Solid Waste Management

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ABSTRACT

This publication is a solid waste management planning guide for Defense Department personnel who are responsible for nonhazardous waste disposal.

This manual discusses managerial, engineering, and operational issues associated with:

- handling and storage of waste
- refuse collection
- transfer stations
- sanitary landfills
- volume reduction techniques
- resource recovery (material and/or energy)
- recycling centers at military bases.

A discussion of hazardous wastes relates to the impacts of hazardous waste materials that might enter a solid waste stream (e.g., contamination of housing wastes with hazardous household cleaning chemicals). This document is not meant to be a comprehensive review of hazardous waste practices in the military.

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NO. NAVFAC MO-213
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DEPARTMENTS OF THE ARMY,
THE NAVY AND THE AIR FORCE
WASHINGTON, D.C.

FOREWORD

This publication is prepared as a solid waste management planning guide for Defense Department personnel who are responsible for waste disposal. THE principles prescribed conform to requirements of the Resource Conservation and Recovery Act (RCRA). Requirements defined reflect present U.S. Environmental Protection Agency (EPA) guidelines established as a result of RCRA. Through dissemination of this information in a joint service format, it is intended that uniformity in solid waste management will be introduced into all services. This guide serves as a primary solid waste manual for the Department of the Navy. For the Departments of Air Force and Army, the information contained in this guide supplements existing waste disposal operations manuals. When information in this publication varies from that contained in other manuals, advice concerning interpretation shall be obtained from:

1. Department of the Army - Office of the Chief of Engineers CEHSC-FU-S

2. Department of the Navy - Naval Facilities Engineering Command (Code 18) or its geographic
Engineering Field Division

3. Department of the Air Force - Air Force Engineering and Services Center HQ AFESC/DEMM

This publication addresses only nonhazardous solid waste management. Hazardous wastes are discussed briefly but in the context that they can enter otherwise nonhazardous solid waste streams, e.g., household cleaning chemicals and/or paint in housing area refuse. Pyrotechnics, radioactive wastes, explosives, and propellants are not discussed.

The document discusses the legal, managerial, and engineering issues associated with collection and disposal of nonhazardous solid wastes.

Legal requirements of the Resource Conservation and Recovery Act of 1976 and its amendments are discussed and referenced throughout the document. Managerial and engineering subjects include:

handling and storage of solid waste

refuse collection

transfer stations

sanitary landfills

volume reduction techniques

resource recovery (material and/or energy)

recycling centers at military bases.

A section on wastes requiring special handling discusses mainly infectious wastes and household chemical hazards.

Recommendations or suggestions for modification, or additional information and instructions that will improve the publication and motivate its use, shall be submitted through appropriate channels to the addressees listed above.

Cancellation. This publication cancels and supersedes Solid Waste Management NAVFAC MO-213, AFP 91-8, PAM 42047, June 1978 and Army TM5-634, July 1958.

By Order of the Secretaries of the Army, the Navy, and the Air Force

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CHAPTER 1. INTRODUCTION

1.1 EXECUTIVE SUMMARY

1.1.1 This update of the Solid Waste Management manual stresses operational changes brought about in waste handling practices as a result of the Resource Conservation and Recovery Act (RCRA) of 1976 (42 USC 6901) and its amendments. New sections are included on the legal implications of the act. The Military Construction Codification Act (PL 97-214) of 1982 is also discussed as it applies to recycling programs in the military.

1.1.2 This manual discusses managerial, engineering, and operational issues associated with:

- handling and storage of waste
- refuse collection
- transfer stations sanitary landfills
- volume reduction techniques
- resource recovery (material and/or energy)
- recycling centers at military bases.

Discussions are intentionally brief.

1.1.3 A serious shortage of suitable landfill sites especially near large metropolitan areas is forcing solid waste managers to look for ways to minimize the volume of buried wastes. Resource recovery, recycling compacting, incineration, and composting are examples of processes being implemented to reduce burdens on landfills. When hauling distances to landfills become excessive, transfer stations may be economically attractive.

1.1.4 The Military Construction Codification Act (PL 97-214) of 1982 provided increased incentives for recycling programs. Highly successful recycling programs already exist at several military installations. Implementation strategies for other installations are included in this document.

1.1.5 Section 4.4 on wastes requiring special handling emphasizes hospital wastes and other unique waste with specific handling and disposal requirements.

1.1.6 Section 4.5 on Hazardous Wastes relates to the impacts of hazardous materials or wastes that might enter a solid waste stream (e.g., contamination of housing wastes with hazardous household cleaning chemicals). It is not meant to be a comprehensive review of hazardous waste practices in the military.

1.1.7 Appendices provide information on:

- landfill permit requirements
- solid waste management contracts
- regional U.S. Environmental Protection Agency (EPA) offices
- state solid waste agencies
- organizations involved in recycling
- estimation of waste generation rates.

A list of acronyms, a glossary, and a subject index are also included.

1.2 PURPOSE. The purpose of the document is to provide technical information for personnel responsible for managing solid waste on military installations in the United States. Installations outside of the United States must abide by technical standards and practices of the host jurisdiction to ensure that environmental protection requirements are fulfilled. These requirements are set forth in status of forces agreements, treaties, and executive orders pertaining to U.S. activities overseas. Good sanitation practices are necessary at all locations regardless of regulatory requirements.

1.3 SCOPE

1.3.1 Management and technical procedures are presented as guides that will ensure:

- conservation of resources
- protection of the environment
- systematic collection of solid wastes
- efficient operation of disposal systems
- minimum expenditure of funds, personnel, equipment, and materials
- compliance with applicable regulations.

1.3.2 The sections discussing legal issues are guidelines only and based on interpretation of regulatory requirements. They are not intended to be legal advice.

CHAPTER 2. BACKGROUND

This background chapter touches on the legal requirements for solid waste handling, the impact of solid waste generation and involvement of base personnel. The discussions under Statutory and Regulatory Requirements focus on:

- RCRA
- other federal statutes
- Defense Logistics Agency
- generic state permit and regulatory requirements for landfills
- regulations relevant to incineration.

Section 2.3 focuses on the need to educate base personnel on specific solid waste issues; i.e., who has to know what and when. Periodic updates of the regulatory requirements must be an integral part of training at military bases.

2.1 STATUTORY AND REGULATORY CONSIDERATIONS.

Solid waste disposal activities at military installations must abide by federal, state, local, and military regulations. Military policy is to abide by the most stringent of the applicable regulations.

2.1.1 Federal Regulations

2.1.1.1 *Resource Conservation and Recovery Act (RCRA).* Prior to the enactment of the Resource Conservation and Recovery Act in September of 1976, solid waste management was governed by the Solid Waste Disposal Act of 1965 (42 USC 3251). Few states, however, had enacted any type of solid waste law. RCRA now sets certain minimum standards for waste management that all states must meet or exceed. Since 1976 many states have adopted their own waste management plans. Often these state plans are more restrictive than RCRA requirements. Military installations must abide by all state and local statutes where they are located. Within DoD regulations governing the sale of recyclable materials are found in the Military Construction Codification Act (PL 97-214).

2.1.1.2 The three main objectives that RCRA addresses are: (1) hazardous waste management; (2) solid waste management; and (3) procurement of materials made from recovered wastes. RCRA was Congress' first attempt at an environmental statute to have the free market mechanism work for environmental protection. Such a mechanism would work by mandating certain standards for disposal of solid and hazardous waste that would protect public health and safety. This action would require those benefitting from the functions that create the waste to pay the cost of its disposal. In effect, the new standards would incorporate costs of health and safety along with the cost of land into the cost of disposal. Then, as the cost of land disposal increased, there would be incentive to provide other more environmentally protective technologies.

2.1.1.3 Solid waste issues have been receiving national attention lately because of dwindling landfill sites and stringent regulatory requirements. A revised set of EPA guidelines for solid waste management is expected in 1989. The new guidelines are expected to focus on landfill design and operation as well as incineration practices.

2.1.1.4 *Procurement of Products Containing Recovered Materials (Robinson 1986).* One of the prime goals of RCRA is to require each federal procuring agency to procure items composed of the highest percentage of recovered materials practicable. The requirement is applicable to procurements in excess of $10,000. Each federal procuring agency is also required to develop an affirmative procurement program which will ensure that items composed of recovered materials will be purchased to the maximum extent practicable. The affirmative procurement program shall contain a promotional and preference program for recovered materials.

2.1.1.5 The EPA is required to provide each federal agency with information on the availability, sources of supply, and potential uses of materials recovered from solid waste. It should be noted that the definition of recovered material includes only material recovered from solid waste and does not include energy recovered from solid waste.

2.1.1.6 RCRA also mandates that the Office of Procurement Policy coordinate the various federal agencies to ensure that items composed of the highest percentage of recovered goods practicable are procured. Furthermore, the Office of Procurement Policy is to coordinate all other policies for federal procurement in such a way as to maximize the use of recovered resources.

2.1.1.7 **Energy Security Act. Public Law 96-294.** The primary goals of Title II of the Act are to reduce the dependence of the United States on imported oil. One portion of the Act dealt with municipal waste-to-energy facilities and the securing of loans to speed their implementation. The Secretary of Energy was prohibited from making loans to any facility unless he first determined that the project was technically and economically sound. Furthermore, the Secretary must ensure that the necessary municipal waste feedstocks are available and will continue to be available for the expected economic life of the project.

2.1.1.8 **Department of Energy Organization Act. Public Law 95-91.** The U.S. Department of Energy developed a National Energy Plan that summarizes all research and development efforts to:

- forestall energy shortages
- reduce waste
- foster recycling
- encourage conservation
- protect the environment.

2.1.1.9 The plan reviewed and appraised the adequacy and appropriateness of available technologies for the treatment of solid waste and developed strategies to maximize private production and investment in significant supply sectors.

2.1.2 State Regulations (General)

2.1.2.1 Section 6001 of the Resource Conservation and Recovery Act of 1976 requires any federal facility engaged in any activity resulting or which may result, in the disposal of solid waste to comply with all federal, state, and local disposal requirements. RCRA sets minimum standards for landfills. States must adopt these or establish more restrictive ones. Although details will differ from state to state, the general permitting procedures and requirements are quite similar.

2.1.2.2 Most state regulations will address the following issues and will likely have similar requirements.

1. Primary responsibility for solid waste handling is assigned to the local government, reserving to the state those functions necessary to ensure effective programs.

2. State regulations require each county, city, or jurisdictional board of health to adopt regulations or ordinances governing solid waste handling. These regulations or ordinances are to protect the public health, prevent air and water pollution, and avoid the creation of nuisance.

3. State laws establish requirements for permits for any solid waste facility from the appropriate state agency.

4. State regulations may define requirements for:

   - storage containers
   - waste collection and transportation
   - plan of operation
   - recordkeeping
   - reporting
   - inspections recycling.

5. Important regulations list minimum functional standards for landfill:

   - performance
   - design
   - maintenance and operation
   - closure and post-closure.

6. Special laws will describe requirements for:

   - operating and closing of inert and demolition waste sites
   - monitoring groundwater
   - establishing a corrective action program in the event of contamination of groundwater.

2.1.3 Department of Defense

2.1.3.1 This document will serve as primary guidance on Solid Waste Management for the Army, Air Force, and Naval branches of the military. Other major documents include:

DoD DIRECTIVE 4165.60, Solid Waste Management--Collection Disposal, Resource Recovery and Recycling Program - Provides DoD policies and procedures relative to the DoD comprehensive solid waste program.

ARMY: AR 420-47, Solid and Hazardous Waste Management - Defines responsibilities, regulatory requirements, and procedures for environmentally safe management of solid and hazardous wastes at Army installations. Describes procedures for collection, storage, and disposal of solid waste.

NAVY: DESIGN MANUAL 5.10, Civil Engineering Solid Waste Disposal - The manual is for use by qualified engineers in selection of a base-specific disposal method of solid waste.

AIR FORCE: AFM 91-11, Solid Waste Management - This manual describes procedures to use in accomplishing solid waste management in an efficient and economical manner consistent with good environmental engineering principles. The information provided on practicable equipment and methods is a basis for implementing a system of refuse collection and disposal.

2.1.3.2 Supplemental information can be found in other military references given in the Bibliography of this report.

2.1.3.3 These guidelines address the environmental and personnel health and safety requirements to be followed in the daily operation of a landfill facility and, therefore, shall be the basis for the development of any operations and maintenance manual for a landfill.

