs: Likely to be more expensive than other waste treatment methods.
/aste Stabilization	See Waste Stabilization			
hemical Treatment — M	Electro Osmosis/Migration DCON-20-OY *Rankng:* *M-2-4 ($2M;N)*	**Evolving Technology** Initial data indicate 90+% removal of uranium and technetium from concrete. The process could also be used to remove oils and organics however, this application needs additional RD&D.	Some development work is required to apply the method to treat the site wastes.	Normal implementation needs. Development costs are estimated to be $ 400-1000K. Capital costs: Not available. Operating costs: Likely to be more expensive than other waste treatment methods.

Waste Ma

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Scrap Transite Alpha-4 Scrap Asbestos Pipe & Insulation	• Asbestos • PCB • Oils • RAD • Organics • Inorganics • Mercury MTC 5210	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation; radiation protection standards; DOE Orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

nagement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	Solvent Extraction WPRO-211/212-OY M *Ranking: M-4-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	Gamma-Radiolysis WPRO-100-OY M *Ranking: M-2-5 ($2M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic	The RD&D effort is estimated to require $ 1.25-2.5 million.
Thermal Treatment	Incineration WPRO-108-OY M *Ranking: M-4-1 ($1M;$6/lb*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. Insert 10: For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste
	Calcination/Roasting DCON-60-OY	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.

Waste M

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Scrap Transite Alpha-4 Scrap Asbestos Pipe & Insulation	• Asbestos ~~MTO 5290~~ • PCB • Oils • RAD • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
EM Problem Facilities—Decontamination and Decommissioning (D&D) Soils, Groundwater and Surface Water (RA) Waste Management (WM)	Alpha-4 Other Scrap Building Materials (e.g. wood, tile, roofing, fixtures, gaskets)	• Debris MTC 5210 • RAD • PCBs • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

nagement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (contd)	**L** Catalytic Destruction WPRO-109-OY *Ranking: L-4-3 ($3M;N)*	**Predemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M Plasma Arc Furnace WPRO-107-OY *Ranking: M-4-3 ($3M;N)*	**Demonstration** This is a developmental technology proposed for the destruction of organics and the immobilization of non-volatile radionuclides and toxic metals in a glassy slag matrix. The attractive features of the technology are that it can be used to treat almost any solid waste and it does not require extensive pre-treatment of the waste feed. The negative aspect of the process is that it is very energy intensive thus, it is likely to be expensive.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. RD&D is required on the process to determine for example, waste destruction and removal efficiencies (DREs), electrode life, materials of construction, power efficiency, effluent characteristics for different waste feeds, and the viability of the process.	The RD&D effort is estimated to require 3 years and $ 10 million.
Waste Stabilization	See Waste Stabilization			
Thermal Treatment	**H** Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. Insert 10: For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	M Plasma Arc Furnace WPRO-107-OY *Ranking: M-3-3 ($3M;N)*	**Demonstration** This is a developmental technology proposed for the destruction of organics and the immobilization of non-volatile radionuclides and toxic metals in a glassy slag matrix. The attractive features of the technology are that it can be used to treat almost any solid waste and it does not require extensive pre-treatment of the waste feed. The negative aspect of the process is that it is very energy intensive thus, it is likely to be expensive.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. RD&D is required on the process to determine for example, waste destruction and removal efficiencies (DREs), electrode life, materials of construction, power efficiency, effluent characteristics for different waste feeds, and the viability of the process.	The RD&D effort is estimated to require 3 years and $ 10 million.

Waste M

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 MTC 5210 Other Scrap Building Materials (e.g. wood, tile, roofing, fixtures, gaskets)	• Debris • RAD • PCBs • Organics • Inorganics • Mercury MTC 5210	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation; radiation protection standards; DOE Orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

nagement

Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Thermal Treatment	**H** Calcination/Roasting DCON-60-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	H Pyrolysis WPRO-110-OY *Ranking: H-3-1 ($1M;N)*	**Accepted** This is an accepted industrial process for the destruction of organics. The process has an organic destruction efficiency greater than 99%.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application, funding, and regulatory approval.
	M Chem Char Process WPRO-114-OY *Ranking: M-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	H Smelting WPRO-111-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment and processing of metals. The technology has a DRE for organics greater than 99%. However, its use for the removal and separation of the radionuclides from the wastes requires additional RD&D. The process could be used for the removal of uranium from the waste but it may not be suitable for the removal of technetium. The disadvantage is that smelting may cause the surface radioactive contamination to become bulk contamination of the waste.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 3-5 million. The payback could be significant yielding a major waste minimization effort due to recovery and recycle of the metals.

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Other Scrap Building Materials (e.g. wood, tile, roofing, fixtures, gaskets)	• Debris MTC 5210 • RAD • PCBs • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation; radiation protection standards; DOE orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

agement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
emical Treatment	**M** Solvent Extraction WPRO-111-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration.** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	L Gamma-Radiolysis WPRO-100-OY *Ranking: L-3-5 ($3M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic byproducts.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	L Electro Osmosis/Migration DCON-20-OY *Ranking: L-3-4 ($2M;N)*	**Evolving Technology** Initial data indicate 90+% removal of uranium and technetium from concrete. The process could also be used to remove oils and organics however, this application needs additional RD&D.	Some development work is required to apply the method to treat the site wastes.	Normal implementation needs. Development costs are estimated to be $ 400-1000K. Capital costs: Not available. Operating costs: Likely to be more expensive than other waste treatment methods.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Other Scrap Building Materials (e.g. wood, tile, roofing, fixtures, gaskets)	• Debris • RAD • PCBs • Organics • Inorganics • Mercury MTC 5210	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
	Alpha-4 Scrap Nickel	• Nickel • RAD • Inorganics • Mercury MTC 5190	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	M	Leaching & Stripping WPRO-213-OY *Ranking:* *M-3-2 ($1M;N)*	**Accepted** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
Waste Stabilization		See Waste Stabilization			
Thermal Treatment	H	Smelting WPRO-111-OY *Ranking:* *H-1-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment and processing of metals. The technology has a DRE for organics greater than 99%. However, its use for the removal and separation of the radionuclides from the wastes requires additional RD&D. The process could be used for the removal of uranium from the waste but it may not be suitable for the removal of technetium. The disadvantage is that smelting may cause the surface radioactive contamination to become bulk contamination of the waste.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 3-5 million. The payback could be significant yielding a major waste minimization effort due to recovery and recycle of the metals.
	H	Calcination/Roasting DCON-60-OY *Ranking:* *H-1-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	H	Mond Process WPRO-112-OY *Ranking:* *H-1-1 ($1M;N)*	**Demonstration** This is accepted technology for the refining of nickel. However its use to separate the nickel from some of the radionuclides (e.g., technetium) needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The technology demonstration is estimated to require $ 1-2 million. The payback for the process is estimated to be greater than $ 20-30 million based on current disposal costs.
	L	Catalytic Destruction WPRO-109-OY *Ranking:* *L-1-3 ($3M;N)*	**Prodemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
Chemical Treatment	M	Leaching & Stripping WPRO-213-OY *Ranking:* *M-1-2 ($1M;N)*	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.

Waste Ma

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Scrap Nickel	• Nickel • RAD • Inorganics • Mercury MTC 5190	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
	Alpha-4 Scrap Aluminum, Copper, and Other Non-Ferrous Metals (except Nickel and Mercury)	• Aluminum • Non-ferrous metal • RAD • Organics • Inorganics • Mercury MTC 5190	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water (RA)
- Waste Management (WM)

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Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Chemical Treatment (contd)	L	Gas Phase (ClF_3) Treatment DCON-16-OY *Ranking:* *L-1-3 ($3M;N)*	**Predemonstration** Laboratory scale studies have shown that this process can effectively remove uranium deposits at room temperature. The process should also be effective in removing other radionuclides such as technetium. However, additional RD&D is needed to demonstrate the full capabilities of the process.	Knowledge of process application, funding, and regulatory approval. Development and demonstration of the optimum process conditions and unit operations for the removal of radioactive contaminants from the wastes and for the recycle of the reactant (ClF3).	The RD&D effort is estimated to require $ 5 million.
Waste Stabilization		See Waste Stabilization			
Thermal Treatment	H	Smelting WPRO-111-OY *Ranking:* *H-3-1 ($1M;N)*	**Accepted** This is accepted industrial technology for the treatment and processing of metals. The technology has a DRE for organics greater than 99%. However, its use for the removal and separation of the radionuclides from the wastes requires additional RD&D. The process could be used for the removal of uranium from the waste but it may not be suitable for the removal of technetium. The disadvantage is that smelting may cause the surface radioactive contamination to become bulk contamination of the waste.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 3-5 million. The payback could be significant yielding a major waste minimization effort due to recovery and recycle of the metals.
	M	Incineration WPRO-108-OY *Ranking:* *M-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	H	Calcination/Roasting DCON-60-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	L	Catalytic Destruction WPRO-109-OY *Ranking:* *L-3-3 ($3M;N)*	**Predemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.

EM Goals

- Clean up Legacy Wastes
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Scrap Aluminum, Copper, and Other Non-Ferrous Metals (except Nickel and Mercury)	Aluminum • Non-ferrous metals • RAD • Organics • Inorganics • Mercury MTC 5190	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment M	Solvent Extraction WPRO-211/212-OY *Ranking: M-3-2 ($2M;N)*	**Accepted** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
M	NAC Process WPRO-105-OY (for Al only) *Ranking: M-3-3 ($4M;N)*	**Predemonstration** The feasibility of the process has been proven at the bench-scale. If proven effective at the industrial -scale, the process could treat and dispose of all the contaminated aluminum from D&D operations. This aluminum would be used in the process to treat the radioactively contaminated nitrate wastes in the Hanford site tanks.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 2-5 million. The payback is expected to be significant especially because the scrap aluminum from the site can be used to dispose of the nitrate wastes in the Hanford site tanks. This is expected to result in significant savings due to minimizing the wastes to be disposed at the two sites.
M	Gamma-Radiolysis WPRO-100-OY *Ranking: M-3-5 ($3M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic byproducts.	The RD&D effort is estimated to require $ 1.25-2.5 million.

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EM Goals

- Clean up Legacy Wastes
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water (RA)
- Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Scrap Aluminum, Copper, and Other Non-Ferrous Metals (except Nickel and Mercury)	• Aluminum MTC 5190 • Non-ferrous metal • RAD • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
Alpha-4 Scrap Ferrous Metal (Iron and Steel)	• Steel MTC 5110 • RAD • Organics • Inorganics • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	**L** Gas Phase (ClF_3) Treatment DCON-16-OY *Ranking: L-3-3 ($3M;N)*	**Predemonstration** Laboratory scale studies have shown that this process can effectively remove uranium deposits at room temperature. The process should also be effective in removing other radionuclides such as technetium. However, additional RD&D is needed to demonstrate the full capabilities of the process.	Further RD&D on the process is needed to develop the optimum processing conditions. Development and demonstration of the optimum process conditions and unit operations for the removal of radioactive contaminants from the wastes and for the recycle of the reactant (ClF3).	The RD&D effort is estimated to require $ 5 million.
	M Leaching & Stripping WPRO-213-OY *Ranking: M-3-2 ($1M;N)*	**Accepted** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
Waste Stabilization	See Waste Stabilization			
Thermal Treatment	**H** Smelting WPRO-111-OY *Ranking: H-4-1 ($1M;N)*	**Accepted** This is accepted industrial technology for the treatment and processing of metals. The technology has a DRE for organics greater than 99%. However, its use for the removal and separation of the radionuclides from the wastes requires additional RD&D. The process could be used for the removal of uranium from the waste but it may not be suitable for the removal of technetium. The disadvantage is that smelting may cause the surface radioactive contamination to become bulk contamination of the waste.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 3-5 million. The payback could be significant yielding a major waste minimization effort due to recovery and recycle of the metals.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Scrap Ferrous Metal (Iron and Steel)	• Steel • RAD • Organics • Inorganics MTC 5110	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
EM Problem Facilities—Decontamination and Decommissioning (D&D) Soils, Groundwater and Surface Water (RA) Waste Management (WM)	Scrap Plastics, Paper, and Cloth (Except PPC and rags)	• Plastics, Paper, Cloth, RAD, Organics, Inorganics MTC 5300	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No.	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	**M** Solvent Extraction WPRO-211/212-OY *Ranking: M-4-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	H Leaching & Stripping WPRO-213-OY *Ranking: H-4-2 ($1M;N)*	**Accepted** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
Thermal Treatment	**H** Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	M Chem Char Process WPRO-114-OY *Ranking: M-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Scrap Plastics, Paper, and Cloth (Except PPC and rags)	• Plastics, Paper, Cloth, RAD, Organics, Inorganics MTC 5300	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
EM Problem Facilities—Decontamination and Decommissioning (D&D) Soils, Groundwater and Surface Water (RA) Waste Management (WM)	Alpha-4 Contaminated Personal Protective Clothing (PPC) and Rags	• Cloth • RAD • Inorganics • Organics MTC 5300	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
hermal Treatment	M	Molten Salt Oxidation WPRO-113-OY *Ranking: M-3-2 ($3M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficienc. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
Vaste Stabilization		See Waste Stabilization			
Chemical Treatment	H	Solvent Extraction WPRO-211/212-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.