2.1.4 Regulations Relevant to Incineration

2.1.4.1 Solid wastes are to be incinerated in facilities designed for that purpose. The most stringent of federal, state, and local requirements apply to military installation incinerator operations.

2.1.4.2 *Environmental.* The design and operation of incinerator facilities must conform with the EPA guidelines published in 40 CFR 240, the Clean Air Act (42 USC 740/et seq.), the Clean Water Act (33 USC 125/et seq.), and pertinent state regulations. The processing of residue and nonhazardous wastes that cannot be thermally processed is subject to EPA guideline 40 CFR 241.

1. Air quality guidelines established by the federal government are contained in 40 CFR 60. Air pollutants from incinerator operations include particulates, carbon monoxide, sulfur oxides, nitrogen oxides, hydrogen chloride, and various heavy metals. Instrumentation and controls are used to monitor and regulate the incineration process in order to protect air quality. Incinerator design criteria are established including the number of chambers,

dwell time, operating temperatures, and requirements for excess oxygen, carbon monoxide, and particulates. Air pollution control devices including cyclones, electrostatic precipitators, wet scrubbers, baghouses, and wetted baffles are used to remove particulate emissions. Proper emphasis on solid waste sorting should eliminate heavy metals from the incinerator feed, and thus reduce the quantities of particulate emissions.

2. Water quality standards are established by the Federal Water Pollution Control Act (FWPCA) and state and local regulations. The use of process water in incinerators varies considerably with the design of the plant. Water may be used in various stages of production for cooling charging chutes, fly ash sluicing, conveying residue, and controlling air pollution. Many plants require from 1000 to 2000 gal of water per ton of refuse processed; water treatment usually requires clarification and pH adjustment because of extreme acidity (less than 2.5 in some systems) and may require biological treatment. Process water contains suspended solids, inorganic materials in solution, and substantial organic material. Flow of nonrecycled process water to a sewage treatment plant shall be restricted to 2% to 5% of the wastewater entering the plant. When monitoring instrumentation indicates excessive discharge contamination, appropriate adjustment shall be made to lower the concentrations to acceptable levels.

3. Vector control is established by maintaining conditions unfavorable for the harboring, feeding, and breeding of vectors. Housekeeping schedules shall be established and maintained. These schedules should provide for cleaning the tipping and residue areas as spillage occurs, emptying the solid waste storage area at least weekly, and routinely cleaning the remainder of the facility.

4. Aesthetic quality of the incinerator facility is maintained through routine housekeeping and by regularly removing solid waste that cannot be processed by the facility.

2.2 IMPACTS OF SOLID WASTE GENERATION

2.2.1 Ecological impacts, such as air and water pollution around old landfills, have prompted new legislation requiring stringent standards for construction, operation, and closure of landfill sites. If present refuse generation rates continue, the cost of disposal of solid wastes will jump dramatically by the year 2000 in many parts of the country. Eastern metropolitan areas will suffer most as “nearby” landfills are closed. Military installations near these crowded areas could also experience a jump in costs for waste disposal. The scarcity of acceptable landfill sites has prompted municipalities and military installations to look at ways of minimizing solid wastes.

2.2.2 Municipal solid waste incineration is being considered and implemented at some larger military bases. Primary concerns with this volume reduction technique are hydrochloric acid and particulates. In many instances, hazardous organic chemicals have been found in incinerator fly ash from large-capacity units. This problem is delaying the acceptance of incineration at many locations.

2.2.3 Generally, incineration at military bases is appropriate only if the heat generated can be used effectively at the base. Generating electricity and selling power are not common practices at military installations.

2.2.4 Mandatory resource recovery is being tried in many states. Oregon, New Jersey, and Rhode Island are examples. Most programs are too new to judge success yet. In states requiring local recycling programs, installations that use the local landfill may be required to participate in some manner. Military installations have special monetary incentives for implementing recycling programs. Details are given in Section 4.3.

2.3 INVOLVEMENT OF BASE PERSONNEL

2.3.1 Landfill Operations. When existing sanitary landfills on military bases become u an new sites must be selected or new disposal options must be considered (e.g., incineration), specific engineering personnel in the military will be heavily involved. Other base staff become involved only from an education standpoint. All base personnel must be kept informed of any new regulations regarding wastes that can no longer be sent to a landfill or cannot be incinerated. Used motor oil, batteries, tires, pesticides, and liquid paints are examples of chemicals that shall no longer be sent to ordinary sanitary landfills. All base personnel must be informed of these requirements. Also, the base shall provide a central drop-off point or provide a regular specific collection time for such chemicals. When sufficient quantities of such wastes have been segregated and properly containerized, they can be shipped to the Defense Reutilization and Marketing Office (DRMO) for disposal. Detailed requirements are given in Section 4.5.

2.3.1.1 When military bases dispose of wastes in public landfills, they abide by the requests of the operator of the landfill. Military personnel are not usually involved in the decision-making processes associated with municipal landfills. Presently, interaction with the landfill operators is infrequent and usually occurs only when there has been an infraction of accepted disposal practices, e.g., improper bagging of asbestos wastes. In the future, frequent interactions may be necessary to avoid problems in the areas of household chemical wastes. Ultimately, each military base remains responsible for the waste it sends to a landfill. Landfills are inspected by environmental regulatory agencies; therefore, waste generators must be certain they are not sending improper materials to disposal facilities.

2.3.2 Resource Recovery. Resource recovery is usually the most visible waste reduction technique on military bases. The keys to success are education and simplicity. Base personnel must be educated and convinced of the worthiness of any recycling effort. Widespread participation demands a simple method for segregation of wastes. Recyclers will participate if the effort is simple and there is a reward for them.

2.3.2.1 A very successful approach has been to involve people in their work place first. Recycling bins are placed so staff can easily drop off recyclable materials on their way out of a building. As recycling programs grow and show real benefit to the participants, the participation rate climbs. A key to the benefits is publicizing how proceeds are spent.

Contests with generous prizes for the winning unit can sustain interest in recycling activities.

2.3.3 Hazardous Wastes. The increasingly stringent guidelines on hazardous wastes demand frequent information updates for base personnel. The base newsletter shall be a routine source of information on new developments. Special meetings may be necessary for groups most directly affected by new rulings. Initiation sessions for new arrivals shall stress hazardous waste handling/storage procedures at a base. Hazardous waste minimization is the most effective strategy for reducing hazardous waste generation. This is done by substitution of less hazardous materials, process changes, and reuse or other recovery procedures.

CHAPTER 3. MANAGEMENT ISSUES

Management Issues usually involve a Branch Chief. From there, considerations will move up the ladder as shown in Figure 3-A as priorities and importance dictate.

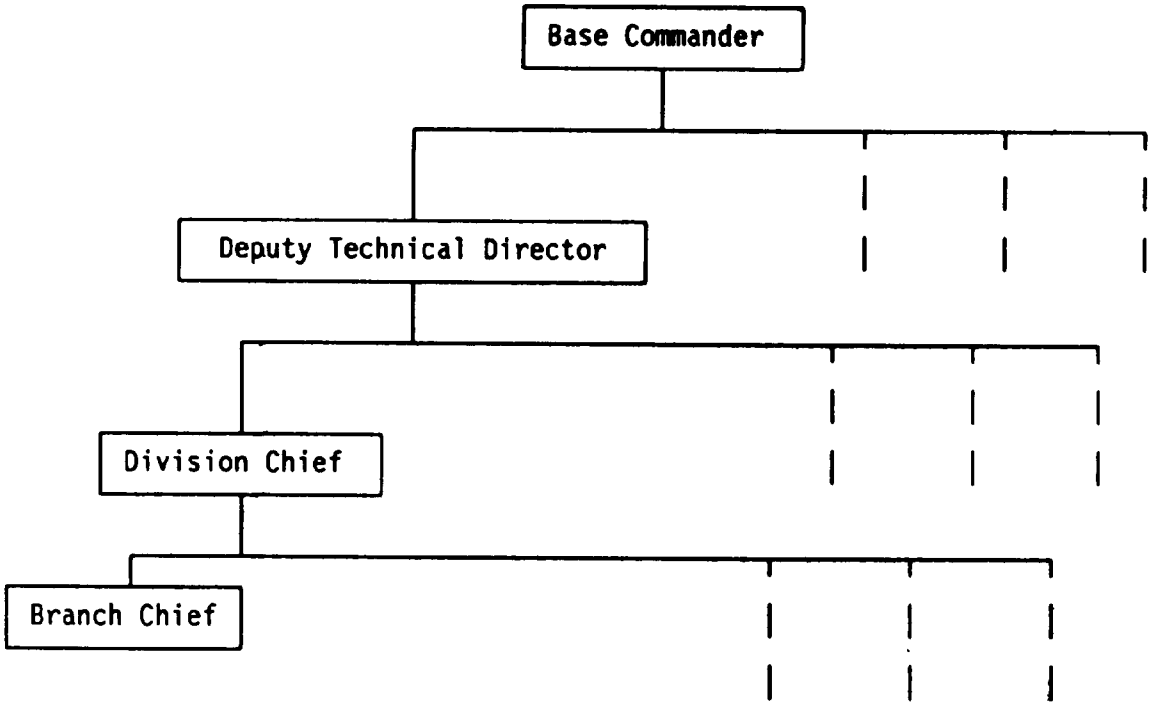


FIGURE 3-A
Management Structure at Typical Military Installations

3.1 PLANNING IN SOLID WASTE MANAGEMENT

3.1.1 Management Objectives. The general objective of management is to provide and maintain the system's required level of service through the efficient use of resources and management control. Specific objectives include:

- Environmental protection. To protect the health and aesthetic conditions of the living environment by removing waste in a sanitary fashion.
- Convenience. To provide a desired level of service (e.g., in terms of frequency and point of collection).
- Continuity. To provide for stability of this vital service. A contingency plan shall be available for periods when there is an interruption of collection service.

- Resource recovery and waste minimization. To reclaim and conserve natural resources.

- Safety. To store and collect the waste in as safe a manner as possible.

- Efficiency. To achieve all these objectives with the highest productivity and least cost.

3.1.2 Collection and Hauling Options

3.1.2.1 Collected solid waste is typically hauled from the point of collection to a disposal site in the collection vehicle. This procedure is called “direct haul."

3.1.2.2 Solid waste may be collected by either military personnel or contractors. There may also be a combination of approaches, depending on conditions at a specific installation. A common arrangement includes contracted collection in the family housing areas, and collection by military personnel from the commercial and industrial sources. However, collection and hauling from all areas of an installation can be accomplished by military personnel, or all solid waste collection can be contracted.

3.1.2.3 Solid waste collection (and in fact all aspects of solid waste management) are subject to the Office of Management and Budget (OMB)-required Commercial Activities (CA) reviews. Through these reviews the feasibility of providing solid waste services through contractors is assessed. If there is a cost advantage to contracted services, preference is given to that approach. Most installations have a Commercial Activities Coordinator who can answer questions about these reviews.

3.1.3 Collection Management

3.1.3.1 *Productivity.* Productivity is the ratio of output (results of activity) to input (resources consumed by the activity). The productivity of solid waste collection can be expressed in many ways, including cost per ton, cost per cubic yard, or work hours per ton/cubic yard.

- *Management responsibility.* It is management’s responsibility to design a solid waste collection system that is efficient and effective.

- *Higher productivity.* Increased productivity is not always achieved simply by the laborers working harder. Instead, in general, productivity can be increased through improved storage and collection methods such as better routing, more efficient storage devices, collecting one side instead of two sides of a street at a time, curbside collection, reduction in crew size, and mechanical systems.

3.1.3.2 *Employee Safety.* The collection and transfer system shall be operated so as to protect the health and safety of all personnel.

Regulations 29 CFR 1910 promulgated by Occupational Safety and Health Administration (OSHA) shall apply. The following general provisions shall apply to collection operations:

- *Safety manual.* Ensure that a safety manual is provided for use by the collection personnel. This manual shall include specific information on local conditions, equipment, methods, safety regulations, policies, and procedures. All personnel shall receive instructions and training in safe container and waste handling techniques and safe collection equipment operation. Back injury prevention shall be emphasized.

- *Safe driving.* Collection vehicles and equipment shall be operated in a safe, efficient manner, strictly obeying all applicable traffic and other laws.

- *Protective Equipment.* Protective equipment such as safety glasses, gloves, and footwear shall be used by collection personnel, and respirators as appropriate. Refer to Subpart I, 29CFR 1910.132-140 of OSHA Standards for General Industry.

- *Scavenging.* Scavenging shall be prohibited at all times to avoid injury and to prevent interference with collection operations.

- *Waste contact.* The potential for physical contact between the collectors and the waste, both solids and liquid, shall be minimized. When conducting manual carry-out collection, a leakproof carrying container shall be used. The collection vehicle operator shall be responsible for immediate cleanup of any spillage caused by his operations.

- *Noise disturbance.* The collection vehicle operator shall be responsible for avoiding any undue noise disturbances in residential areas.

- *Vehicle.* Vehicles shall have backup alarms as specified by DOT.

3.1.4 EPA Checklist

3.1.4.1 All operations concerning collection and storage of solid waste must comply with EPA guidelines or those established by state and local governments, which may be more stringent.

3.1.4.2 The EPA has developed a checklist of solid waste systems and operation policies (Figure 3-lB). The checklist summarizes the types of decisions that will be made by management in designing a solid waste collection and disposal system. Most, but not all, are relevant to military installations.

3.1.5 l,abor Relations. In any service or industry that is as labor-intensive as solid waste collection and disposal, a key to high productivity is management's ability to lead and work with employees. Management can promote and increase worker morale and productivity by developing better labor-relations techniques.

- Accidents shall be rapidly reported through supervisors to base safety office. Employees shall be trained to recognize unsafe acts and conditions and correctly perform job.

CHECKLIST OF POLICIES AND PRACTICES

I. System Policies
- A. Organizational Policies
  1. Institutional arrangements
  2. Financing methods
  3. Billing system
  4. Subsidization of particular groups
  5. Legal issues
- B. Level-of-Service Policies
  1. Who receives service
  2. Citizen option versus mandatory services
  3. Point of collection
  4. Frequency of collection
  5. Type of storage devices
  6. Limit on amount of waste or number of containers
  7. Mechanized collection
  8. Yard wastes
  9. Bulk items
  10. Separate collection of garbage or recyclable materials
  11. Inner city cleanup programs
  12. Service for elderly and handicapped
  13. Corner-lot residences

II. Operational Policies
- A. Route Policies
  1. Crew size
  2. Type and size of equipment
  3. Whether drivers collect
  4. "Limousine" service
  5. Shuttle system
  6. Reservoir system
  7. Whether collection vehicle must be full before going to disposal site
  8. Times and sites for lunch and breaks
  9. Scheduling
  10. Vehicle routings and districts
  11. One-side or both-sides-of-street collection
  12. Whether vehicles can back down short street segments or make U-turns
  13. Routing on steep hills
  14. Dealing with enclosures and other obstacles
  15. Dealing with excessive haul times
  16. Seasonal variation of routes
- B. Labor Policies
  1. Wage structure
  2. Career ladder, seniority
  3. Training
  4. Safety measures and preventive health care
  5. Insurance and pension plans
  6. Holidays, vacations, sick leave
  7. Absenteeism
  8. Incentive system
- C. Management Policies
  1. Organizational structure
  2. Management information system
  3. Cost accounting system
  4. Handling requests and complaints
  5. Supervisory communications system
  6. Public relations program

FIGURE 3-1B
A Checklist of Policies and Practices for Solid Waste Management. Source: K. A. Shuster, EPA

! *Training.* Organized training in basic public relations, work rules, unit operations, safety, and equipment use and care shall be scheduled at regular intervals. Such training can reduce equipment breakdowns, improve both employee and public relations, reduce injury compensation claims, and ultimately reduce costs.

! *Safety.* Solid waste collection workers have a high injury frequency rate. Dramatic cost savings can be realized by implementing safety programs. Such safety devices as gloves, safety glasses, respirators, and special footwear can contribute significantly to the health and safety of workers.

3.1.6 Route Planning. The refuse foreman and collection truck drivers shall be involve in the routing process. To ensure maximum productivity, management shall consider potential cost savings from the three categories of routing: macro-routing, route balancing, and micro-routing.

! Macro-routing. Macro-routing determines the assignment of the daily collection routes to disposal facilities. The objective is to minimize the round-trip haul time (and hence hauling cost) from the collection routes to the disposal site. This generally means hauling to the closest disposal site. However, the closest site may not be the best choice if it has limited capacities (such as an incinerator), requires a long service time, has a poor safety record, or other such considerations. The selection of a disposal site for each collection route requires the supervisor to consider all factors that can reduce costs. Information essential to macro-routing includes haul times from the routes to the various processing and disposal sites, crew size and vehicle capacity, safety considerations, service times at the sites, condition of the site, and short and long-range capacities and costs of the sites.

! *Route balancing.* Route balancing is the process of determining the optimum number of services that constitute a fair day's work and dividing the collection task among the crews so that they have equal workloads. The data required for this analysis are: (1) time and distance data related to the components of the collection day; (2) the number and type of services and where they are located; (3) the average amount of waste generated per service, including seasonal variations; and (4) basic equipment and labor cost data. Route balancing is accomplished by analyzing each component of time in the collection day, or how each crew spends its time. Typical time components include:

  - going to or from garage to route
  - route collection time
  - to or from route to disposal site
  - time at disposal site
  - time for official breaks
  - slack time (lost time due to weather, breakdowns, etc.)

! *Micro-routing.* Micro-routing determines the path each collection vehicle will follow. The objective of micro-routing is to minimize the noncollection distance (repeat distance and streets with no services)

and delay times (such as U-turns, heavily trafficked streets, and left turns) for each collection vehicle. A common-sense approach to micro-routing includes the following general rules:

- Routes shall not be fragmented or overlapping. Each route shall be compact, consisting of street segments clustered in the same geographical area.

- The collection route shall be started as close to the garage or motor pool as possible.

- Heavily traveled streets shall not be collected during rush hours.

- Services on dead-end streets can be considered as services on the street segment that they intersect, since they can be collected only by passing down that street segment. To keep left turns at a minimum, however, the dead-end streets shall be collected when they are to the right of the truck. They must be collected by walking down, backing down, or making a U-turn.

- When practical, steep hills shall be collected on both sides of the street while the vehicle is moving downhill, for safety, ease, speed of collection, reduced wear on vehicle, and conservation of gas and oil.

- Higher elevations shall be at the start of the route.

- For collection from one side of the street at a time, it is generally best to route with many clockwise turns around blocks (Figure 3-1C).

- For collection from both sides of the street at the same time, it is generally best to route with long straight paths across street blocks.

- Minimize left turns, which generally are more difficult and time consuming than right turns. Also, right turns are safer, especially for right-hand-drive vehicles.

3.1.7 Collection Personnel

3.1.7.1 *Regular schedules.* For maximum efficiency, assign personnel with refuse-handling duties to regular schedules.

3.1.7.2 *Crew size.* Crew size selection will be affected by the amount of waste per stop, number and location of collection points, type of storage containers, haul time to unloading point, wage rates, labor preference, and management. In high-density population areas, the larger quantity of waste at a given stop makes larger trucks with three-man crews economically competitive with smaller crew sizes.

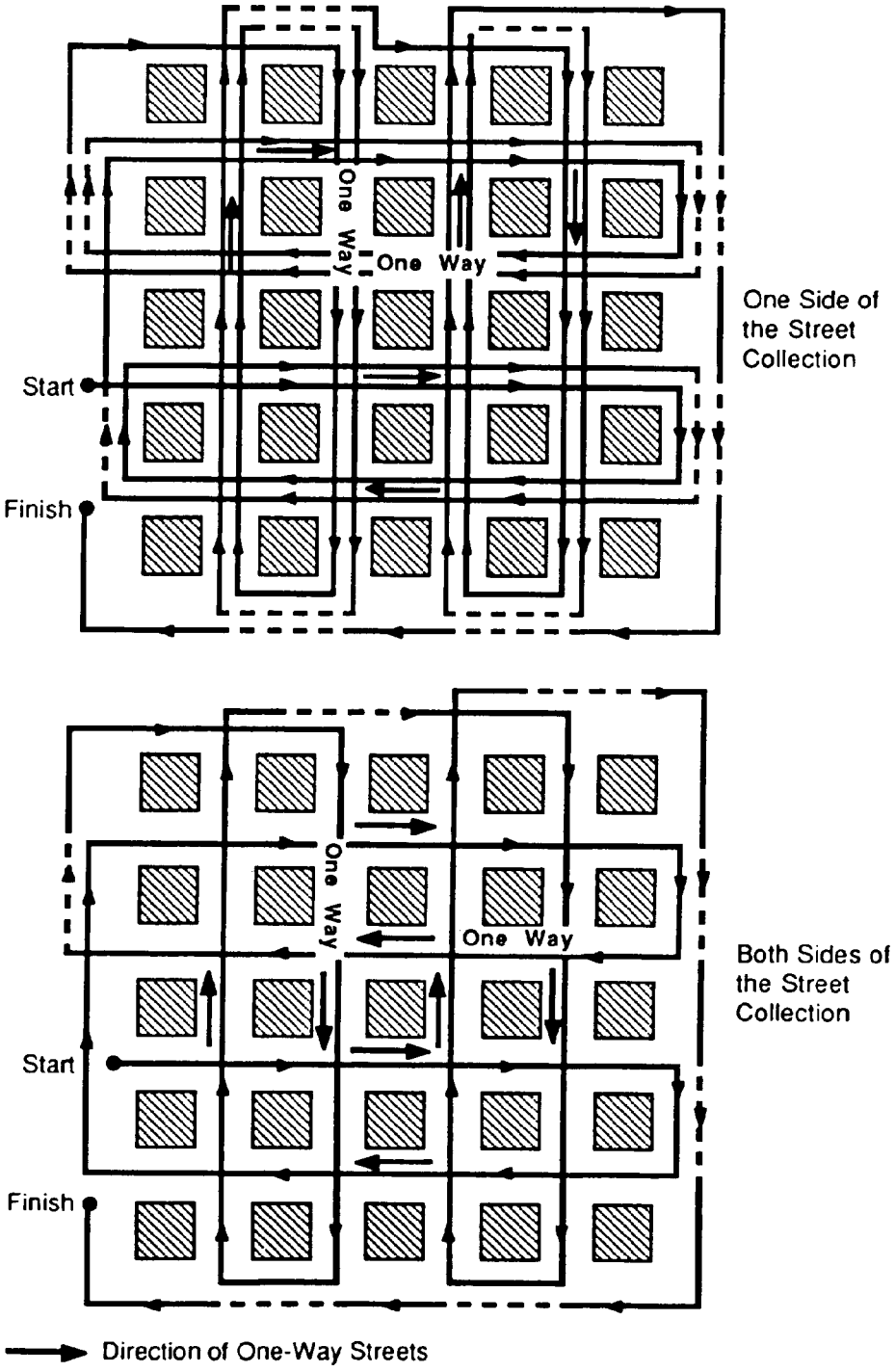


FIGURE 3-1C
Micro-Routing. Source: K. A. Shuster, EPA

3.1.7.3 *Collection crew.* Truck drivers and loaders are to be well-trained, competent personnel who are assigned regularly to refuse collection.

! *Driver.* The truck driver is the foreman of the loaders working on the truck. Duties include assisting the loaders in loading heavy or bulky materials, maintaining proper records, performing vehicle safety and maintenance checks, and general supervision of the loaders. Drivers are to obey all traffic laws. Drivers shall be trained and tested for each vehicle they are to operate.

! *Loaders.* Loaders, as well as drivers, must be familiar with requirements for segregation of materials. Loaders are required to:

- empty all solid waste from containers
- immediately clean up all spilled garbage
- protect private and public property
- make no undue noise
- serve as ground guides when backing the truck.

3.1.7.4 *Supervision.* The supervisor is in charge of refuse collection and disposal activities, and the efficiency and economy of the collection system depends on him. He supervises the collection crew; ascertains all conditions and changes that affect quantities, types, or distribution of materials collected; and effects changes in the collection system accordingly. Where more than one type of collection vehicle is used, the supervisor assigns trucks to pickup stations and routes for best utilization of each type of truck.

3.1.7.5 *Crew collection methods.* The more common collection methods appropriate for family housing areas include:

! *Assigned crew.* The crew is assigned to a collection vehicle for the entire working day. Assigned crew collection is efficient when the travel time to the disposal site is short.

! *Shuttle system.* While their driver is traveling to and from the disposal site, the crew is shuttled to help another crew. This method is more efficient when the travel time to the disposal site is long, but requires a dispatcher to coordinate the crews.