EM Goals

- Clean up Legacy Wastes
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Personal Protective Clothing (PPC) and Rags	• Cloth • RAD • Inorganics • Organics MTC 5300	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
Alpha-4 Spent Ion Exchange Media (i.e. resins and spent activated carbon)	• Ion Exchange Media • Organics • Inorganics • RAD MTC 3115	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date	Waste Processing

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Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Thermal Treatment (contd)	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-3-2 ($3M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	H	Steam Stripping WPRO-221-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is an accepted industrial process that can remove volatile organics with >99+% efficiency especially from contaminated aqueous streams. The application of the process to satisfactorily remove hazardous and radioactive species needs to be	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	L	Chem Char Process WPRO-114-OY *Ranking:* *L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
Waste Stabilization		See Waste Stabilization			
Chemical Treatment	M	Elution WPRO-104-OY *Ranking:* *M-3-1 ($0.1M;N)*	**Demonstration** This is accepted technology for the treatment of spent ion exchange media. However, the site specific applications may need to be demonstrated.	Demonstrate the effectiveness of the technology to meet the site requirements.	This technology has no unique implementation needs.
		Leaching & Stripping WPRO-213-OY *Ranking:* M-3-1 ($0.1M,N)	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	L	Supercritical Water Oxidation WPRO-216-OY *Ranking:* *L-3-3 ($3M;N)*	**Demonstration**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Significant development is needed to solve the problems of corrosion, plugging, and caking of the reactors. Overall experience is also needed on the specific problems that may be associated with the processing of particular types of wastes. This information could be used to develop a technology database to support the applicability and relative merits of this promising	The RD&D effort is estimated to require $ 1.6 million for a 3 year development plan.

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop	Alpha-4 Spent Ion Exchange Media (i.e. resins and spent activated carbon)	• Ion Exchange Media • Organics • Inorganics • RAD MTC 3115	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Facilities—

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment	**M** Incineration WPRO-108-OY *Ranking:* *M-3-1 ($1M;N)*	**Accepted** The feasibility of the process has been proven at the bench-scale. If proven effective at the industrial -scale, the process could treat and dispose of all the contaminated aluminum from D&D operations. This aluminum would be used in the process to treat the radioactively contaminated nitrate wastes in the Hanford site tanks. This process would thus help treat and dispose of two major DOE wastes.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste
	M Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-3-2 ($3M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	H Calcination/Roasting DCON-60-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	H Molten Glass Combustor WPRO-116-OY *Ranking:* *H-3-2 ($2M;N)*	**Demonstration** This is accepted industrial technology for mixed wastes treatment. The process can achieve DREs greater than 99%. EPA has accepted this process as best demonstrated available technology (BDAT) for the treatment of hazardous high-level nuclear wastes. Operating costs for the process are likely to be high.	Some development work is required to apply the method to treat the site wastes.	Knowledge of process application, funding, and regulatory approval.
	L Catalytic Destruction WPRO-109-OY *Ranking:* *L-3-3 ($3M;N)*	Predemonstration This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	H Steam Stripping WPRO-221-OY *Ranking:* *H-3-1 ($1M;N)*	**Accepted**	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.

EM Goals

- Clean up Legacy Wastes
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
Alpha-4 Spent Ion Exchange Media	• Ion Exchange • Organics • Inorganics • RAD MTC 3115	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
Alpha-4 Waste Processing Sludges (precipitates from water treatment processes)	• Sludges • RAD • Organic • Inorganics MTC 3120	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (cont.)	**L** Chem Char Process WPRO-114-OY *Ranking: L-3-7 ($5M;N)*	**Predemonstraton** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	Steam Stripping WPRO-221-OY *Ranking: H-3-1 ($1M;N)*	**Accepted**	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
Waste Stabilization	See Waste Stabilization			
Chemical Treatment	**M** Solvent Extraction WPRO-211/212-OY *Ranking: M-4-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	H Leaching & Stripping WPRO-213-OY *Ranking: H-4-1 ($1M;N)*	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.

Waste M

EM Goals
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship

EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water (RA)
Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Waste Processing Sludges (precipitates from water treatment processes).	•Sludges • RAD • Organic • Inorganics MTC 3120	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Chemical Treatment (contd) H	Incineration WPRO-108-OY *Ranking:* *H-4-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste
	Catalytic Destruction WPRO-109-OY *Ranking:* *L-4-3 ($3M;N)*	**Predemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
Thermal Treatment H	Calcination/Roasting DCON-60-OY *Ranking:* *H-4-1 ($1M;N*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
L	Chem Char Process WPRO-114-OY *Ranking:* *L-4-3 ($3M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
M	Wet Air Oxidation WPRO-215-OY *Ranking:* *M-4-2 ($2M;N)*	**Demonstration** The process is commercially available. It is capable of greater than 99+% destruction of some organics however; it may not be able to completely destroy certain refractory organics such as halogenated aromatics (e.g., PCB). Processing costs are likely to be high.	Demonstrate the effectiveness of the technology to meet the site requirements.	The development effort is estimated to require approximately $ 1 million.
L	Microwave Heating WPRO-115-OY *Ranking:* *L-4-3 ($4M;N)*	**Demonstration** This is a novel technology for the thermal treatment of radioactive wastes. The technology is at the laboratory scale of development.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 2.5 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Processing Solid Residuals	• Residue • RAD • Organics • Inorganics MTC 5490	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water (RA)
- Waste Management (WM)

nagement

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Thermal Treatment	H	Molten Glass Combustor WPRO-116-OY *Ranking:* *H-4-2 ($2M;N)*	**Accepted** This is accepted industrial technology for mixed wastes treatment. The process can achieve DREs greater than 99%. EPA has accepted this process as best demonstrated available technology (BDAT) for the treatment of hazardous high-level nuclear wastes. Operating costs for the process are likely to be high.	Some development work is required to apply the method to treat the site wastes.	Knowledge of process application, funding, and regulatory approval.
Biotreatment	M	Biodegradation WPRO-117-OY *Ranking:* *M-4-3 ($3M;N)*	**Evolving Technology** This is a promising technology for hazardous waste treatment. The process can achieve impressive treatment efficiencies for certain organics. However, the process is slow and may not be able to completely destroy certain refractory organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.
Waste Stabilization	H	See Waste Stabilization *H-3-1 ($1M;N)*			
Chemical Treatment	M	Leaching & Stripping WPRO-213-OY *Ranking:* *M-3-1 ($1M;N)*	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99%; however, each application requires additional RD&D to determine optimum leachant composition and process	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	M	Solvent Extraction WPRO-211/212-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	L	Transmutation WPRO-219-OY *Ranking:* *L-3-10 ($10M;N)*	**Conceptual** The future of an industrial scale transmutation facility is highly dependent on the availability of a permanent high level waste repository. A "national" transmutation facility would greatly facilitate the destruction and disposal of "problem" radionuclides such as	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	An industrial-scale national transmutation facility would need to be developed and built. The cost for such a "national" facility is estimated to be in the billion dollars range and would require several years to build.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Processing Solid Residuals	• Residue • RAD • Organics • Inorganics MTC 5490	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation, radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water (RA)
Waste Management (WM)

agement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
hermal Treatment	**H** Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound incinerated.
	H Roasting/Calcination DCON-60-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is accepted industrial technology for the treatment of ores. However, its use for the removal and destruction of oils and organics from the site wastes needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-3-2 ($3M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	M Wet Air Oxidation WPRO-215-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** The process is commercially available. It is capable of greater than 99+% destruction of some organics however, it may not be able to completely destroy certain refractory organics such as halogenated aromatics (e.g., PCB). Processing costs are likely to be high.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The development effort is estimated to require approximately $ 1 million.
	L Chem Char Process WPRO-114-OY *Ranking: L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Clean up Legacy Wastes • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Processing Solid Residuals	• Residue • RAD • Organics • Inorganics MTC 5490	Refer to the Regulatory Compliance chapter of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation; radiation protection standards; DOE Orders; and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water (RA)
Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment	**M** Microwave Heating WPRO-115-OY *Ranking:* *M-3-3 ($4M;N)*	**Demonstration** This is a novel technology for the thermal treatment of radioactive wastes. The technology is at the laboratory scale of development.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 2.5 million.
	H Molten Glass Combustor WPRO-116-OY *Ranking:* *H-3-2 ($2M;N)*	**Accepted** This is accepted industrial technology for mixed wastes treatment. The process can achieve DREs greater than 99%. EPA has accepted this process as best demonstrated available technology (BDAT) for the treatment of hazardous high-level nuclear wastes. Operating costs for the process are likely to be high.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	RAD in Water MTC 1000 MTC 1900	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

nagement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	**M** Adsorption WPRO-202/203-OY *Ranking:* *M-3-2 ($2M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	L Electrolysis WPRO-205-OY *Ranking:* *L-3-4 ($3M;N)*	**Demonstration** The basic technology is well established in industry however, its application to meet the site requirements needs to be developed and demonstrated. Removal efficiencies for the process are in general greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	M Reverse Osmosis WPRO-206-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** Reverse osmosis is commercial technology for treating aqueous streams. When properly designed and operated the technology is capable of greater than 99% rejection of the salts. However, additional RD&D may be required to develop membranes that meet the site specific requirements.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	M Ultrafiltration WPRO-206-OY *Ranking:* *M-3-3 ($3M;N)*	**Demonstration** Ultrafiltration is also a membrane separation process that is similar to reverse osmosis. However, it will not remove low to intermediate molecular weight solutes from the liquid stream.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	M Inorganic Microporous Filters WPRO-207-OY *Ranking:* *M-3-8 ($5M;N)*	**Predemonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments, they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
hemical Treatment	Chemical Fixation WPRO-208-OY *Ranking:* *H-3-2 ($2M;N)*	**Demonstration** This process consists of fixing the contaminants by chemical reaction so that they can be removed by filtration or other separation techniques. The process should be capable of 90%+ treatment efficiencies.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	RAD in Water MTC 1000	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	Chemical Reduction WPRO-209-OY *Ranking:* *M-4-3 (<$1M;N)*	**Predemonstration** This process consists of chemically reacting the contaminants with appropriate reagents to alter the chemical state of the contaminants to make them easier to remove from the fluid. Treatment efficiencies should generally be greater than 95%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	Chemical Precipitation WPRO-210-OY *Ranking:* *E-5-1 (<$1M;N)*	**Demonstration** Precipitation technologies are fairly mature. Iron co-precipitation is presently being used at the K-25 Site Central Neutralization Facility for separating radionuclides from the aqueous wastes. However, significant development is still necessary to meet the increasingly stringent regulatory limits on the wastewater discharges. For example, precipitation using potassium ferrate has not been demonstrated and additional RD&D is required to prove its applicability and performance in treating the wastewater.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
	Solvent Extraction WPRO-211/212-OY L *Ranking:* *L-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	Ion Exchange WPRO-217/218-OY H *Ranking:* *H-3-2($2M;N*	**Demonstration** This is one of the accepted methods used in industry for treating liquids. Treatment efficiencies can be greater than 99% depending upon the application, the ion exchange media, and the solutes to be removed.	The use of the technology to meet the site requirements needs to be demonstrated.	Development costs are estimated to be $ 1.25 million.