! *Reservoir system.* All crews work a large (usually centralized) area after they have completed their assigned routes. No crew is dismissed until the entire reservoir area has been collected.

! *Curbside collection.* The collection is made from containers placed at the curbside rather than at the doorstep in housing areas. Doorstep collection is not an encouraged method.

! *One side* of *street.* Generally, the collection is made on one side of street when the streets are wide, heavily traveled, or have a median divider. Also, if mechanically handled collection is used, one-side- of-street collection may be required.

! *Both sides of the street.* The collection is made on both sides of the street when the streets are narrow, lightly traveled, one-way, or when bulk containers are used and have to be mechanically handled.

3.1.8 Transfer Stations

3.1.8.1 Transfer facilities are intermediate locations for gathering waste. These facilities shall be considered when:

1. access to small but restricted-access military bases must be limited

2. disposal sites are greater than 10 miles from the collection routes

3. small-capacity collection trucks (under 20 yd3) are used

4. medium-sized containers for collection of wastes from industrial activities are used extensively.

3.1.8.2 A solid waste transfer system becomes economical when the overall cost of transfer station construction/operation and waste haul to the disposal site in transfer vehicles is less than the cost of direct haul in collection vehicles.

3.1.8.3 Solid waste transfer is not required at some bases since the distance from the collection areas to the disposal site is generally short (e.g., less than 5 miles). In some instances, however, the disposal site might be located at a remote onsite location or at an off-base regional facility. In those cases a transfer system could prove economical.

3.1.8.4 Some bases use transfer stations near their entry gates. Base personnel are used to collect solid waste and deliver it to the transfer stations. Contractors then transport wastes from the main gate to a disposal site. When collection routes are complicated or waste generation rates fluctuate from week to week, this concept minimizes retraining problems if contractors are changed. It also allows “on call” garbage collection since base personnel are generally more readily available than contractor personnel.

3.1.8.5 The state regulations applying to transfer stations vary greatly. Permitting is always required, but some states treat transfer stations procedurally the same as landfills and incinerators. Others are much more lenient. Permitting requirements shall be studied thoroughly before a decision is made to set up a transfer station.

3.1.9 Scrap Recycling

3.1.9.1 DoD 4160.21-H, Defense Scrap Yard Handbook, outlines practical, cost-effective methods for the recovery and recycling of scrap (defined as personal property that has been discarded and which appears to have no value except for its basic material content).

3.1.9.2 The broad objectives of the DoD Scrap Recycling Program are to:

1. ensure that no property with utilization or sales value which exceeds the value of its material content is processed as scrap

2. optimize procedures for cost-effective recovery, recycling, or sales of scrap including precious-metal-bearing materials

3. ensure that processing of scrap is in strict compliance with all applicable safety, health regulations, and environmental protection guidelines.

3.1.9.3 *Responsibilities.* The Federal Property and Administrative Services Act of 1949, as amended, assigned to the Administrator of General Services responsibility for the disposition of excess and surplus personal property (including scrap) generated by federal agencies in the United States. The Administrator delegated responsibility for disposition of all DoD generations of such property to the Secretary of Defense, who subsequently assigned overall command and management of the Defense Personal Property Utilization and Disposal Program to the Defense Logistics Agency. Specific responsibilities of the DoD installations primarily concerned with scrap recycling are outlined in Table 3-lA (DoD 4160.21-H). Specific responsibilities of the DoD installations for the management and disposal of hazardous materials and hazardous waste are outlined in DoD 4160.21-M, Chapter XXI.

3.2 DISPOSAL ALTERNATIVES. Selection of the proper disposal methods for use at an installation shall be based on protection of the environment and relative cost to the government. A resource recovery analysis shall be conducted before the disposal method is selected. Disposal may take the form of one or a combination of the following methods.

3.2.1 Contracting. Contracts with municipal or private individuals may be favorable when compared with the cost of in-house disposal. Large municipal operations of solid waste disposal facilities are frequently more efficient and environmentally more acceptable than smaller installation operations. Contracts can also be used when funds for capital expansions in an in-house facility are limited.

3.2.2 Sanitary Landfill. A sanitary landfill is an engineered disposal method in which solid waste is spread, compacted, and covered with soil daily. When properly designed, the sanitary landfill can handle nearly all types of solid waste while providing substantial environmental protection. RCRA regulations discourage the use of landfills and encourage generators to seek alternative methods of waste disposal.

3.2.2.1 Hazardous wastes shall not be disposed of at a sanitary landfill.

TABLE 3-lA
Responsibilities of DoD Installations

Military Services:	a. Provide administrative and logistics support to tenanted Defense Reutilization and Marketing Regions (DRMRs) and to Defense Reutilization and Marketing Offices (DRMOs) and their Off-Site Branches, in consonance with applicable Interservice Support Agreements (ISAs). The U.S. Army Logistics Management College also provides specialized training support by conducting the Defense Scrap Management Course and Defense Metals Identification and Recovery Course.
	b. Establish and operate the DoD Resource Recovery and Recycling programs (Deputy Secretary of Defense Memorandum, Sales of Recyclable Materials 10 USC 2577, 28 Jan 83).
	c. Establish Qualifying Recycling Programs at DoD installations including those which operate under the industrial fund.
	d. Ensure that those installations and defense agencies with Qualifying Recycling programs make concerted efforts to divert or recover scrap or waste from the waste streams, as well as efforts to identify, collect, properly segregate, and maintain the integrity of the recyclable materials in order to maintain or enhance the marketability of the materials.
	e. Report/turn in all authorized scrap generations to their servicing DRMOs.
	f. Prepare disposal turn-in documents (DTID) (DD Form 1348-1 DoD Single Line Item Release/Receipt Document,) and accurately identify all scrap listed thereon.
	g. Indicate on DTID that DoD qualifying Recycling Program material is identified as such with funds to be deposited to the Budget Clearing Account **F3875--(xx 17 Navy. 21 Army, 57 Air Force and 97 for DoD Installations). No other account is acceptable. The reimbursable fund citation must be on documentation in order for sales proceeds to be returned.

TABLE 3-lA
(cont'd.)

Military Services: cont'd.)	h. Properly containerize all hazardous property in scrap condition turn-in. Identify by labeling containers and annotate DD Form 1348-1accordingly.
	i. Monitor, with DRMD personnel, all property sent to landfills to ensure no economically salable or recyclable property is discarded.
	j. Request DRMS provide sales services as needed for recyclable, marketable materials generated as a result of resource recovery programs.
Defense Logistics Agency (DLA):	a. Coordinate DoD policy guidance (developed by the Assistant Secretary of Defense (Production and Logistics) or other organizational elements of the Office of the Secretary of Defense) with the Military Services and other DoD components, and with federal civil agencies, as appropriate.
	b. Program, budget, fund, account for, allocate, and control personnel spaces and other resources required to support DLA scrap recycling installations.
	c. Provide agency-level command and control of the Defense Personal Property Utilization and Disposal Program (including scrap recycling, regulated property disposal, and precious metals recovery) worldwide.
Defense Reutilization and Marketing Service (DRMS):	a. Manage the DoD Scrap Recycling Program (including precious metals recovery) and related financial records.
	b. Command and control DRMRs.
	c. Implement applicable policies, develop procedures and techniques, and initiate other appropriate actions to ensure cost-effective and environmentally safe implementation of scrap-related programs.

TABLE 3-lA
(cont'd.)

Defense Reutilization and Marketingd.	d. Comply with DoD guidance on demilitarization of scrap generations. Service (DRMS) (cont'd.):
	e. Provide technical guidance to DRMRs regarding equipment procurement and development of facilities required to enhance program effectiveness.
	f. Maintain and control the Consolidated DoD Bidders List.
	g. Respond to private and public sector inquiries pertaining to the recovery and sale of scrap.
	h. Provide sales services and marketing advice to the Military Services on the operation of the DoD Directive 4165.60, Solid Waste Management-Collection Disposal, Resource Recovery Recycling Program.
Defense Reutilization and Marketing Regions (DRMRs):	a. Supervise and provide administrative and technical support to assigned sales office(s) and DRMDs.
	b. Coordinate, develop, and implement required ISAs with DOD components.
	c. Conduct sales and provide related contracting support.
	d. Provide appropriate comand guidance and technical assistance to DRMOs.
	e. Assist all assigned organizational elements to obtain needed equipment and facilities.
	f. Ensure that scrap is handled and stored in strict compliance with applicable safety, health, and environmental protection guidelines as well as security procedures.
	g. Monitor compliance with DoD guidance on the demilitarization of scrap.

TABLE 3-lA
(cont'd.)

Defense Reutilization and Marketing Office (DRMO):	a. Provide technical assistance to generating installations in the identification, segregation, collection, and storage of scrap at its source and, where feasible, provide containers to the scrap generator.
	b. Receive authorized scrap generations.
	c. Ensure adequate storage and security for scrap receipts.
	d. Dispose of scrap in such a way as to maximize net return to the Government.
	e. Perform market research to determine best sales method and optimum lot sizes.
	f. Optimize procedures for recovery of strategic and critical materials (including precious metals) from scrap generations.
	g. Ensure that scrap is handled and stored in strict compliance with applicable safety, health, and environmental protection guidelines as well as security procedures.
	h. Comply with DoD guidance on demilitarization of scrap.
Defense Property Disposal Precious Metals Recovery Program:	a. Manage Precious Metals Recovery Program (PMRP).
	b. Provide recovery equipment to generating installations on a nonreimbursable basis.

TABLE 3-lA
(cont'd.)

Defense Property Disposal Precious Metals Recovery Program (cont'd.):	c. Issue disposition instructions for the movement of precious-metal bearing materials to collection/recovery sites.
	d. Perform contracting and contracting support functions regarding the recovery of precious metals by commercial refiners.
	e Provide technical support to DoD and participating federal civil agency generating installations and DRMOs and assist them in improving the cost effectiveness of the PMRP.
Defense Industrial Supply Center (DISC):	a. Serve as integrated DoD manager for precious metals.
	b. Store and issue refined precious metal recovered through the PMRP. Costs incurred by DRMS are totally reimbursed by DISC from Defense Stock Fund.
Defense Contract Administration Services (DCAS) [Applies to DCAS and its subordinate Defense Contract Administration Services Regions (DCASRs), Defense Contract Administration Services Plant Representative Offices (DCASPROs) under the direction of the Director, DLA]:	a. Administer assigned contracts, including those which require contractors to dispose of scrap generated from work specified in their work contracts.

3.2.2.2 Factors to be considered in a cost appraisal of the sanitary landfill disposal method include:

- permitting cost/requirements
- social considerations (future growth) affecting design, operation, and closure
- land cost
- equipment cost
- labor cost for operation and maintenance
- installation overhead to support the site design costs
- benefits in reclaiming useless land
- environmental considerations affecting design, operation, and/or closure
- monitoring costs to avoid potential problems
- potential DoD natural resources program impacts
- future land utilization needs.

3.2.2.3 Innovations in landfill operations to reduce refuse volume and extend useful landfill life include covering of baled compacted refuse and the use of a shredder to get better consistency in the material deposited.

3.2.2.4 Under new and proposed environmental regulations, construction of new sanitary landfills will require installation of a liner and leak detection system, leachate collection and treatment system, and methane collection and disposal. These items will increase construction and operation cost considerably.

3.2.3 Construction Debris or Demolition Landfill. This method is commonly used to dispose of construction and demolition materials and incinerator ashes for the purpose of changing an existing grade. Factors to be considered in the cost appraisal process include land cost and the future use of the land. Excavation in fill areas may be difficult when large concrete or stone pieces have been discarded.

3.2.4 Incineration. Incinerator operation is a waste reduction or energy recovery method and not a disposal method. The maximum economic advantage, therefore, is realized by locating the plant as close to the center of the refuse collection effort as possible. Certain criteria will affect the location of the plant as follows.

3.2.4.1 *Traffic.* Consideration must be given to the frequency and size of vehicles utilizing the incinerator facility. Access roads shall be all-season permanent roads; however, travel on and across primary roads shall be minimized.

3.2.4.2 *Elevation.* Locating an incinerator on a hillside may reduce the amount of ramp construction and excavation needed.

3.2.4.3 *Aesthetics.* The site selected shall allow the facility to be screened from public view, particularly operations associated with tipping, residue discharge, and waste salvage areas. Grounds shall be appropriately landscaped to add to the appearance of the facility. Topography and location shall be screened to mitigate noise and odors from the incinerator. Prevailing wind direction shall be evaluated to avoid odors being transmitted to residential sites. Screening effects of plantings or walls may also reduce conflicts with other land uses.

3.2.4.4 *Labor schedules.* Trained personnel are essential for efficient incinerator operation. If experienced operators are not available, training will be given under supervision of the chief operator. Common labor duties can be performed by less experienced personnel.

- *One shift operation.* Many incinerators have sufficient capacity to burn all suitable refuse within one 8-h working day. One operator can perform all the work at a small incinerator. This includes cleaning and trimming the fire before closing in the afternoon. The operator's working hours shall be coordinated with the collection time to permit all the refuse to be incinerated and duties completed within the normal working day. Larger incinerators may require various skills for operation and maintenance. Staffing varies with the schedule of operations, number of shifts, degree of automation of plant operations and labor regulations. Most incinerator operations require 0.5 to 0.75 manhours per ton of refuse processed, excluding residue removal and major repairs.

- *Staggered hours operation.* Some incinerators have insufficient capacity to burn all refuse delivered in an 8-h working day. To provide proper refuse disposal, the incinerator must be operated longer than 8 h. Plan the operators' schedules to provide for morning cleaning of the incinerator before deliveries of refuse start, and also for later afternoon burning until all refuse has been charged, the fire trimmed, and building cleaned. Staggering the working hours permits operation of the incinerator for a period longer than 8 h, without requiring a full second shift of operators. It also provides for adequate operating personnel during the peak hours of the day when the refuse is being collected and delivered to the incinerator.

- *Refuse deliveries.* Scheduling deliveries of refuse evenly throughout the day smooths operations; i.e., the unloading platform or pit is not congested or full, and the incinerator is neither overloaded nor operating at fractional capacity. Coordinate labor shifts with collection and delivery schedules.

3.2.4.5 The residual product, noncombustible solid waste and ash, is removed from the incinerator for disposal, usually by land burial.

3.2.4.6 *Manufacturer Information.* Manufacturer-sponsored training shall be included as part of the procurement package for an incinerator. The manufacturer must provide a detailed operating and maintenance manual. State and federal regulations shall be consulted to determine the allowable emission standards. No incinerator shall be purchased which does not meet these standards. A guarantee in writing shall be obtained from the manufacturer stating that the incinerator will operate at or below the maximum allowable emissions, and liability will be retained by the manufacturer for getting the incinerator into compliance.

3.2.5 Composting. Composting is an engineered process to promote the biochemical decaying of organic material. The product, compost, may be used as a soil conditioner or fuel. As a soil conditioner, compost provides improved workability, increased water retention, and resistance to erosion. In considering the composting process, market availability and reliability are critical to the cost appraisal. Separate collection, segregation, or sorting of garbage from other refuse and increased capital and operating costs may be substantial when compared with the same value of the product. Compost is useful for agricultural purposes and may be used as a cover material on slopes or at a sanitary landfill because of its resistance to erosion. Composting may also prove practical when agricultural tenants (with leases per 10 USC 267) are able to use the material for soil conditioning. In some processes, cured compost may serve as a feedstock for other products, including wallboard, fertilizer, and fuel. As a fuel, the energy yield is poor when compared with alternative fuel sources.

3.2.6 Pyrolysis. Another method of volume reduction is pyrolysis. This system is to a pressure cooker in using heat and pressure to convert refuse to oil and sludge. This system was effective in treating sewage sludge at a military installation but was neither cost effective nor easy for the user to maintain.

3.2.7 Materials Recover . Materials may be recovered for recycling or reuse through one 0 a vane y of techniques discussed in Section 4.3. Reusable or recyclable materials are separated at the source, whenever possible, to reduce the overall cost. Materials commonly processed this way include high-grade paper, newspaper, corrugated cardboard, glass, batteries, waste oil, and aluminum cans and other metals. Also, methane gas can be captured from properly designed collection systems for use during landfill operations.

3.2.8 Miscellaneous Disposal Methods. Alternatives for disposal may be available for special applications.

3.2.8.1 *Hog Feeding.* This method requires separate handling, transportation, and processing of select types of garbage. To serve as the sole supply for a minimum efficient size farm requires an installation with a complement of about 10,000 personnel. Processing is regulated at the local, state, and federal level. Where markets exist, revenues from the sale of this output may be advantageous. The DRMO will supervise the sale in accordance with Defense Disposal Manual (DoD 4160.21-M).

3.2.8.2 *Garbage Grinding.* This is usually an individual disposal method of grinding select garbage and disposing of it through the sewer network and wastewater treatment process. Garbage grinding is usually not an acceptable alternative on a large scale. The capacity of the sewage disposal facility and cost of grinder installation shall be considered in comparison to the savings realized in the remaining disposal process.

3.2.8.3 *Open Burning.* Open burning is generally prohibited except for the infrequent burning of agricultural wastes in the field, silvicultural treatment for forest management purposes, land clearing debris, construction debris, diseased trees, debris from emergency cleanup operations, and ordnance.

3.2.8.4 Open burning of ordnance requires a RCRA Permit (40 CFR 264, Subpart X). The open burning and detonation of waste explosives is described in 40 CFR 265.382. Waste explosives include waste that has the potential to detonate and bulk military propellants that cannot safely be disposed of through other modes of treatment. Detonation is a violent chemical reaction within a chemical compound, or a mechanical mixture involving heat and pressure which proceeds through the reacted material at a supersonic velocity, exerting extremely high pressure on the surrounding medium, and forming a propagating shock wave originally of supersonic velocity. Open burning is the combustion reaction of any material without control of combustion air, containment of combustion reaction in air enclosed device, and/or control of gaseous combustion product emissions. Owners or operators choosing to open burn or detonate waste explosives must do so in accordance with the following table and in a manner that does not threaten human health or the environment. All explosives to be disposed of by detonation or open burning should be turned over to Explosive Ordnance Disposal (EOD) office. The individual should never attempt to detonate or open burn explosives without first contacting EOD.

Pounds of waste explosives or propellants	Minimum distance from open burning or detonation to the property of others, m (ft)
O to 100	204 (670)
101 to 1,000	380 (1,250)
1,001 to 10,000	530 (1,730)
10,001 to 30,000	690 (2,260)

3.2.8.5 Disposal of explosives or explosives-contaminated wastes is the responsibility of EOD. Disposal of explosives by detonation or open burning should take place on a range or impact area that has an approved Environmental Assessment for detonation. Many installations are not allowed to open burn waste explosives and must use an incinerator designed for explosives or explosives-contaminated wastes. If no such incinerator exists on an installation, these types of wastes must be shipped to an installation having one. In either case, no waste explosives should be burned without first contacting the installation EOD office. Reference should also be made to any command's standard operating procedure on explosives incineration.

3.2.9 Environmental Health and Safety Requirements

Decisions concerning disposal methods must consider the health and safety of installation personnel and the local population. Factors to be considered before selecting the disposal method include:

- pollution of groundwaters, surface waters, and potable water supply
- air quality
- dust control and respiratory health hazards
- noise control
- litter control and aesthetic nuisance avoidance
- traffic safety both on and off site
- fire safety
- ingress control
- vector and bird control
- gas generation and migration (sanitary landfill).

3.2.10 Cost Considerations

Items to be considered in comparing costs among the various disposal methods shall include:

Operating costs

- materials and supplies
- labor costs including fringe and additional benefits
- equipment rental
- cost of utilities: electricity, water, telephone, and others
- maintenance and repair of equipment and facilities
- permit and closure costs.

Capital costs

- facilities, land, and land improvements such as roads, aprons, and fences
- equipment
- investment costs and cost of capital.

Overhead

- supervision, where this varies among disposal methods
- installation support.

3.3 PLAN DEVELOPMENT

3.3.1 Plan development consists of evaluating the technical/legal/social economic alternatives identified through the evaluation process and tying them to a new budget plan. Major modifications to existing facilities or construction of new ones require line item listing in military budgets. Such expenditures do not come out of normal base operating funds. Third-party financing is another option for acquiring solids handling equipment or setting up resource recovery facilities.

3.3.2 Requests for new equipment such as trucks, have to compete with vehicle requests for other base activities. Replacement of completely worn out equipment is more normal than replacing just to keep with state-of-the-art practices.

3.3.3 Any request for funds must be accompanied by a cost-effectiveness analysis.

3.3.4 Planning Steps

3.3.4.1 In most cases, the engineer and the decision maker do not have an opportunity to study the entire solid waste management system and develop a total knowledge of the base under all conditions. Time and economic constraints often lead to decisions based on little or no information. In order for engineers and decision makers to be able to respond to these situations and to ensure that the best use is made of time and available funds in the resolution of solid waste management problems, the following step-by-step planning procedure is recommended.

3.3.4.2 *Step 1: Problem Definition and Specification.* The first and most critical step in any planning study is to obtain a clear problem statement and corresponding specifications from the persons responsible for making decisions about solid waste management. Problem statements and specifications usually are derived from the concerns of the public or regulatory agencies. Difficulties often arise because solid waste Systems are not well understood at all levels of decision making. Consequently, the engineer may have to redefine a problem that was originally specified at a higher level.

3.3.4.3 *Step 2: Inventory and Data Accumulation.* An inventory is made of all pertinent factors about the installation, and data are collected as needed to meet the problem specifications. The main purpose of the inventory is to define the existing solid waste system(s) as completely as needed and as accurately as possible and to collect certain other basic information (such as population data)--a task that requires a considerable amount of judgment. It is an important step in planning because all subsequent recommendations for action will be based on the findings of this step. Therefore, it is essential that at this level of planning all the functional elements of the solid waste management system be considered.

3.3.4.4 *Step 3: Evaluation and Alternative Development.* This step involves the detailed evaluation and analysis of the data accumulated in Step 2. During this step the programs of the plan begin to be formed. In some cases, it may be necessary to collect additional data and information. Reliability and maintainability must be considered when evaluating alternatives. However, before the programs are formed, it is important to review the original problem statement and specifications. Often some revisions are needed in light of the data gathered during the inventory.

3.3.4.5 Since a problem can have more than one solution, it is beneficial for decision-making purposes to develop alternatives composed of one or more programs. When practical, these alternatives shall be documented for presentation in the plan.

3.3.4.6 In developing alternatives, it is especially important that all functional elements be coordinated to ensure system continuity--from onsite storage through processing and final disposal. By evaluating the coordinated programs, the planner is able to recommend viable alternatives.

3.3.4.7 *Step 4: Program and Plan Selection.* A limited number of alternatives are selected by the engineer for inclusion in the plan. The alternatives are reviewed by the engineer, the chief engineer, and the base commander, when appropriate. The logic of alternatives is reviewed and programs are changed as necessary to include review comments. The administrative control of all programs is identified and evaluated during this step. This is important because solid waste management will not function properly without responsive control. Hence, the engineer must develop a thorough knowledge of the social and jurisdictional structure of the base.

3.3.4.8 The final action in this step is the selection of a preferred set of activities to form the plan. The programs can be selected from a single alternative, or they can be selected from various alternatives. The final selection will be made by the base commander and/or designees.

3.3.4.9 *Step 5: Development of Implementation Schedule(s).* When planning failures have occurred, the lack of a well-defined implementation schedule acceptable to administrative and management organizations is often the principal contributing factor. The degree of documentation in any implementation schedule depends on the type of programs developed in the plan. If possible, the degree of documentation that will be required for implementation shall be set by the engineer and decision maker during the problem-specification stage (Step 1) of the plan development. Most military solid waste management plans will be local in nature and require rather simple implementation schedules such as step-by-step sequences for a chosen program.

3.4 PLAN SELECTION AND IMPLEMENTATION

3.4.1 Once a complete waste management plan including a line item budget has been selected, organization structures must be put in place. Then schedules and milestones must be set. Planned reviews and updates shall be included in the schedule. Again, the requirements of RCRA Subtitle D must be carefully reviewed.

3.4.2 Figure 3-4A shows an implementation schedule for a management plan that involves the functional elements of storage, collection, transfer/transport, and disposal. In essence it covers starting from scratch at a new military installation. Less complicated activities can, however, be isolated on the chart so reasonable schedules could be proposed for them.

3.4.3 Implementation steps can be discussed only briefly. There are no "standard practices" in solid waste management to cover the wide variety of options that can arise.