Waste M

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	RAD in Water MTC 1000	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
		Heavy Metals in Water MTC 1900	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
hermal Treatment	Distillation WPRO-222-OY *Ranking: M-3-0 (<1$M;N)*	**Demonstration** This is an accepted industrial process for treating liquids. Depending upon the contaminant being removed, the separation efficiency can be greater than 99%. However, the use of the process to meet site requirements will need to be demonstrated. Capital and operating costs could be high.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	H Evaporation WPRO-223-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is similar to distillation and is an accepted industrial process for treating contaminated liquids. It is usually used when the solvent is of low value and can be disposed. Like distillation, the operating costs can be high for certain applications.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
Biological Treatment	L Biosorption WPRO-226-OY *Ranking: L-3-5 ($5M;N)*	**Predemonstration** Data in the scientific literature suggests that given the right conditions, this process should be able to achieve impressive (>95%) treatment efficiencies however, most of the information is based on laboratory-scale data. There is little pilot plant or industrial scale data on the process.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-3 million.
Physical Treatment	M Adsorption WPRO-202/203-OY *Ranking: M-3-2 ($2M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	L Electrolysis WPRO-205-OY *Ranking: L-3-4 ($3M;N)*	**Demonstration** The basic technology is well established in industry however, its application to meet the site requirements needs to be developed and demonstrated. Removal efficiencies for the process are in general greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	Heavy Metals in Water MTC 1900	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water—Remedial Action (RA)
Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.)	Reverse Osmosis WPRO-206-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** Reverse osmosis is commercial technology for treating aqueous streams. When properly designed and operated the technology is capable of greater than 99% rejection of the salts. However, additional RD&D may be required to develop membranes that meet the site specific requirements.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	Ultrafiltration WPRO-206-OY *Ranking:* *M-3-3 ($3M;N)*	**Demonstration** Ultrafiltration is also a membrane separation process that is similar to reverse osmosis. However, it will not remove low to intermediate molecular weight solutes from the liquid stream.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	Inorganic Microporous Filters WPRO-207-OY *Ranking:* *M-3-8 ($5M;N*	**Predemonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments, they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
	High Gradient Magnetic Separations WPRO-204-OY *Ranking:* *M-3-2 ($2M;N)*	**Predemonstration** The treatment is commercially available for example, for the removal of trace impurities from kaolin clays. Removal efficiencies for the process are greater than 99%. However, its use to treat mixed waste contaminated fluids needs additional RD&D.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.
Chemical Treatment	Chemical Fixation WPRO-208-OY *Ranking:* *H-3-2 ($2M;N)*	**Predemonstration** This process consists of fixing the contaminants by chemical reaction so that they can be removed by filtration or other separation techniques. The process should be capable of 90%+ treatment efficiencies.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	Chemical Reduction WPRO-209-OY *Ranking:*	**Demonstration** This process consists of chemically reacting the contaminants with appropriate reagents to alter the chemical state of the contaminants to make them easier to remove from the fluid. Treatment efficiencies should generally be greater than 95%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25-2.5 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater (cont.)	Heavy Metals in Water MTC 1900	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment (cont.)	Chemical Precipitation WPRO-210-OY *Ranking: E-5-1 (<$1M;N)*	**Demonstration** Precipitation technologies are fairly mature. Iron co-precipitation is presently being used at the K-25 Site Central Neutralization Facility for separating radionuclides from the aqueous wastes. However, significant development is still necessary to meet the increasingly stringent regulatory limits on the wastewater discharges. For example, precipitation using potassium ferrate has not been demonstrated and additional RD&D is required to prove its applicability and performance in treating the wastewater.	Demonstrate the effectiveness of the technology to meet the site requirements.	**The demonstration effort is estimated to require $ 0.4 million.**
	L Solvent Extraction WPRO-211/212-OY *Ranking: L-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	**The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.**
	H Ion Exchange WPRO-217/218-OY *Ranking: H-3-2 ($2M;N)*	**Demonstration** This is one of the accepted methods used in industry for treating liquids. Treatment efficiencies can be greater than 99% depending upon the application, the ion exchange media, and the solutes to be removed.	The use of the technology to meet the site requirements needs to be demonstrated.	**Development costs are estimated to be $ 1.25 million.**
ThermalTreatment	Evaporation WPRO-223-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is similar to distillation and is an accepted industrial process for treating contaminated liquids. It is usually used when the solvent is of low value and can be disposed. Like distillation, the operating costs can be high for certain applications.	The use of the technology to meet the site requirements needs to be demonstrated.	**Knowledge of process application(s) and funding.**

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	PCBs in Water MTC 1900 MTC 2210	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science-Technology Needs	Implementation Needs
Physical Treatment	**H** Foaming WPRO-201-OY *Ranking:* *H-2-1 ($1M;N*	**Demonstration** This process is used to recover particulates from liquids (e.g., aqueous streams). Removal efficiencies are generally greater than 90%. The process is a variation of filtration in which chemicals are added to the liquid to create a foam. The foam traps the particulates. The foam is then processed elsewhere to recover the particulates.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Sedimentation WPRO-201-OY *Ranking:* *H-2-1 ($1M;N*	**Demonstration** Sedimentation is also a variation of filtration in which gravity forces are used to remove the particulates from the fluid. Removal efficiencies should generally be greater than 90%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Adsorption WPRO-202/203-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on process to develop the nnology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	M Inorganic Microporous Filters WPRO-207-OY *Ranking:* *M-2-8 ($5M;N)*	**Demonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments; they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
Chemical Treatment	**M** Chemical Dechlorination WPRO-209-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** This process consists of chemically reacting the contaminants with appropriate reagents to alter the chemical state of the contaminants to make them easier to remove from the fluid. Treatment efficiencies should generally be greater than 95%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25-2.5 million.

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- Cleanup Legacy
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Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	PCBs in Water MTC 1900 MTC 2210	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
hemical Treatment ont.)	**M** Solvent Extraction WPRO-211/212-OY *Ranking: M-2-2 ($2M;N*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M Gamma-Radiolysis (WPRO-100-OY) *Ranking: M-2-5 ($3M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic by products.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	M Wet Air Oxidation (WPRO-215-OY) *Ranking: M-2-2 ($2M;N*	**Predemonstration** The process is commercially available. It is capable of greater than 99+% destruction of some organics however, it may not be able to completely destroy certain refractory organics such as halogenated aromatics (e.g., PCB). Processing costs are likely to be high.	Demonstrate the effectiveness of the technology to meet the site requirements.	The development effort is estimated to require approximately $ 1 million.
hermal Treatment	**E** Incineration WPRO-108-OY *Ranking: E-2-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.

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Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	PCBs in Water MTC 1900 MTC 2210	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
	Volatile Organic Compounds in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (cont.)	**H** Distillation WPRO-222-OY *Ranking: H-2-2 ($2M;N)*	**Demonstration** This is an accepted industrial process for treating liquids. Depending upon the contaminant being removed, the separation efficiency can be greater than 99%. However, the use of the process to meet site requirements will need to be demonstrated. Capital and operating costs could be high.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	L Catalytic Destruction WPRO-109-OY *Ranking: L-2-3 ($3M;N)*	**Demonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
Biological Treatment	Aerobic Digestion WPRO-224-OY *Ranking: M-4-3 ($2M;N)*	**Predemonstration** This is a promising technology for destroying hazardous organics. Under the right conditions, this process should be able to achieve greater than 99% destruction of the organics. Additional RD&D is needed to determine the applicability of the process to meet the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	M Anaerobic Digestion WPRO-225-OY *Ranking: M-2-3 ($3M;N)*	**Predemonstration** This is a promising technology for destroying hazardous organics. Under the right conditions, this process should be able to achieve greater than 99% destruction of the organics. Additional RD&D is needed to determine the applicability of the process to meet the site requirements.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.
	L Microbial Dechlorination WPRO-227-OY *Ranking: L-2-5 ($5M;N)*	**Predemonstration** This process is at an early stage of development. Based on the available information, it appears the process should be able to achieve destruction efficiencies greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.
Physical Treatment	Air Sparging WPRO-200-OY *Ranking: M-4-1 ($0.5M;N)*	**Accepted** This is an acceptable industrial process with removal efficiencies in the 90+%	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	The implementation needs will be determined by the site requirements.

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Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	Volatile Organic Compounds in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.)	M	Adsorption WPRO-202/203-OY *Ranking:* *M-3-1 ($1M;N)*	**Demonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	M	Solvent Extraction WPRO-211/212-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
		Stripping WPRO-213-OY *Ranking:* *M-4-2 ($2M;N)*	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	Volatile Organic Compounds in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply: Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Chemical Treatment (cont.)	L	Ozonation-Photolysis WPRO-214-OY *Ranking:* *L-3-3 ($3M;N)*	**Demonstration** This process can be very useful in destroying organics (especially refractory organics) in water. DREs for the process can be greater than 90+%. Even though some organics are easily destroyed by the process, they are rarely completely oxidized and may be converted to other hazardous species. To be successful, a thorough knowledge of the waste to be treated is essential. The process is comparatively expensive for the treatment of organics.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	M	Wet Air Oxidation WPRO-215-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** The process is commercially available. It is capable of greater than 99+% destruction of some organics however, it may not be able to completely destroy certain refractory organics such as halogenated aromatics (e.g., PCB). Processing costs are likely to be high.	Demonstrate the effectiveness of the technology to meet the site requirements.	The development effort is estimated to require approximately $ 1 million.
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking:* *H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
		Thermal Desorption WPRO-106-OY *Ranking:* *M-2-2 ($1M, $1/lb)*	**Accepted** This technology has been used by industry to remove and recover volatiles form contaminated media such as soils. The process is claimed to have a >99% removal efficiency for recovering volatile organic compounds (VOCs) from soil. The application of the process to treat other contaminated media (such as concrete rubble) needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application, funding, and regulatory approval.

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Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	Volatile Organic Compounds in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (cont.)	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	Chem Char Process WPRO-114-OY *Ranking:* *L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	Steam Stripping WPRO-221-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is an accepted industrial process that can remove volatile organics with >99+% efficiency especially from contaminated aqueous streams. The application of the process to satisfactorily remove hazardous and radioactive species needs to be demonstrated.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	Distillation WPRO-222-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is an accepted industrial process for treating liquids. Depending upon the contaminant being removed, the separation efficiency can be greater than 99%. However, the use of the process to meet site requirements will need to be demonstrated. Capital and operating costs could be high.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	Evaporation WPRO-223-OY *Ranking:*	**Demonstration** This is similar to distillation and is an accepted industrial process for treating contaminated liquids. It is usually used when the solvent is of low value and can be disposed. Like distillation, the operating costs can be high for certain applications.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	Catalytic Destruction WPRO-109-OY *Ranking:* *L-3-3 ($3M;N)*	**Demonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.