3.4.4 Developing Alternatives. Waste management programs are presented to decision makers in the form of alternatives so that the decision makers can make their own judgments on the probable success of each one. The most important requirement for an alternative is that it be quantifiable with

respect to equipment, disposal sites, economics, etc. An alternative can be as simple as specifying the details of one-person versus two-person collection crews, or it may be as complex as specifying landfill disposal of all wastes versus processing wastes at multiple stations and selling recovered materials to numerous dispersed markets. Every alternative must satisfy the requirement of measurability. Documentation for each alternative, regardless of complexity, must encompass the following: (1) performance, (2) economic analysis, (3) impact assessment, and (4) administration and management and an implementation schedule.

3.4.4.1 *Performance.* Performance means getting the job done. The work force and equipment required to provide the level of service desired by the installation must be specified. The details of performance will vary with individual installations, but Significant details that must be identified include (1) level of service, (2) equipment reliability and flexibility, (3) equipment and work force expandability, and (4) program compatibility with other environmental programs (air and water) and with future changes in solid waste technology.

3.4.4.2 With these details established, it is possible to contrast performance functions of a recommended program with performance functions of alternatives without additional planning studies. This is an important part in achieving plan implementation.

3.4.4.3 *Economic Analysis.* Once the details of performance have been identified, it is important to analyze the economic impacts of each alternative. The analysis must include estimates of capital cost as well as of operating costs. The cost of an alternative normally will be expressed as an annual cost. When divided by the annual quantity of wastes handled, the cost can also be expressed as a unit cost. Unit costs, such as dollars per ton, are often used to compare the cost effectiveness of alternatives.

3.4.4.4 When cost estimates are completed, financing methods can be identified. Some alternatives will require line item appropriations, whereas others may be financed from a general operating fund.

3.4.4.5 *Impact Assessment.* The programs of a waste management plan will have an impact on an installation through changes to the natural environment and through involvement of the base personnel. Any activities that significantly affect the environment (e.g., landfill and incineration) require an Environmental Assessment. Although environmental assessments do not need to be approved by EPA, state, or local regulatory agencies, it is prudent that federal agencies solicit comments from EPA, state, and local agencies prior to finalizing these documents. If an Environmental Impact Statement (EIS) is required, then formalized procedures for EPA approval must be followed.

3.4.4.6 Activities that require voluntary support of base personnel (e.g., recycling) must anticipate human reactions to such requests. Few hard and fast rules apply. A useful generalization is to keep all requests for voluntary participation simple and painless and simultaneously emphasize the benefits to participants.

3.4.4.7 *Administration and Management.* The administrative functions and organizations for implementation must also be identified for each

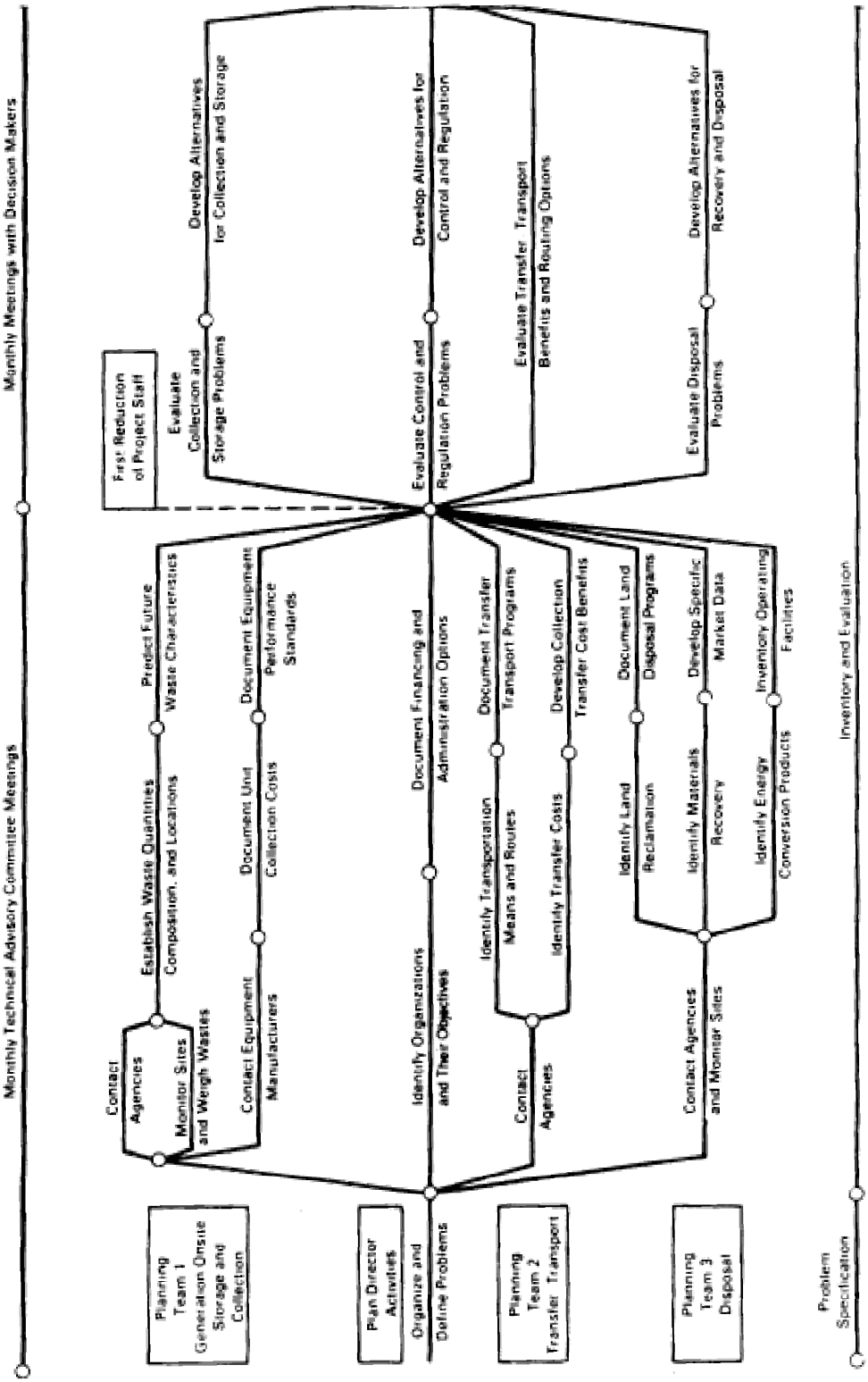


FIGURE 3-4A. Plan Implementation Schedule

Note The management plan covers a region and involves the functional elements of storage, collection, transfer transport, and disposal

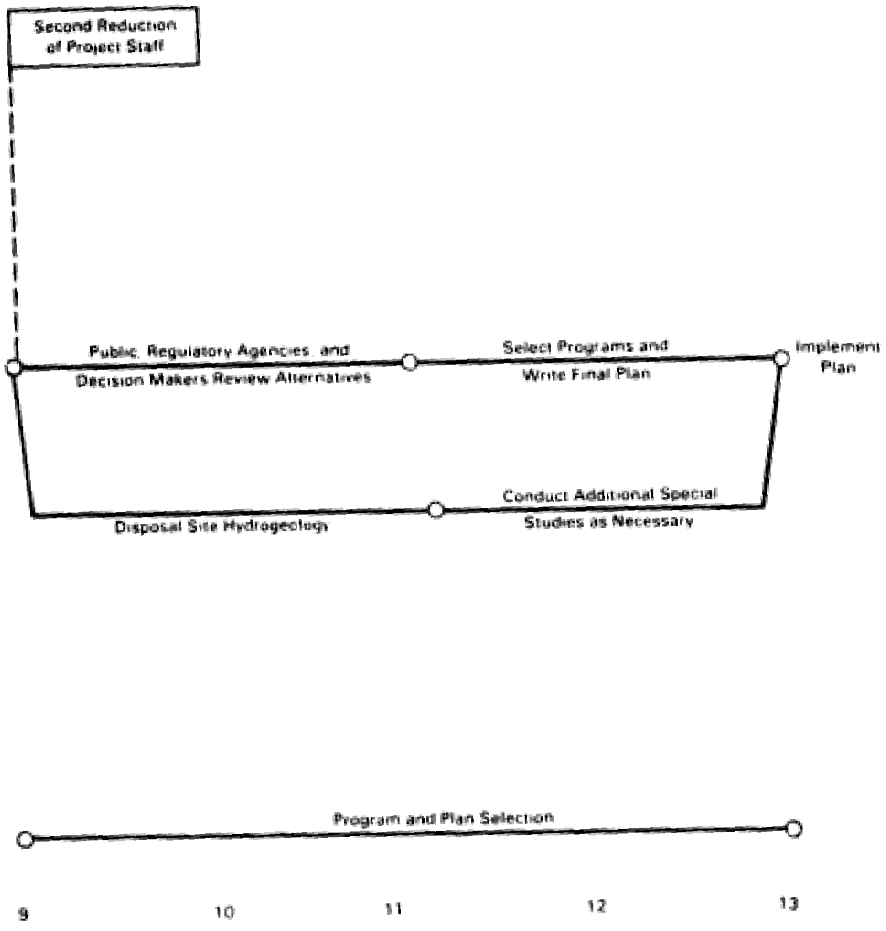


FIGURE 3-4A. Plan Implementation Schedule (cont'd)

alternative. It is most practical for the engineer to develop details of administration only for the short-term planning period (7 years into the future). Detailed administrative planning for the long term is meaningless because changes can occur so rapidly in the solid waste management field. Managers responsible for operations during the short term will usually establish organizational policies and functions for the long term.

CHAPTER 4. ENGINEERING AND OPERATIONAL ISSUES

Engineering and operational issues include the mechanics of obtaining data, analyzing the data, and deciding on a plan of action to solve a particular solid waste handling problem. This chapter addresses the following issues:

- solid waste generation
- technologies for
  - handling and storage of waste
  - collection of wastes
  - transfer and transport of waste
  - landfill design and operation
  - processing techniques and equipment
- resource recovery and recycling
- wastes requiring special handling
- hazardous wastes that may enter normally nonhazardous waste streams.

4.1 GENERATION OF SOLID WASTES

4.1.1 The Resource Conservation and Recovery Act defines solid wastes as:

> "Any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point-sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 Stat. 880), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923)."

4.1.2 The types and quantities of solid wastes generated will vary geographically and seasonally. Military installations often have unique activities that generate wastes not found in ordinary municipal wastes. Furthermore, populations at military installations do not follow a normal growth pattern because the growth is controlled by mission requirements. Consequently, determining accurate annual waste generation rates would require a survey at the installation in question.

4.1.3 A knowledge of the quantities and characteristics of solid wastes to be disposed of is important since these factors affect:

1. method and frequency of pickup

2. viability of transfer stations

3. method of disposal to be selected (e.g., incineration, landfilling, etc.)

4. size and/or throughput capacity of the disposal facility required

5. environmental impacts at the disposal location (e.g., types of potential air or water pollutants)

6. viability of Resource Recovery and Recycling Programs (RRRP)

7. potential for waste reduction/minimization.

4.1.4 Solid waste types and quantities generated for a military installation can best be determined by means of a field survey. If resources are unavailable to conduct such a survey, estimates can be made based on existing solid waste generation data for other similar installations.

4.1.5 Solid Waste Types. The types of solid waste that can be expected to be generate at various naval installation sources are presented in Table 4-lA. Although the information is dated, it illustrates the variability in waste composition that can be expected depending on the primary function of an installation. Solid waste composition and quantities that can be expected from various sources are presented in Tables 4-lB and 4-1C.

4.1.5.1 Figure 4-lA compares one Navy survey with a State of Washington survey. The difference in composition is significant. Figure 4-lB breaks down the Washington data by classification of generator as either (1) residential, (2) manufacturing, or (3) commercial/institutional. Again, significant differences are apparent.

4.1.5.2 The figures presented are not meant to be used as design figures for any particular installation. The important point of the information is that both composition and quantity of solid waste will vary significantly depending on the location and the function of the military installation. From an historical standpoint two trends were noticed: (1) total generation rates increased over time and (2) the composition is moving toward more plastics in all streams.

4.1.6 Waste Quantities. Table 4-18 shows reported average per capita solid waste generation rates for military installations as a whole. The table also compares military versus civilian generation rates.

4.1.6.1 The variability of the data in Tables 4-lB and 1C infers that accurate numbers can be determined only by conducting several surveys at the site in question. A quick method would be to check delivery records at the final disposal site. More accurate methods are discussed in Appendix F.