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Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	Volatile Organic Compounds in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
	Semi-Volatile Organics in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project. - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Biological Treatment	**L** Aerobic Digestion WPRO-224-OY *Ranking:* *L-3-2 ($2M;N)*	**Predemonstration** This is a promising technology for destroying hazardous organics. Under the right conditions, this process should be able to achieve greater than 99% destruction of the organics. Additional RD&D is needed to determine the applicability of the process to meet the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
Physical Treatment	**H** Foaming WPRO-201-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This process is used to recover particulates from liquids (e.g., aqueous streams). Removal efficiencies are generally greater than 90%. The process is a variation of filtration in which chemicals are added to the liquid to create a foam. The foam traps the particulates. The foam is then processed elsewhere to recover the particulates.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Sedimentation WPRO-201-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** Sedimentation is also a variation of filtration in which gravity forces are used to remove the particulates from the fluid. Removal efficiencies should generally be greater than 90%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Reverse Osmosis WPRO-206-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** Reverse osmosis is commercial technology for treating aqueous streams. When properly designed and operated the technology is capable of greater than 99% rejection of the salts. However, additional RD&D may be required to develop membranes that meet the site specific requirements.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	L Ultrafiltration WPRO-206-OY *Ranking:* *L-3-3 ($3M;N)*	**Demonstration** Ultrafiltration is also a membrane separation process that is similar to reverse osmosis. However, it will not remove low to intermediate molecular weight solutes from the liquid stream.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.
	Adsorption WPRO-202/203-OY *Ranking:* *L-4-2 ($1M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.

EM Goals	Y-12 Site Problem	Problem Area/Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	Semi-Volatile Organics in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	L Ozonation-Photolysis WPRO-214-OY *Ranking: L-3-3 ($3M;N)*	**Demonstration** This process can be very useful in destroying organics (especially refractory organics) in water. DREs for the process can be greater than 90+%. Even though some organics are easily destroyed by the process, they are rarely completely oxidized and may be converted to other hazardous species. To be successful, a thorough knowledge of the waste to be treated is essential. The process is comparatively expensive for the treatment of organics.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	M Solvent Extraction WPRO-211/212-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M Wet Air Oxidation WPRO-215-OY *Ranking: M-3-2 ($2M;N)*	**Predemonstration** The process is commercially available. It is capable of greater than 99+% destruction of some organics however, it may not be able to completely destroy certain refractory organics such as halogenated aromatics (e.g., PCB). Processing costs are likely to be high.	Demonstrate the effectiveness of the technology to meet the site requirements.	The development effort is estimated to require approximately $ 1 million.
	M Gamma-Radiolysis WPRO-100-OY *Ranking: M-3-5 ($3M;N)*	**Evolving Technology** The radiolytic destruction of halogenated and aromatic compounds at the laboratory scale is well documented. However, its application on an industrial scale needs additional RD&D. The process is capable of high (>90%) destruction efficiencies for organics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Some of the issues to be resolved are the complete characterization of the radiolytic decomposition products under different conditions and for different waste materials and their relative toxicity. Another issue is the possibility of combining the radiolysis with enhanced biodegradation of the radiolytic by products.	The RD&D effort is estimated to require $ 1.25-2.5 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	Semi-Volatile Organics in Water MTC 1900 MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Thermal Treatment	**H** Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted:** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	L Chem Char Process WPRO-114-OY *Ranking: L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	H Steam Stripping WPRO-221-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is an accepted industrial process that can remove volatile organics with >99+% efficiency especially from contaminated aqueous streams. The application of the process to satisfactorily remove hazardous and radioactive species needs to be demonstrated.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	L Catalytic Destruction WPRO-109-OY *Ranking: L-3-3 ($3M;N)*	**Predemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.

EM Goals

- Cleanup Legacy
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Wastewater	Mercury in Water MTC 1900	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	**H** Sedimentation WPRO-201-OY *Ranking:* *H-5-1 ($1M;N)*	**Demonstration** Sedimentation is also a variation of filtration in which gravity forces are used to remove the particulates from the fluid. Removal efficiencies should generally be greater than 90%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Filtration WPRO-201-OY *Ranking:* *M-5-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	L Inorganic Microporous Filters WPRO-207-OY *Ranking:* *L-5-8 ($5M;N)*	**Predemonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments, they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
	H Adsorption WPRO-202/203-OY *Ranking:* *H-5-1 ($1M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations; and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	M Electrolysis WPRO-205-OY *Ranking:* *M-5-2 ($2M;N)*	**Demonstration** The basic technology is well established in industry however, its application to meet the site requirements needs to be developed and demonstrated. Removal efficiencies for the process are in general greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	**M** Ion Exchange WPRO-217/218-OY *Ranking:* *M-5-2 ($2M;N)*	**Demonstration** This is one of the accepted methods used in industry for treating liquids. Treatment efficiencies can be greater than 99% depending upon the application, the ion exchange media, and the solutes to be removed.	The use of the technology to meet the site requirements needs to be demonstrated.	Development costs are estimated to be $ 1.25 million.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Wastewater	Mercury in Water MTC 1900	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
	Alpha-4 Contaminated Oil	RAD in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment (cont.)	M	Chemical Fixation WPRO-208-OY *Ranking:* *M-5-2 ($2M;N)*	**Demonstration.** This process consists of fixing the contaminants by chemical reaction so that they can be removed by filtration or other separation techniques. The process should be capable of 90%+ treatment efficiencies.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
Physical Treatment	H	Centrifugation WPRO-201-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Filtration WPRO-201-OY *Ranking:* *H-3-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M	Foaming WPRO-201-OY *Ranking:* *M-3-1 ($1M;N)*	**Demonstration** This process is used to recover particulates from liquids (e.g., aqueous streams). Removal efficiencies are generally greater than 90%. The process is a variation of filtration in which chemicals are added to the liquid to create a foam. The foam traps the particulates. The foam is then processed elsewhere to recover the particulates.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	L	Inorganic Microporous Filters WPRO-207-OY *Ranking:* *L-3-8 ($5M;N)*	**Predemonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments, they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
	M	High Gradient Magnetic Separations WPRO-204-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** The treatment is commercially available for example, for the removal of trace impurities from kaolin clays. Removal efficiencies for the process are greater than 99%. However, its use to treat mixed waste contaminated fluids needs additional RD&D.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	RAD in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.) M	Adsorption WPRO-202/203-OY *Ranking: M-3-1 ($1M;N*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment M	Chemical Precipitation WPRO-210-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** Precipitation technologies are fairly mature. Iron co-precipitation is presently being used at the K-25 Site Central Neutralization Facility for separating radionuclides from the aqueous wastes. However, significant development is still necessary to meet the increasingly stringent regulatory limits on the wastewater discharges. For example, precipitation using potassium ferrate has not been demonstrated and additional RD&D is required to prove its applicability and performance in treating the wastewater.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
M	Solvent Extraction WPRO-211/212-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	RAD in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

agement

Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Chemical Treatment (cont.)	**M** Leaching & Stripping WPRO-213-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	L Bucky Ball Chemistry WPRO-101-OY *Ranking: L-3-10 ($8M;N)*	**Evolving Technology** This is a novel technology that has many potential applications in fields such as mixed wastes treatment, nuclear medicine, tribology, and material science. Conceptually, the technology is sophisticated (uses lasers) and yet simple. For mixed wastes treatment, the process would essentially encapsulate the radioactive and hazardous metals at the elemental level in high molecular weight carbon cages (called fullerenes) thereby isolating them from the environment.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop the technology is estimated to require $ 10 million. The payback is estimated to be in the range of $ 150 million considering savings in waste treatment and disposal costs and potential spinoffs in other fields such as nuclear medicine and new materials.
Thermal Treatment	**H** Incineration WPRO-108-OY *Ranking: H-3-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	L Chem Char Process WPRO-114-OY *Ranking: L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.

Waste Ma

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	RAD in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing
		Heavy Metals in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
iotreatment	**L** Biosorption WPRO-226-OY *Ranking: L-3-5 ($5M;N)*	**Predemonstration** Data in the scientific literature suggests that given the right conditions, this process should be able to achieve impressive (>95%) treatment efficiencies however, most of the information is based on laboratory-scale data. There is little pilot plant or industrial scale data on the process.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-3 million.
hysical Treatment	**H** Centrifugation WPRO-201-OY *Ranking: H-3-1 ($0.1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Decantation WPRO-201-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is an accepted process for the separating solids from liquids. The removal efficiency for the process can vary from 80 to 90+% depending upon the materials being separated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Filtration WPRO-201-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Foaming WPRO-201-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** This process is used to recover particulates from liquids (e.g., aqueous streams). Removal efficiencies are generally greater than 90%. The process is a variation of filtration in which chemicals are added to the liquid to create a foam. The foam traps the particulates. The foam is then processed elsewhere to recover the particulates.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	L Ultrafiltration WPRO-206-OY *Ranking: L-3-3 ($3M;N)*	**Demonstration** Ultrafiltration is also a membrane separation process that is similar to reverse osmosis. However, it will not remove low to intermediate molecular weight solutes from the liquid stream.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	M Electrolysis WPRO-205-OY *Ranking: M-3-2 ($2M;N)*			

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	Heavy Metals in Oil MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.)	**M** High Gradient Magnetic Separation WPRO-204-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** The basic technology is well established in industry however, its application to meet the site requirements needs to be developed and demonstrated. Removal efficiencies for the process are in general greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	L Inorganic Microporous Filters WPRO-207-OY *Ranking: L-3-8 ($5M;N)*	**Demonstration** The treatment is commercially available for example, for the removal of trace impurities from kaolin clays. Removal efficiencies for the process are greater than 99%. However, its use to treat mixed waste contaminated fluids needs additional RD&D.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.
	M Adsorption WPRO-202/203-OY *Ranking: M-3-1 ($1M;N)*	**Predemonstration** This is novel technology being developed for filtration applications. Some of the advantages of these filters are that they can be used in severe environments, they can be readily cleaned if they get fouled, and they can be re-used indefinitely. Their separation efficiency can be 99%+.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
		Demonstration Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	**H** Chemical Precipitation WPRO-210-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** Precipitation technologies are fairly mature. Iron co-precipitation is presently being used at the K-25 Site Central Neutralization Facility for separating radionuclides from the aqueous wastes. However, significant development is still necessary to meet the increasingly stringent regulatory limits on the wastewater discharges. For example, precipitation using potassium ferrate has not been demonstrated and additional RD&D is required to prove its applicability and performance in treating the wastewater.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	Heavy Metals in Oil MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science Technology Needs	Implementation Needs
Chemical Treatment	**L** Solvent Extraction WPRO-211/212-OY *Ranking:* *L-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M Washing & Leaching WPRO-213-OY *Ranking:* M-3-1 ($1M;N)	**Demonstration** This is an accepted technology in industry with removal efficiencies greater than 99% however, each application requires additional RD&D to determine optimum leachant composition and process conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	L Bucky Ball Chemistry WPRO-101-OY *Ranking:* *L-3-10 ($8M;N)*	**Evolving Technology** This is a novel technology that has many potential applications in fields such as mixed wastes treatment, nuclear medicine, tribology, and material science. Conceptually, the technology is sophisticated (uses lasers) and yet simple. For mixed wastes treatment, the process would essentially encapsulate the radioactive and hazardous metals at the elemental level in high molecular weight carbon cages (called fullerenes) thereby isolating them from the environment.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop the technology is estimated to require $ 10 million. The payback is estimated to be in the range of $ 150 million considering savings in waste treatment and disposal costs and potential spinoffs in other fields such as nuclear medicine and new materials.
Thermal Treatment	**H** Incineration WPRO-108-OY *Ranking:* H-3-1 ($1M;$6/lb)	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the Incinerator are estimated to be $ 6 per pound of waste incinerated.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	Heavy Metals in Oil MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
		PCB in Oil MTC 2210	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No: OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (cont.)	L	Chem Char Process WPRO-114-OY *Ranking:* *L-3-7 ($5M;N)*	**Predemonstration** This is a developmental technology based on coal char gasification. The process is claimed to achieve near total destruction of the organics and produces an inert char residue that contains the non-volatile toxic metals and radionuclides. This char residue can either be vitrified to yield a glassy slag or immobilized in cement.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-3-2 ($2M;N)*	**Predemonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficiency. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
BioTreatment	L	Biosorption WPRO-226-OY *Ranking:* *L-3-5 ($5M;N)*	**Predemonstration** Data in the scientific literature suggests that given the right conditions, this process should be able to achieve impressive (>95%) treatment efficiencies however; most of the information is based on laboratory-scale data. There is little pilot plant or industrial scale data on the process.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-3 million.
Physical Treatment	M	Adsorption WPRO-202/203-OY *Ranking:* *M-3-1 ($1M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	M	Solvent Extraction WPRO-211/212-OY *Ranking:* *M-3-2 ($2M;N)*	**Demonstration** The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M	Washing & Leaching WPRO-213-OY *Ranking:* M-3-1 ($1M;N	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
		Gamma Radiolysis WPRO-100-OY L-4-5 (<$2M,High)			

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	PCB in Oil MTC 2210	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
hemical Treatment cont.)	**M** Chemical Precipitation WPRO-210-OY *Ranking: M-3-1 ($1M;N)*	**Evolving Technology** See page 6.3-15 **Demonstration** The development effort is estimated to require approximately $ 1 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
	L Supercritical Water Oxidation WPRO-216-OY *Ranking: L-3-3 ($3M;N)*	**Demonstration**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. The RD&D effort is estimated to require $ 2.5 million.	The RD&D effort is estimated to require $ 1.6 million for a 3 year development plan.
	M Chemical Dechlorination WPRO-209-OY *Ranking: M-3-2 ($2M;N)*	**Predemonstration** Knowledge of process application(s) and funding.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25-2.5 million.
hermal Treatment	**E** Incineration WPRO-108-OY *Ranking: E-3-1 ($1M;$6/lb)*	**Accepted** The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated, Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	L Chem Char Process WPRO-114-OY *Ranking: L-3-7 ($5M;N)*	**Predemonstration** The RD&D effort is estimated to require $ 5 million for a 3-year R&D program.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M Distillation WPRO-222-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** Demonstration costs are estimated to be $ 0.5-1 million.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
iological Treatment	**L** Microbial Dechlorination WPRO-227-OY *Ranking: L-3-5 ($5M;N)*	**Evolving Technology** This process is at an early stage of development. Based on the available information, it appears the process should be able to achieve destruction efficiencies greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.
	M Aerobic Digestion WPRO-224-OY *Ranking: M-3-3 ($3M;N)*	**Demonstration** This is a promising technology for destroying hazardous organics. Under the right conditions, this process should be able to achieve greater than 99% destruction of the organics. Additional RD&D is needed to determine the applicability of the process to meet the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	Non-Halogenated Organics in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	**M** Centrifugation WPRO-201-OY *Ranking:* *M-2-1 ($1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	Decantation WPRO-201-OY *Ranking:* *4-3-1 (<$0.1M;N)*	**Demonstration** This is an accepted process for the separating solids from liquids. The removal efficiency for the process can vary from 80 to 90+% depending upon the materials being separated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Gravity Separation WPRO-201-OY *Ranking:* *M-2-1 ($1M;N)*	**Demonstration** Sedimentation is also a variation of filtration in which gravity forces are used to remove the particulates from the fluid. Removal efficiencies should generally be greater than 90%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Adsorption WPRO-202/203-OY *Ranking:* *M-2-1 ($1M;N)*	**Predemonstration** The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	**M** Solvent Extraction WPRO-211/212-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M Gamma Radiolysis WPRO-100-OY *Ranking:* *M-2-5 ($3M;N)*	**Evolving Technology** The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. Demonstrate the effectiveness of the technology to meet the site requirements. See page 6.3-15.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	M Supercritical Water Oxidation WPRO-216-OY *Ranking:* *M-2-3 ($3M;N)*	**Demonstration**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. The RD&D effort is estimated to require $ 2.5 million.	The RD&D effort is estimated to require $ 1.6 million for a 3 year development plan.
Thermal Treatment	**H** Distillation WPRO-222-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted industrial process for treating liquids. Depending upon the contaminant being removed, the separation efficiency can be greater than 99%. However, the use of the process to meet site requirements will need to be demonstrated. Capital and operating costs could be high.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Oil	Non-Halogenated Organics in Oil MTC 2220	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
		Mercury in Oil MTC 2000	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking:* *H-2-1 (1M;$6/lb)*	**Accepted** The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $6 per pound of waste incinerated.
	L	Chem Char Process WPRO-114-OY *Ranking:* *L-2-7 ($5M;N)*	**Predemonstration** The RD&D effort is estimated to require $ 5 million for a 3-year R&D program.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	M	Low Temperature Separation WPRO-220-OY *Ranking:* *M-2-2 ($2M;N)*	**Predemonstration** This is an accepted industrial process for the separation of low-boiling components from high-boiling components. The process can achieve separation efficiencies greater than 99%.	Further RD&D on the process is needed to develop the optimum processing conditions.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
Biotreatment	M	Anaerobic Digestion WPRO-224-OY *Ranking:* *M-2-3 ($3M;N)*	**Predemonstration** This is a promising technology for destroying hazardous organics. Under the right conditions, this process should be able to achieve greater than 99% destruction of the organics. Additional RD&D is needed to determine the applicability of the process to meet the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
Physical Treatment	H	Decantation WPRO-201-OY *Ranking:* *H-5-1 ($1M;N)*	**Demonstration** This is an accepted process for the separating solids from liquids. The removal efficiency for the process can vary from 80 to 90+% depending upon the materials being separated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M	Filtration WPRO-201-OY *Ranking:* *M-5-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M	Gravity Separation WPRO-201-OY *Ranking:* *M-5-1 ($1M;N)*	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.

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EM Goals

- Cleanup Legacy
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Contaminated Oil	Mercury in Oil MTC 2000	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
	RAD in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	M Centrifugation WPRO-201-OY *Ranking: M-5-1 ($1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
Chemical Treatment	M Chemical Fixation WPRO-208-OY *Ranking: M-5-2 ($2M;N*	**Predemonstration** Development costs are estimated to be $ 1.25 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
Thermal Treatment	H Thermal Desorption WPRO-106-OY *Ranking: H-5-2 ($2M;$1/lb)*	**Demonstration** Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, need to develop better understanding of the immobilization chemistry and mechanisms.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application, funding, and regulatory approval.
	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-5-2 ($2M;N)*	Predemonstration Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
Physical Treatment	H Filtration WPRO-201-OY *Ranking: H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Centrifugation WPRO-201-OY *Ranking: H-2-1 ($1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H Foaming WPRO-201-OY *Ranking: H-2-1 ($1M;N)*	**Demonstration** Develop and demonstrate the effectiveness of the WMES to minimize site wastes and waste disposal costs.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M Ultrafiltration WPRO-206-OY *Ranking: M-2-3 ($3M;N)*	**Demonstration** The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $.0.75 million.
	M Electrolysis WPRO-205-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** An industrial-scale national transmutation facility would need to be developed and built. The cost for such a "national" facility is estimated to be in the billion dollars range and would require several years to build.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Solvents (Halogenated and Non-Halogenated)	RAD in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

agement

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	**M** High Gradient Magnetic Separations WPRO-204-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The implementation needs will be determined by the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.
	L Inorganic Microporous Filters WPRO-207-OY *Ranking: L-2-8 ($5M;N)*	**Predemonstration** The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
	M Adsorption WPRO-202/203-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	**M** Chemical Precipitation WPRO-210-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The development effort is estimated to require approximately $ 1 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
	Chemical Fixation WPRO-208-OY *Ranking: L-2-2 (<$1M;N)*	**Demonstration** Development costs are estimated to be $ 1.25 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	M Solvent Extraction WPRO-211/212-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M Leaching & Stripping WPRO-213-OY *Ranking: M-2-1 ($1M;N)*	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	L Bucky Ball Chemistry WPRO-101-OY *Ranking: L-2-10 ($8M;N)*	**Evolving Technology** The RD&D effort is estimated to require $ 2-5 million. The payback is expected to be significant especially because the scrap aluminum from the site can be used to dispose of the nitrate wastes in the Hanford site tanks. This is expected to result in significant savings due to minimizing the wastes to be disposed at the two sites.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop the technology is estimated to require $ 10 million. The payback is estimated to be in the range of $ 150 million considering savings in waste treatment and disposal costs and potential spinoffs in other fields such as nuclear medicine and new materials.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Solvents (Halogenated and Non-Halogenated)	RAD in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws; signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

nagement

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking:* *H-2-1 ($1M;$6/lb)*	**Accepted** The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 28 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	H	Distillation WPRO-222-OY *Ranking:* *H-2-1 (<$1M;N)*	**Demonstration** Demonstration costs are estimated to be $ 0.5-1 million.	None	Knowledge of process application(s) and funding.
	L	Chem Char Process WPRO-114-OY *Ranking:* *L-2-7 ($5M;N)*	**Prodemonstration** The RD&D effort is estimated to require $ 5 million for a 3-year R&D program.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
Physical Treatment	H	Centrifugation WPR-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This process is a variation of filtration operations in which centrifugal action is used to separate the heavier components from the lighter fluid. Removal efficiencies are generally greater than 95+%.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Filtration WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
		Foaming WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** Develop and demonstrate the effectiveness of the WMES to minimize site wastes and waste disposal costs.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	M	Ultrafiltration WPRO-206-OY *Ranking:* *M-2-3 ($3M;N)*	**Demonstration** The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop applicable membranes is estimated to require $ 0.75 million.

Waste M

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Solvents (Halogenated and Non-Halogenated)	Heavy Metals in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	M Electrolysis WPRO-205-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The basic technology is well established in industry however, its application to meet the site requirements needs to be developed and demonstrated. Removal efficiencies for the process are in general greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	M High Gradient Magnetic Separation WPRO-204-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** The implementation needs will be determined by the site requirements.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.
	L Inorganic Microporous Filters WPRO-207-OY *Ranking: L-2-8 ($5M;N)*	**Predemonstration** The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.	Further research, development, and demonstration (RD&D) on the technology to deployment.	The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.
	M Adsorption WPRO-202/203-OY *Ranking: M-2-1 ($1M;N)*	**Demonstration** The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
Chemical Treatment	M Ion Exchange WPRO-217/218-OY *Ranking: M-2-1 ($1M;N)*	**Demonstration** The RD&D effort is estimated to require $ 1-3 million.	The use of the technology to meet the site requirements needs to be demonstrated.	Development costs are estimated to be $ 1.25 million.
	Chemical Precipitation WPRO-210-OY *Ranking: M-2-2 ($2M;N)*	**Accepted** The development effort is estimated to require approximately $ 1 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
	Chemical Fixation WPRO-208-OY *Ranking: L-2-2 (<$1M;N)*	**Demonstration** Development costs are estimated to be $ 1.25 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	M Acid Stripping WPRO-213-OY *Ranking: M-2-1 ($1M;N)*	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	L Bucky Ball Chemistry WPRO-101-OY *Ranking: L-2-10 ($8M;N)*	**Evolving Technology** The RD&D effort is estimated to require $ 2-5 million. The payback is expected to be significant especially because the scrap aluminum from the site can be used to dispose of the nitrate wastes in the Hanford site	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort to develop the technology is estimated to require $ 10 million. The payback is estimated to be in the range of $ 150 million considering savings in waste treatment and disposal costs and potential spinoffs in other fields such as nuclear medicine and new materials.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Solvents (Halogenated and Non-Halogenated)	Heavy Metals in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing
		PCB in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

agement

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking:* *H-2-1 ($1M;$6/lb)*	**Demonstration** The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 28 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	L	Chem Char Process WPRO-114-OY *Ranking:* *L-2-7 ($5M;N*	**Predemonstration** The RD&D effort is estimated to require $ 5 million for a 3-year R&D program.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
BioTreatment	L	Biosorption WPRO-226-OY *Ranking:* *L-2-5 ($5M;N)*	**Predemonstration** The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-3 million.
Physical Treatment	H	Decantation WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for the separating solids from liquids. The removal efficiency for the process can vary from 80 to 90+% depending upon the materials being separated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Foaming WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** Develop and demonstrate the effectiveness of the WMES to minimize site wastes and waste disposal costs.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Filtration WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Adsorption WPRO-202/203-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** The RD&D effort is estimated to require $ 1-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.