4.1.6.2 For military installations in general, waste generators can be conveniently categorized into 11 groups.

TABLE 4-1A
Average Composition of Solid Waste from Various Navy Installation Sources(1)

Solid Waste Component	Transmission Building/ Laundry Facilities	Exchanges & Commissaries	Ordnance Manufacture and Assembly	Offices, Training Rooms, Dispensaries, and Quarters	Food Service (Cafeteria, Mess, Galley, Canteen, Club)	Shops, Berthing Piers, and Wharves	Storehouses & Warehouses	Ways-Drydocks, Marine Railway, Motor Pool
Paper	84	84	74	72	67	66	64	47
Garbage	<1	<1	<1	<1	5	<1	<1	<1
Metal	3	2	<1	5	5	7	3	8
Textiles	<1	<1	<1	<1	<1	5	<1	4
Plastic	7	9	4	12	14	<1	11	7
Leather	NO	NO	<1	NO	NO	<1	NO	NO
Rubber	<1	NO	<1	<1	NO	<1	NO	2
Vegetation	3	<1	<1	3	<1	<1	<1	NO
Inerts	2	<1	<1	<1	<1	1	1	2
Wood	NO	4	6	2	3	5	15	29
Glass, Ceramics	NO	<1	NO	<1	4	<1	<1	<1
Miscellaneous(2)	NO	<1	11	2	<1	5	2	<1
Total	100	100	100	100	100	100	100	100

(1) Visually determined; values are percent by volume.
(2) Miscellaneous included fluorescent bulbs, fibrous barrels, and carpet trimmings.
(NO - None observed)

TABLE 4-1B
Average Daily Waste Generation Rates from Military and Municipal Sources

	Year	Total Waste Generation, lbs per capita/day	Ref
Military			
Air Force Survey	1971	3.94	1
NCEL Survey	1972	5.81	1
Navy Solid Waste Management Manual	1978	3.3	1
Navy, Guam	1984	5.33	2
Army, Ft. Lewis	1988	3.67	3
Municipal			
EPA National avg.	1975	3.2	4
Charlotte, NC	1977	6.7	4
Omaha, NE	1978	3.3	4
Phoenix, AZ	1978	6.3	4
San Diego Co., CA	1980	5.8	4
King Co., (Seattle, WA)	1982	5.5	4
EPA National avg.	1986	3.6	5
EPA National avg.	1987	3.6	6
Washington State	1987	6.43	7
Puget Sound (WA)	1987	6.48	7
Delaware State	1988	3.29	8

References

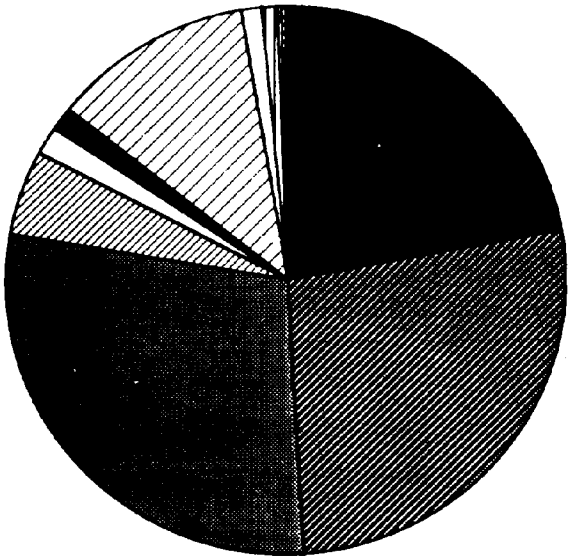
1 SCS Engineers (1984)
2 Roberts (1984)
3 Dave Hanke (Ft. Lewis) Personal Communication (1989)
4 Robinson (1986)
5 Wallgren (1987)
6 Thayer (1989)
7 Matrix Management Group (1988)
8 Vasuki and Canzano (1988)

TABLE 4-1C
Typical Physical Compositions of Some Solid Waste Streams
(All in % by Weight)

	1975 USA Typical City	1971-1975 Davis, CA	1987 Wash. State Residential	Wash. State Commercial/ Institutional	1987 Wash. State Manufacturing	1987 Wash State Total Wastes	1988 Delaware Total Wastes	1984 Navy Charleston	1981 Navy Jacksonville	1987 Tucson, Arizona
Food Wastes	15	9.5	10.9	11.7	2.6	8.8	8.3	22.0	13.5	1.7
Paper	40	43.1	25.7	25.1	23	20.8	20	26.9	47.9	11.1
Cardboard	4	6.5	4.8	16.7	11.6	7.6	25	28.6		18.6
Plastics	3	1.8	8	9.4	12.3	7.4	9	4.9	11.1	7.3
Textiles	2	0.2	3.1	3.5	1.5	3.6		1.8		
Rubber	0.5	0.8	0.8	4.2	1.2	1.7	1.3	1.4		
Leather	0.5	0.7	0.2	0	0.2	0.1			3	
Garden Trim.	12	14.3	22.3	2.9	0.8	18	17.3			17.1
Wood	2	3.5	1.2	7.4	11.6	7.1		11.6	0.8	4.1
Glass	8	7.5	7.2	4.5	3.1	5.2	0.8	1.2	9.4	7.9
Tin Cans	6	5.2	2.5	0.9	0.2	1.5				
Nonferrous Metals	1	1.5	2	4.7	1.2	3.5	1.5	0.6		5.3
Ferrous Metals	2	4.3	0.6	7.2	3.7	3.5	6	0.9	6	
Dirt, Ashes, Brick	4	1.1	7.6	3.4	27.3	9.8	10.8	0.3	0.5	8
Disposable Diapers			3.2	0		1.5				3.6
Reference	1	1	2	2	2	2	3	4	5	6

1 Tchobanoglous, Theisen, and Eliassen (1977)
2 Matrix Management Group (1988)
3 Vasuki and Canzano (1988)
4 Bond, Bingham, and Roberts (1987)
5 Zimmerle (1984)
6 Time (1988)

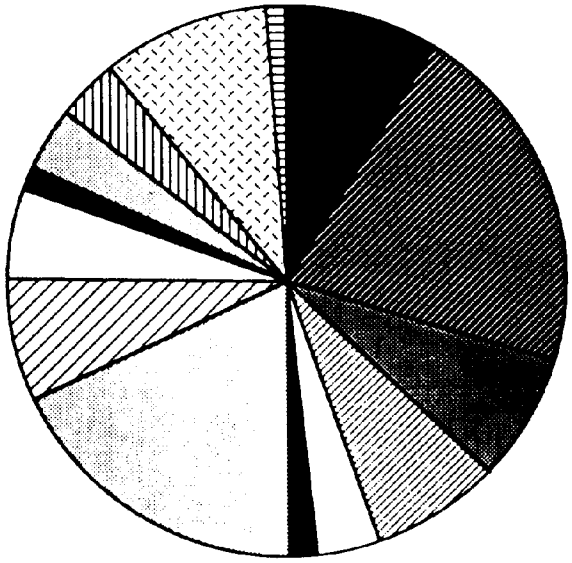
Navy Survey 1984



- Food Wastes
- Paper
- Cardboard
- Plastics
- Textiles
- Rubber
- Leather #
- Garden Trim. #
- Wood
- Glass
- Tin Cans #
- Nonferrous metals #
- Ferrous Metals
- Dirt, Ashes, Brick
- Disposable Diapers #

*Includes garden trimmings
Segments not shown
(unknown or <1%)

Total Wastes
State of Washington 1987



- Food Wastes
- Paper
- Cardboard
- Plastics
- Textiles
- Rubber
- Leather
- Garden Trim.
- Wood
- Glass
- Tin Cans
- Nonferrous metals
- Ferrous Metals
- Dirt, Ashes, Brick
- Disposable Diapers

FIGURE 4-1A
Comparison of Naval Data with State of Washington Data
on Solid Waste Composition

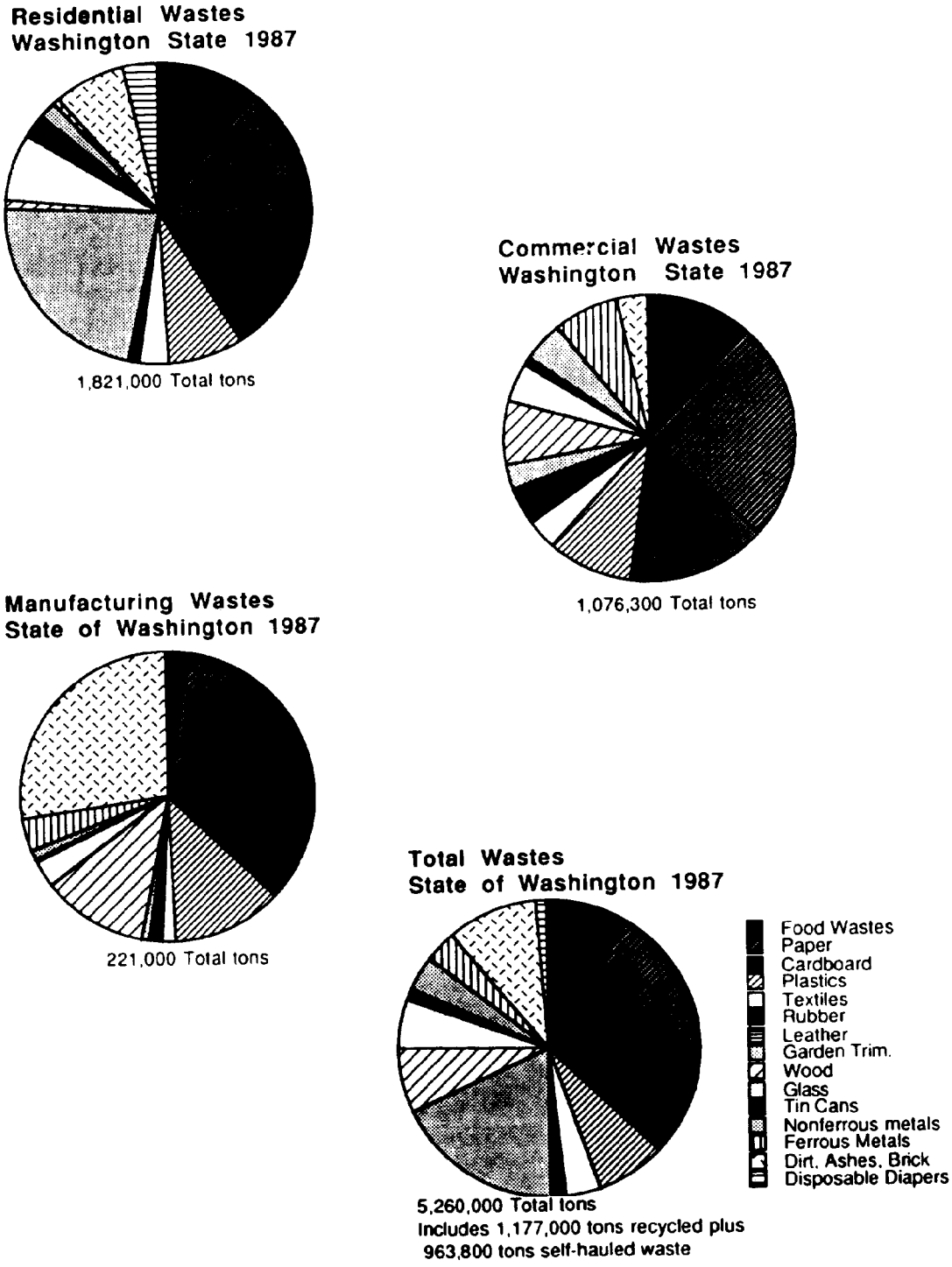


FIGURE 4-1B
Breakdown of State of Washington Data by Category of Generator

1. Residential

   Most residential waste is garbage (food wastes). Next follows paper. then glass, metal, and miscellaneous.

2. Commissaries and Exchanges

   The bulk of the wastes at commissaries and exchanges is clean, high-quality corrugated containers and is excellent material for resale or recycling.

3. Clubs and Messing

   Wastes from clubs and mess halls consist of paper, plastic wrap, cans, bottles, and food preparation trimmings exclusive of bones and fat. Wet garbage is generally disposed of in the installation sanitary sewer system through garbage grinders, while grease, bones, and fat are collected separately and sold.

4. Administrative Offices and Classrooms

   Solid wastes from offices and classrooms consist mainly of paper.