Waste M

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Contaminated Solvents (Halogenated and Non-Halogenated)	PCB in Solvents MTC 2200	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	Solvent Extraction WPRO-211/212-OY M *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	Gamma-Radiolysis WPRO-100-OY M *Ranking:* *M-2-5 ($3M;N)*	**Evolving Technology** The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment. See page 6.3-15.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	Chemical Dechlorination WPRO-209-OY M *Ranking:* *M-2-2 ($2M;N)*	**Predemonstration** Knowledge of process application(s) and funding.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25-2.5 million.
	Stripping WPRO-213-OY M *Ranking:* *M-2-1 ($1M;N)*	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
Thermal Treatment	Incineration WPRO-108-OY E *Ranking:* *E-2-1 ($1M;$6/lb)*	**Accepted** The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	Molten Salt Oxidation WPRO-113-OY M *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** Further RD&D on the process is needed to develop the optimum processing conditions.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	Distillation WPRO-222-OY M *Ranking:* *M-2-1 ($1M;N)*	**Demonstration** Demonstration costs are estimated to be $ 0.5-1 million.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	Chem Char Process WPRO-114-OY L *Ranking:* *L-2-7 ($5M;N)*	**Predemonstration** The RD&D effort is estimated to require $ 5 million for a 3-year R&D program.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
Biotreatment	Microbial Dechlorination WPRO-227-OY L *Ranking:* *L-2-5 ($5M;N)*	**Evolving Technology** This process is at an early stage of development. Based on the available information, it appears the process should be able to achieve destruction efficiencies greater than 90%.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.

EM Goals
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship

EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water—Remedial Action (RA)
Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Contaminated Mercury	RAD in Mercury MTC 5400	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR); radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified. If determined to be a RCRA-hazardous waste, then the following milestones may apply. Begin the design phase for the three RCRA storage facilities for the 9201-4 D&D project - Target Date 10/1/97. (Milestone No. OR270127). Complete the construction of the three RCRA storage facilities for the 9201-4 D&D project - Target Date 6/30/2005. (Milestone No. OR270128).	Waste Processing

nagement

Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment	H	Gravity Separation WPRO-201-OY *Ranking:* *H-4-1 ($1M;N)*	**Demonstration** Development and demonstration of the WMES is estimated to require $ 3-5 million. The savings from implementing the system could be around $ 1 billion or more.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
Chemical Treatment	H	Leaching WPRO-213-OY *Ranking:* H-4-2 ($1M;N	**Demonstration** The use of the technology to meet the site requirements needs to be demonstrated.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	Demonstrate the effectiveness of the technology to meet the site requirements.
	M	Chemical Precipitation WPRO-210-OY *Ranking:* M-4-2 ($1M;N)	**Demonstration** The development effort is estimated to require approximately $ 1 million.	Demonstrate the effectiveness of the technology to meet the site requirements.	The demonstration effort is estimated to require $ 0.4 million.
Thermal Treatment	M	Distillation WPRO-222-OY *Ranking:* M-4-1 ($1M;N)	**Demonstration** Demonstration costs are estimated to be $ 0.5-1 million.	The use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.

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EM Goals

- Cleanup Legacy
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations	VOCs in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

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Alternatives	Technologies	Status	Science-Technology Needs	Implementation Needs
Physical Treatment	M Low Temperature Separation WPRO-220-OY *Ranking:* *M-1-2 ($2M;N)*	**Predemonstration** **This is an accepted industrial process for the separation of low-boiling components from high-boiling components. The process can achieve separation efficiencies greater than 99%.**	Further RD&D on the process is needed to develop the optimum processing conditions.	**The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.**
	L Inorganic Membrane Separation WPRO-300-OY *Ranking:* *L-1-8 ($5M;N)*	**Predemonstration** **The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	**The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.**
	M Adsorption WPRO-202/203-OY *Ranking:* *M-1-1 ($1M;N)*	**Predemonstration** **Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	**The RD&D effort is estimated to require $ 1.25 million.**
	H Scrubbers WPRO-301-OY *Ranking:* *H-1-1 ($1M;N)*	**Demonstration** **Scrubbers are comercially available though need to be demonstrated for particular applications at K-25.**	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	**Knowledge of process application(s) and funding.**
Chemical Treatment	M Solvent Scrubbing WPRO-211/212-OY *Ranking:* *M-1-2 ($2M;N)*	**Demonstration** **Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics.**	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	**The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.**

Waste M...

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations	VOCs in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
		Non-Volatile Organics in Gases	Refer to the Regulatory Compliance of Vol. 1.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment	H — Incineration WPRO-108-OY *Ranking: H-1-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, RD&D is required to develop better understanding of the process technology to improve its acceptability.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.
	M — Catalytic Destruction WPRO-109-OY *Ranking: M-1-2 ($2M;N)*	**Predemonstration** This technology has been demonstrated to be effective (DRE>99+%) for the destruction of liquid and gaseous organic wastes. However, its use to remove and destroy the organics from solids needs additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M — Molten Salt Oxidation WPRO-113-OY *Ranking: M-1-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficienc. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	L — Electron Beam Destruction WPRO-304-OY *Ranking: L-1-3 ($3M;N)*	**Predemonstration** Development work with the compounds of interest at the bench scale needs to be done to justify scale-up testing.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M — Steam Stripping WPRO-221-OY *Ranking: M-1-1 ($1M;N)*	**Demonstration** This is an accepted industrial process that can remove volatile organics with >99+% efficiency especially from contaminated aqueous streams. The application of the process to satisfactorily remove hazardous and radioactive species needs to be demonstrated.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
	L — Flameless Thermal Oxidizers WPRO-305-OY *Ranking: L-1-3 ($3M;N)*	**Demonstration** Development work with the compounds of interest at the bench scale needs to be done to justify scale-up testing.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-1.5 million.
Physical Treatment	M — Low Temperature Separation WPRO-220-OY *Ranking: M-1-2 ($2M;N)*	**Predemonstration** This is an accepted industrial process for the separation of low-boiling components from high-boiling components. The process can achieve separation efficiencies greater than 99%.	Further RD&D on the process is needed to develop the optimum processing conditions.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.

EM Goals

- Cleanup Legacy
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

Facilities—Decontamination and Decommissioning (D&D)

Soils, Groundwater and Surface Water—Remedial Action (RA)

Waste Management (WM)

Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Non-Volatile Organics in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.)	L	Inorganic Membrane Separation WPRO-300-OY *Ranking:* *L-1-8 ($5M;N)*	**Predemonstration** The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.
	M	Filtration WPRO-201-OY *Ranking:* *M-1-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Scrubbers WPRO-301-OY *Ranking:* *H-1-1 ($1M;N)*	**Demonstration** Scrubbers are comercially available though need to be demonstrated for particular applications at K-25.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
Chemical Treatment	M	Solvent Scrubbing WPRO-211/212-OY *Ranking:* *M-1-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
Thermal Treatment	H	Incineration WPRO-108-OY *Ranking:* *H-1-1 ($1M;$6/lb)*	**Accepted** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application, funding, and regulatory approval. For example, the K-25 Site TSCA Incinerator is a 30 MMBtu/h unit that is permitted to destroy low-level radioactively contaminated mixed wastes. The unit was built at a capital cost of $ 26 million (1987 dollars). Obtaining regulatory approval for the TSCA Incinerator took over 8 years. The 1993 destruction costs at the incinerator are estimated to be $ 6 per pound of waste incinerated.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Non-Volatile Organics in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
		Particulates in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Thermal Treatment (cont.)	M	Catalytic Destruction WPRO-109-OY *Ranking:* *M-1-2 ($2M;N)*	**Predemonstration** The EPA considers incineration to be the best demonstrated available technology (BDAT) for the destruction of organics. Incineration can achieve DREs greater than 99.999% for certain organics. However, additional RD&D on several aspects of incineration is still required.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Molten Salt Oxidation WPRO-113-OY *Ranking:* *M-1-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficienc. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
	L	Electron Beam Destruction WPRO-304-OY *Ranking:* *L-1-3 ($3M;N)*	**Predemonstration** Development work with the compounds of interest at the bench scale needs to be done to justify scale-up testing.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 0.75-1.5 million.
	M	Steam Stripping WPRO-221-OY *Ranking:* *M-1-1 ($1M;N)*	**Demonstration** This is an accepted industrial process that can remove volatile organics with >99+% efficiency especially from contaminated aqueous streams. The application of the process to satisfactorily remove hazardous and radioactive species needs to be demonstrated.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 1-2 million to meet site specific needs.
		Flameless Thermal Oxidizers WPRO-305-OY *Ranking:* *L-1-3 ($3M;N)*	**Demonstration** Development work with the compounds of interest at the bench scale needs to be done to justify scale-up testing.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-1.5 million.
Physical Treatment	M	Inorganic Membrane Separation WPRO-300-OY *Ranking:* *M-2-5 ($5M;N)*	**Predemonstration** The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Particulates in Gases (cont.)	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives		Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.)	M	Adsorption WPRO-202/203-OY *Ranking:* *M-2-1 ($1M;N)*	**Demonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	H	Filtration WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	H	Scrubbers WPRO-301-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** Scrubbers are comercially available though need to be demonstrated for particular applications at K-25.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
	M	Cyclone Separation WPRO-302-OY *Ranking:* *M-2-1 ($1M;N)*	**Evolving Technology** Application of commercially available cyclones to specific K-25 problems must be investigated before full-scale use	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	L	High Gradient Magnetic Separation WPRO- 204-OY *Ranking:* *L-2-2 ($2M;N)*	**Demonstration** The treatment is commercially available for example, for the removal of trace impurities from kaolin clays. Removal efficiencies for the process are greater than 99%. However, its use to treat mixed waste contaminated fluids needs additional RD&D.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Particulates in Gases (cont.)	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
		Inorganics in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Chemical Treatment	Solvent Scrubbing WPRO-211/212-OY *Ranking:*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics. This technology when used with other waste treatment processes would enhance the overall waste treatment strategy. However, the use of the technology for the treatment of solid wastes requires additional RD&D.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
Thermal Treatment	M Molten Salt Oxidation WPRO-113-OY *Ranking: M-2-2 ($2M;N)*	**Demonstration** This is not a new process however, its application for treating hazardous and radioactive contaminants has not been demonstrated. One advantage of the process is that the process and equipment is transportable (as opposed to a fixed treatment facility) and can be located near the waste site. The process should be capable of destroying organics with a >99% efficienc. Additional RD&D is required to fully develop the process to treat mixed wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.4 million for a 3 year development effort.
Physical Treatment	M Inorganic Membrane Separation WPRO-300-OY *Ranking: M-3-5 ($5M;N)*	**Predemonstration** The RD&D effort to develop inorganic microporous filters is estimated to require $ 0.75-1 million. The payback is estimated to be $20-25 million based on significantly reduced waste disposal costs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.5-2 million to further develop the process to meet the site needs.
	M			

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Inorganics in Gases (cont.)	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing
		Radioactive Elements in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Physical Treatment (cont.) M	Adsoprtion WPRO-202/203-OY *Ranking: M-3-1 ($1M;N)*	**Predemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
H				
M	Filtration WPRO-201-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
L	Scrubbers WPRO-301-OY *Ranking: H-3-1 ($1M;N)*	**Demonstration** Scrubbers are comercially available though need to be demonstrated for particular applications at K-25.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
Chemical Treatment M	Cyclone Separation WPRO-302-OY *Ranking: M-3-1 ($1M;N)*	**Demonstration** Application of commercially available cyclones to specific K-25 problems must be investigated before full-scale use.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
	High Gradient Magnetic Separation WPRO-204-OY *Ranking: L-3-2 ($2M;N)*	**Demonstration** The treatment is commercially available for example, for the removal of trace impurities from kaolin clays. Removal efficiencies for the process are greater than 99%. However, its use to treat mixed waste contaminated fluids needs additional RD&D.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to be $ 0.5-1 million.
Physical Treatment H	Solvent Scrubbing WPRO-211/212-OY *Ranking: M-3-2 ($2M;N)*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Waste Off-Gases from D&D, RA, and WM Operations (cont.)	Radioactive Elements in Gases	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Processing

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

nagement

Alternatives		Technologies	Status	Science Technology Needs	Implementation Needs
Physical Treatment	H	Scrubbers WPRO-301-OY *Ranking:* H-2-1 ($1M;N)	**Demonstration** Scrubbers are comercially available though need to be demonstrated for particular applications at K-25.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated.	Knowledge of process application(s) and funding.
		Adsorption WPRO-202/203-OY *Ranking:* *H-2-1 ($1M;N)*	**Prodemonstration** Laboratory studies indicate removal efficiencies greater than 90% for the removal of radioactive species using various adsorbing media. Further development is necessary to develop more effective adsorption media for the treatment of mixed waste contaminated liquids. Development would include for example, scale-up studies, development of high surface area and appropriate particle size media for continuous operations, and the development of appropriate media for the removal of various contaminants.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1.25 million.
	H	Filtration WPRO-201-OY *Ranking:* *H-2-1 ($1M;N)*	**Demonstration** This is an accepted process for separating solids from fluids. The process can achieve removal efficiencies greater than 99%. The use of the process to meet the site requirements will however, need to be demonstrated.	The use of the technology to meet the site requirements needs to be demonstrated.	Demonstration costs are estimated to require up to $ 1 million.
Chemical Treatment		Solvent Scrubbing WPRO-211/212-OY *Ranking:*	**Demonstration** Continuous solvent extraction in counter-current contactors (e.g., centrifugal contactors) is demonstrated technology for the separation of heavy metals or organics from aqueous or organic solutions. Centrifugal contactor based processes for the separation and recovery of radionuclides has been technology at DOE nuclear processing sites for over 25 years. The technology can be applied to treat and recover a wide range of contaminant concentrations. The advantages of the centrifugal contactor based extraction process are its relatively small size, small hold-up volume, and rapid start-up characteristics.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 1-2.5 million. The payback could be significant.
	M	Ion Exchange WPRO-217/218-OY *Ranking:* *M-2-2 ($2M;N)*	**Demonstration** Accepted method used in industry for treating liquids. Treatment efficiencies can be greater than 99% depending upon the application, the ion exchange media, and the solutes to be removed.	The use of the technology to meet the site requirements needs to be demonstrated.	Development costs are estimated to be $ 1.25 million.

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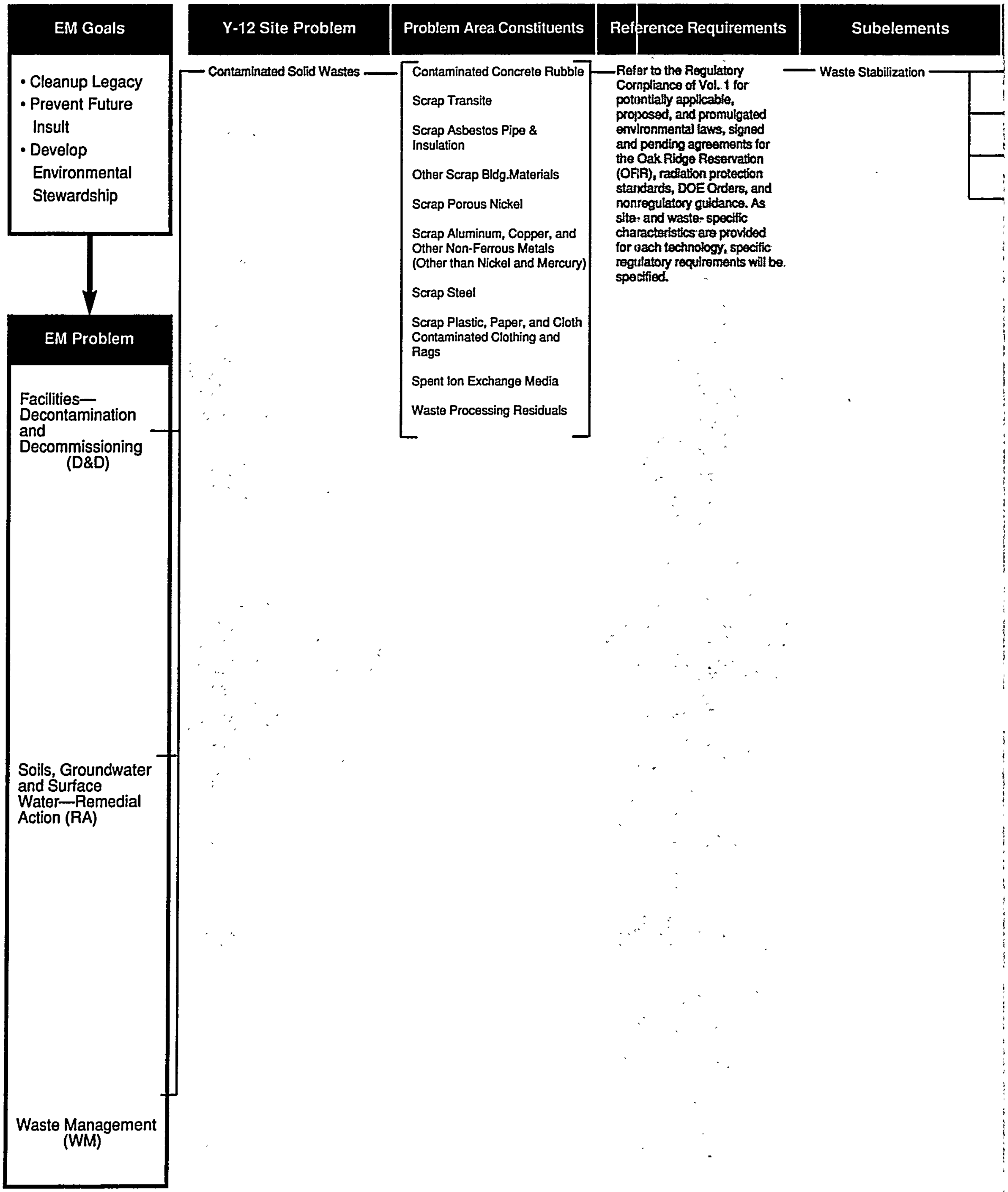
EM Goals
• Cleanup Legacy
• Prevent Future Insult
• Develop Environmental Stewardship
EM Problem
Facilities—Decontamination and Decommissioning (D&D)
Soils, Groundwater and Surface Water—Remedial Action (RA)
Waste Management (WM)
Y-12 Site Problem
Contaminated Solid Wastes
Problem Area Constituents
Contaminated Concrete Rubble
Scrap Transite
Scrap Asbestos Pipe & Insulation
Other Scrap Bldg.Materials
Scrap Porous Nickel
Scrap Aluminum, Copper, and Other Non-Ferrous Metals (Other than Nickel and Mercury)
Scrap Steel
Scrap Plastic, Paper, and Cloth Contaminated Clothing and Rags
Spent Ion Exchange Media
Waste Processing Residuals
Reference Requirements
Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.
Subelements
Waste Stabilization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Solidification Macroencapsulation Microencapsulation Chemical Fixation	Cementitious Materials WSTA-100-OY H-2-1 ($0.5M;$300/ft^3)	**Accepted** This is an accepted method for stabilizing hazardous and low-level radioactive wastes for disposal. However, the technology (as currently practiced) is more art than science. This method generally results in a 0.5 to 2-fold increase in the volume of the final wasteform for disposal.	Though an accepted technology, the use of the technology to meet the site requirements needs to be demonstrated. Also, need to develop better understanding of the immobilization chemistry and mechanisms.	Knowledge of process application, funding, and regulatory approval. In general cementitious stabilization/solidification costs range between $ 50 to $ 500 per cubic foot of waste. These costs are very dependent upon the wastes being solidified, the cementitious materials being employed, and the performance criteria for the wasteform.
	Polymer Impregnated Concrete WSTA-101-OY H-2-1 ($0.5M;$300/ft^3)	**Evolving Technology** The goal is to develop an alternate wasteform that is less leachable (and thus more acceptable) than cementitious wasteforms. The polymer addition serves to waterproof the final wasteform thus reducing the migration of the immobilized contaminants into the environment. This method is also expected to result in a one to two-fold increase in the final wasteform volume for disposal.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.
	Plastics–Thermoplastics WSTA-102/103-OY H-2-1 ($0.5M;$300/ft^3)	**Predemonstration** The bitumen stabilization process is determined to be at the demonstration level while the polyethylene process is determined to be at the Predemonstration level of development. Depending upon the wastes being stabilized, thermoplastic stabilization processes result in a net decrease in the final wasteform volume. The technology is not mature and additional research, development, and demonstration (RD&D) is needed to further develop the technology and its acceptability as a stabilization method by the regulators.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.
	Plastics–Thermosetting WSTA-104-OY H-2-1 ($0.5M;$300/ft^3)	**Predemonstration** This process is especially suitable for stabilizing spent ion exchange resin beds for disposal. The process does not require high temperatures or dried wastes and normally results in no net increase in the volume of the final wasteform. However, if the method is used to stabilize a net increase in the volume of the final wasteform could result. Additional RD&D on the process could help increase its applicability to stabilizing other wastes.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 2-5 million. The payback could be significant.

EM Goals

- Cleanup Legacy
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

Y-12 Site Problem

Contaminated Solid Wastes

Problem Area Constituents

- Contaminated Concrete Rubble
- Scrap Transite
- Scrap Asbestos Pipe & Insulation
- Other Scrap Bldg.Materials
- Scrap Porous Nickel
- Scrap Aluminum, Copper, and Other Non-Ferrous Metals (Other than Nickel and Mercury)
- Scrap Steel
- Scrap Plastic, Paper, and Cloth Contaminated Clothing and Rags
- Spent Ion Exchange Media
- Waste Processing Residuals

Reference Requirements

Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.

Subelements

Waste Stabilization

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Solidification (cont.) Macroencapsulation (cont.) Microencapsulation (cont.) Chemical Fixation (cont.)	High-Temperature Crystalline Materials WSTA-105-OY	**Evolving Technology** This is a developmental technology which uses high temperatures to immobilize the wastes in a ceramic wasteform. These wasteforms are generally inert and exhibit very low leachability characteristics. Depending upon the waste characteristics ceramic wasteforms can result in a significant decrease in the volume of the final wasteform which can translate into significant savings in waste disposal costs.	Further research, development, and demonstration (RD&D) on the process to develop the technology to deployment.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.
	High-Temperature Noncrystalline Materials WSTA-106-OY	**Predemonstration** This is an accepted process for the disposal of high-level nuclear wastes however, its suitability for the disposal of hazardous and low-level radioactive wastes needs to be established. Because of the high processing temperatures, this process results in the decrease of the final wasteform volume. Under normal environmental conditions the final wasteform is inert and nonleachable.	Demonstrate the effectiveness of the technology to meet the site requirements.	The RD&D effort is estimated to require $ 5-10 million. The payback could be significant.

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EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Minimize the generation of hazardous and mixed wastes.	• Solvents • RAD • PCB • Organices • Inorganics • Metals • Wood • Plastics • Cloth • Paper • Asbestos • Mercury	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Minimization

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
• Minimize the creation of wastes. • Characterize and segregate the wastes as early in the operation as possible to minimize hazardous waste generation • Maximize the use of non-hazardous substitutes. • Transfer potential waste materials (e.g. specialty freons) to other DOE plants having a need for the material • Seek opportunities to use contaminated spent materials in other DOE applications (e.g. contaminated metal for use in supercollider) • Maximize the recycle of treated spent materials • Sell maximum materials as scrap as legally permitted. • Establish acceptable Below Regulatory Concern (BRC) and "de-minimus" values. • Think Waste Minimization!		**Demonstration**	The science and technology needs are expected to be minimal because incorporating the waste minimization ethic will not require new technology but a change in operating philosophy, attitudes and behavior.	General implementation needs include inculcating the waste minimization philosophy among site personnel through education and establishing acceptable BRC and de-minimus values for radioactive contamination levels in potential wastes so that significant quantities of potential waste materials can either be recycled, sold as scrap, or disposed at lower costs.
Waste Minimization Evaluation System (WMES)	Computer Software WMIN-100-OY	**Demonstration** A prototype software program was used to analyze waste minimization at a solvent degreasing operation at the Y-12 Plant. This application showed areas where the degreasing operations could be improved from a waste minimization perspective.	Develop and demonstrate the effectiveness of the WMES to minimize site wastes and waste disposal costs. The science/technology needs include for example, software development (e.g., programing and process simulation) and expertise capture.	Development and demonstration of the WMES is estimated to require $ 3-5 million. The savings from implementing the system could be substantial.

EM Goals	Y-12 Site Problem	Problem Area Constituents	Reference Requirements	Subelements
• Cleanup Legacy • Prevent Future Insult • Develop Environmental Stewardship	Alpha-4 Pond Waste Sludge	Waste from 9204-1 D&D operations	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste- specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Disposal

EM Problem

- Facilities—Decontamination and Decommissioning (D&D)
- Soils, Groundwater and Surface Water—Remedial Action (RA)
- Waste Management (WM)

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
Low Level Waste On Site (Oak Ridge Reservation)	Class L-1 Landfill (WDIS-106)	**Predemonstration:** Not currently available. Facility being designed and developed for 1999 opening.	Demonstration of acceptability of trench disposal. Waste form must be demonstrated to meet waste acceptance criteria	**Development cost:** **Capital cost:**$81 million **Operating cost:** $8 million annually.
	Borehole (WDIS-100)	**Predemonstration:** Not currently available or being designed.	Acceptability of concept needs to be tested. Waste form must be identified and demonstrated to meet waste acceptance criteria.	**Development cost:** Estimated $3 million to demo concept. **Capital cost:** **Operating cost:**
	Interim Waste Management Facility (IWMF) Tumulus (WDIS-109)	**Accepted:** In use at SOLID WASTE STORAGE AREA(SWSA) 6 at X-10. Limited volume for storage.	Waste form must be demonstrated to meet waste acceptance criteria.	Not applicable
Low Level Waste Off Site (DOE)	Hanford, Wa (WDIS-108)	**Accepted:** But not available for use.	Waste form must be demonstrated to meet waste acceptance criteria.	**Development cost:** Unknown **Capital cost:** **Disposal cost:** est. $200/ft[2]
	Nevada Test Site (WDIS-102)	**Accepted:** In operation. Constraints posed by Waste certification and WAC may prohibit shipments from Oak Ridge.	Waste form must be demonstrated to meet waste acceptance criteria.	**Development cost:** Not known **Disposal cost:** $200/ft[6] + Programatic and packaging, handling, and transportation cost (*SEE STATUS*)
Low Level Waste Off Site (Commercial)	Chem-Nuclear,Barnwell, SC (WDIS-110)	**Accepted:** Availability unknown.	Waste form must be demonstrated to meet waste acceptance criteria.	**Development cost:** Not known **Disposal cost:** Not available
	US Ecology, Hanford (WDIS-112)	**Accepted:** Operating	Waste form must be demonstrated to meet waste acceptance criteria.	**Disposal cost:** Not available
	Envorocare, Clive, UT (WDIS-104)	**Accepted:** Operating	Waste form must be demonstrated to meet waste acceptance criteria.	**Disposal cost:** $30-50/ft[3]
Mixed Waste On Site (Oak Ridge Reservation)	"Area of Contamination" configuration defined under CERCLA and located at K1417 pad. Proposed disposal area would consist of monolithic blocks of stabilized waste which would be covered with engineered cap	**Predemonstration:** Site is being proposed. No design or licensing has taken place.	Design and testing of acceptability of concept necessary. Waste form must be demonstrated to meet waste acceptance criteria.	**Development cost:** Unknown **Capital cost:** **Operating cost:**
Mixed Waste Off Site (Commercial)	Envirocare, Clive, UT (WDIS-104)	**Accepted:** Negotiations for access by Oak Ridge currently ongoing.	Waste form must be demonstrated to meet waste acceptance criteria & LDR	**Development cost:** Unknown **Disposal cost:** $30-50/ft[3]
	Mixed Waste Disposal Unit (WDIS-113)	**Conceptual:** No design yet	Unknown	Unknown
Mixed Waste Off Site (DOE)	Hanford, WA (WDIS-108)	Unknown	Waste form must be demonstrated to meet waste acceptance criteria.	**Development cost:** Unknown **Capital cost:** **Operating cost:**

Waste Ma

EM Goals

- Clean Up Legacy Waste
- Prevent Future Insult
- Develop Environmental Stewardship

EM Problems

Facility Decontamination and Decommissioning (D&D)

Remedial Action (RA)—Soils, Ground Water and Surface Water

Waste Management (WM)

Y-12 Site Problems	Problem Areas/Constituents	Reference Requirements	Subelements
Alpha-4 Waste Generator/Packaging/ Transportation Interface	• Poor definition of needs	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging, Handling, and Transportation (WPH&T)
Alpha-4 Radioactive Material Shipments	• Excepted quantities of radioactive materials	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging, Handling, and Transportation (WPH&T)
	• Non-fissile radioactive materials having low specific activity (LSA)	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging Handling & Transportation
	• Non-fissile radioactive materials which are not radioactive themselves but which have radioactive materials distributed on their surfaces, that is surface contaminated objects (SCO)	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging Handling & Transportation
	• Non-fissile concentrated wastes having total activities less than Type A package limits	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging Handling & Transportation
	• Non-fissile concentrated wastes having total activities greater than Type A package limits	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Packaging Handling & Transportation
	• Wastes containing fissile material	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging Handling & Transportation

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
efine interfaces	Standard systems engineering technologies	**Interface working groups need to be formed**	None	$1 million (1992 dollars)
H&T at minimum, in accepted ackages	Standard	**Accepted**	None	Not currently estimated
hip in bulk, unpackaged, or in dustrial packaging (IP) (IP-1, -2, IP-3); ship in IP-2, do not evelop IP-3	Low-Specific-Activity materials processing, preparation and packaging WPHT-102-OL	**Must evolve to comply with new DOT/NRC regulations**	New packaging designs required to satisfy expected new IP-2 packaging requirements	IP-2 packaging development cost $1 million (1992 dollars)
any alternatives (e.g., manual, echanical, automated andling, road, rail, water ansport)	Standard	**Accepted**	None	Not currently estimated
hip in industrial packaging (IP- IP-2, IP-3)	Surface Contaminated Objects Processing, Preparation and Packaging WPHT-103-OL	**Must evolve to comply with new DOT/NRC regulations**	Methods for producing SCO and for satisfying SCO requirements and new IP packaging requirements need to be developed	$1-2 million (1992 dollars)
any alternatives	Standard	**Accepted**	None	Not currently estimated
ype A package	Type A Radioactive Material Transport Packages (Multi-Use) WPHT-104-OL	**New standardized Type A package designs need to be developed and qualified to meet regulations. Designs must be user friendly and available to a wide variety of users.**	An operationally efficient multi-use Type A package, or packages, for radioactive materials needs to be developed.	$1 million (1992 dollars)
any alternatives	Standard	**Accepted**	None	Not currently estimated
ghtweight containers, ackage certification	Type B Radioactive Material Packages WPHT-105-OL	**Certified package design can be identified from RAMPAC database and Packaging Management Transportation System (PMTS) database which will identify numbers and status of packagings available under development by EM-561.**	New package designs may be required	Not currently estimated
any alternatives	Standard	**Accepted**	None	Not currently estimated
ghtweight containers, ackage certification	Type-A or Type-B Fissile Radioactive Material Packages WPHT-106-OL	**Certified package design can be identified from RAMPAC and PMTS databases which will identify numbers and status of packagings available under development by EM-561.**	New package designs may be required	Not currently estimated
any alternatives	Standard	**Accepted**	None	Not currently estimated

EM Goals
• Clean Up Legacy Waste
• Prevent Future Insult
• Develop Environmental Stewardship

EM Problems
Facility Decontamination and Decommissioning (D&D)
Remedial Action (RA)—Soils, Ground Water and Surface Water
Waste Management (WM)

Y-12 Site Problems	Problem Areas Constituents	Reference Requirements	Subelements
Alpha-4 Radioactive Material Shipments (con't)	• Onsite	Refer to the Regulatory Compliance of Vol. 1 for potentially applicable, proposed, and promulgated environmental laws, signed and pending agreements for the Oak Ridge Reservation (ORR), radiation protection standards, DOE Orders, and nonregulatory guidance. As site- and waste-specific characteristics are provided for each technology, specific regulatory requirements will be specified.	Waste Packaging
			Handling & Transportation
	• Mixed Wastes	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging
			Handling & Transportation
Alpha-4 Non-Radioactive Material Shipments	• PCB Contaminated Wastes	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging
			Handling & Transportation
	• Asbestos	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging
			Handling & Transportation
	• Non-Radioactive Hazardous Waste	Refer to the Regulatory Compliance of Vol. 1.	Waste Packaging
			Handling & Transportation

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Alternatives	Technologies	Status	Science/Technology Needs	Implementation Needs
ffsite packaging, equivalent afety of offsite packaging	Type A, Type B, Fissile, Strong Tight, IP, Performance Oriented Packaging (POP), and Bulk packaging or packaging equivalent in safety	**Accepted**	New package designs may be required	Not currently estimated
lany alternatives	Standard	**Accepted**	None	Not currently estimated
Jse package designs approved or radioactive contents	Mixed waste and waste having more than one hazard	**Accepted**	New package designs may be required	Not currently estimated
Many alternatives	Standard	**Accepted**	None	Not currently estimated
POP container	Performance Oriented Packaging (POP) Packaging Group (PG) PGII—air, vessel; PGIII—rail, highway (if reportable quantity), Bulk—Strong Tight Container WPHT-107-OL	**Accepted**	New package designs may be required	Not currently estimated
Many alternatives	Standard	**Accepted**	None	Not currently estimated
PGI & PG II POP container	Friable, white—POP PGIII Friable, blue or brown—POP PGII WPHT-108-OL	**Accepted**	New package designs may be required	Not currently estimated
Many alternatives	Standard	**Accepted**	None	Not currently estimated
POP container	RCRA non-bulk: POP PGI, II, III Specification packaging Bulk - Strong Tight Containers WPHT-109-OL	**Accepted**	New package designs may be required	Not currently estimated
Many alternatives	Standard	**Accepted**	None	Not currently estimated

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