5. Industrial Wastes

   These wastes are generated during overhaul of ships, aircraft, and other vehicles. The wastes are highly variable in quantity and nature. Much of the material is metal and can be treated as recyclable scrap.

6. Construction/Landscaping Wastes

   Lumber, broken concrete, and other building materials are frequently taken to special landfill areas reserved for that type of waste. The “Reserved” area can be adjacent to a regular landfill. The separation results because construction debris often requires different controls and different covers.

7. Motor Pool Wastes

   This category includes automotive, vehicular, and aviation ground-support equipment repair and maintenance activities. The solid wastes generated from these facilities consist primarily of paper and cardboard, along with some quantities of nonreusable wooden crating and packaging materials. Oils and greases generated in these facilities are handled separately, while metals and broken parts are generally segregated from the solid waste stream and disposed of as scrap. Used tires and batteries are also common waste materials.

8. Medical Wastes

   The principal wastes from hospitals and dispensaries include garbage, paper, and trash; surgical, laboratory, and autopsy wastes; outdated

medicine, and noncombustibles such as cans and bottles. Some of these wastes present physical, toxicological, or pathological hazards. Appropriate guidelines for handling these materials are provided in Section 4.4.

9. Military Activity Wastes

Wastes generated during maneuvers include wastes similar to mess facilities plus other wastes such as spent ammunition. Ammunition shells are frequently recycled and reused. Other wastes created on maneuvers are seldom collected.

10. Foreign Garbage

Ships coming into port will have stored aboard the trash generated while the ship was at sea.

Most of the waste is unusable garbage followed by paper, metal, glass, and other. Aircraft and ships returning from foreign ports must have all solid waste off-loaded and incinerated or sterilized prior to disposal.

11. Litter

Roadway barrow pits, beaches, and recreation areas are frequent repositories for litter. Most is metal cans or loose paper. Laws do exist against littering but strict enforcement is not yet practical.

Wastes from all these sources have some recyclable components. Economics presently dictates which materials are recycled.

4.2 TYPES OF TECHNOLOGIES

4.2.1 This section discusses various options for the handling of solid wastes. Topics start from solid waste storage at generation sites and end with ultimate disposal. Recycling issues are presented in detail.

4.2.2 Several methods of waste reduction and disposal are available to military installations. Each provides varying degrees of productivity to the overall refuse collection and disposal process; and their relative merits should be assessed based on local conditions and local, state, and federal policies with respect to solid waste management. The method or combination of methods chosen must prevent nuisance and health hazards by controlling certain agents and conditions, rodents, odors, air pollution, surface water and groundwater pollution, and spread of pathogens and hazardous gases. Selecting the appropriate disposal method should be based on least cost where such studies are conclusive while in accordance with local, state, and federal requirements.

4.2.3 Handling and Storage at Generation Site

4.2.3.1 Storage requirements for solid wastes are spelled out in the Federal Regulation 40 CFR 243. Excerpts follow:

(a) All solid wastes (or materials which have been separated for the purpose of recycling) shall be stored in such a manner that they do not constitute a fire, health, or safety hazard or provide food or harborage for vectors, and shall be contained or bundled so as not to result in spillage. All solid waste containing food wastes shall be securely stored in covered or closed containers which are nonabsorbent, leakproof, durable, easily cleanable (if reusable), and designed for safe handling. Containers shall be of an adequate size and in sufficient numbers to contain all food wastes, rubbish, and ashes that a residence or other establishment generates in the period of time between collections. Containers shall be maintained in a clean condition so that they do not constitute a nuisance, and to retard the harborage, feeding, and breeding of vectors. When serviced, storage containers shall be emptied completely of all solid waste.

(b) Storage of bulky wastes shall include, but is not limited to, removing all doors from large household appliances and covering the item(s) to reduce the problems of an attractive nuisance, and the accumulation of solid waste and water in and around the bulky items.

(c) Reusable waste containers which are emptied manually shall not exceed 75 pounds (34.05 kg) when filled, and shall be capable of being serviced without the collector coming into physical contact with the solid waste.

4.2.3.2 Data on types and sizes of containers used in various applications are given in Tables 4-2-3A and B (Tchobanoglous, Theisen, and Eliassen 1977). Table 4-2-3B provides information so the proper container can be selected for a particular location. Figure 4-2-3A shows several medium capacity solid waste containers.

4.2.3.3 The requirement for waste containers will reflect the characteristics of the source including the rate of waste generation, density of population, and ease of access to both the generating installation and collection system. Proper selection of containers will increase productivity and should provide reasonable benefits to both the discarding unit and to the collection installations.

4.2.3.4 *Location of Containers.* Traditionally, containers at military installations have been located in one of two places: curb or alley, or central collection locations. The use of other locations must be supported by an economic or environmental analysis. Central location collection provides greater productivity in the collection process; however, greater costs for equipment are inherent. Aesthetics is an important consideration in selecting a site location for any container(s).

4.2.3.5 *Receptacle Stands.* Suitable stands for refuse receptacles at pickup stations are essential for efficient and economical collection operations. Discarding units segregate refuse and police the pickup station.

TABLE 4-2-3A
Data on the Types and Sizes of Containers Used
for the Onsite Storage of Solid Wastes

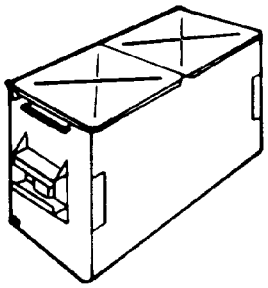
Type	Capacity Unit	Capacity Range	Capacity Typical	Dimensions(1) Unit	Dimensions(1) Typical
Small:					
Container, plastic or galvanized metal or wheeled	gal	20-80	30	in.	20D x 26H (30 gal)
Barrel, plastic, aluminum, or fiber	gal	20-65	30	in.	20D x 26H (30 gal)
Disposable paper bags					
Standard	gal	20-55	30	in.	15W x 12d x 43H (30 gal)
Leak resistant	gal	20-55	30	in.	as above
Leakproof	gal	20-55	30	in.	as above
Disposable plastic bag				in.	18W x 15d x 65H (10 ft^3)
Medium:					
Container	yd^3	1-10	4	in.	72W x 42d x 65H (4 yd^3)
Large:					
Container					
Open top, roll off (also called debris boxes)	yd^3	12-50	--(2)	ft	8W x 6H x 20L (35 yd^3)
Used with stationary compactor	yd^3	20-40	--(2)	ft	8W x 6H x 18L (30 yd^3)
Equipped with self-contained compaction mechanism	yd^3	20-40	--(2)	ft	8W x 8H x 22L (30 yd^3)
Container, trailer-mounted					
Open top	yd^3	20-50	--(2)	ft	8W x 12H x 20L (35 yd^3)
Enclosed, equipped with self-contained compaction mechanism	yd^3	20-40	--(2)	ft	8W x 12H x 241 (35 yd^3)

(1) D = diameter, H = height, W = width, d = depth
(2) Size varies with waste characteristics and local site conditions.

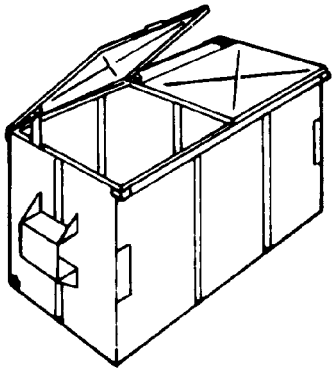
Note: gal x 0.003785 = m^3
in. x 2.54 = cm
yd^3 x 0.7646 = m^3
ft x 0.3048 = m

TABLE 4-2-3B
Typical Applications and Limitations of Containers
Used for the Onsite Storage of Solid Wastes

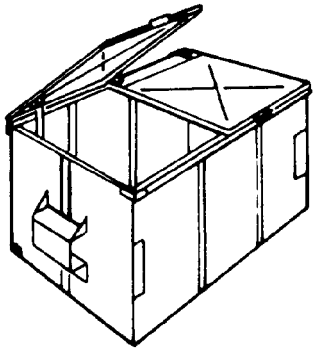
Container	Typical Applications	Limitations
Small:		
Container, plastic or metal or wheeled	Very low volume sources, such as individual residences, walkways in recreation areas, and small isolated commer—cial establishments; residential areas with setout collection service; wheeled containers are efficient for family housing.	Containers are damaged over time and degraded in appear-ance and capacity; containers add extra weight that must be lifted during collection operations; containers are not large enough to hold bulky wastes.
Disposable paper bags	Individual residences with packout collection service, can be used alone or as a liner inside a household con-tamer; low- and medium-rise residential areas	Bag storage is more costly; if bags are set out on streets or curbside, dogs or other animals tear them and spread their contents; paper bags themselves add to the waste load.
Disposable plastic	Individual residences with setout collection service; can be used alone or as a liner inside household container. Bags are useful in holding wet garbage inside household containers as well as in commercial containers (residential areas; commercial areas; and industrial areas)	Bag storage is more costly; bags tear easily, causing litter and unsightly conditions; bags become brittle in very cold weather, causing breakage; plastic lightness and durability causes later disposal problems.
Medium:		
Container	Medium-volume waste sources that might also have bulky wastes; location shall be selected for direct—collection access (barracks; offices; light industrial areas)	Snow inside the containers forms ice and lowers capacity while increasing weight; containers are difficult to get truck to after heavy snows.
Large:		
Container, open top or lightweight plastic top	High—volume office areas; bulky wastes in industrial areas; location of open top containers shall be within a covered area but with direct-collection truck access	Initial cost is high; snow inside containers lowers capacity. Lightweight plastic not as durable as metal lids.



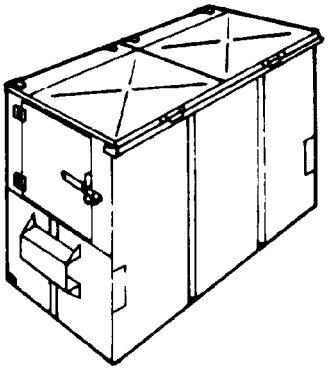
(2 Cubic Yards)



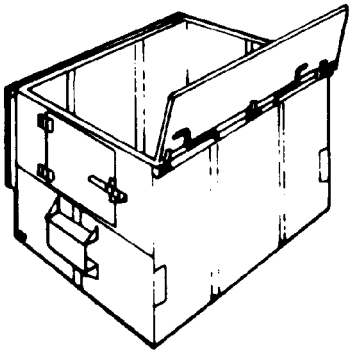
(3 Cubic Yards)



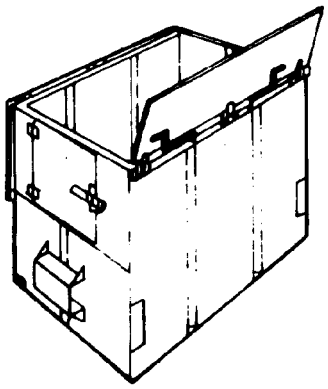
Top Loading
(4 Cubic Yards)



Top and End Loading
(4 Cubic Yards)



Low Top and End Loading
(6 Cubic Yards)



High Top and End Loading
(6 Cubic Yards)

FIGURE 4-2-3A
Medium-Capacity Refuse Containers

Adequate receptacle stands are an aid to good housekeeping. Scheduled spraying for control of insects and rodent-control measures must be established as required by prevailing weather conditions. The following guidelines apply to receptacle stands.

- Locate receptacle stands at established pickup stations only.
- Stands for garbage cans are constructed in conjunction with a can-washing facility at mess halls, service clubs, and exchanges. Because of the low-loading height of most compactor trucks, do not place these stands on porches or loading docks.
- Because of the height of multiple containers, they are more easily loaded when placed adjacent to a loading dock or platform and loaded through their top doors. Whenever possible, locate the receptacle stand for this kind of container in such a position.
- Build stands large enough to accommodate enough receptacles to meet installation requirements for segregation of materials.
- Concrete stands are easily cleaned and seldom require maintenance. Wood stands are not satisfactory at mess halls or other locations where food is dispensed. Existing wooden stands will be replaced with concrete stands whenever replacement or major repairs are required. On paved areas, construction of separate stands is not normally required. Do not enclose receptacle stands. Screened stands are difficult to keep clean and also create a fly-breeding environment. In some instances, a shelter over the can stand may be desirable to protect the cans and contents from becoming wet during rainy weather. Stands shall be at least 30 cm (12 in.) above grade. Stands or pads shall accommodate the wheel-bearing load of loading vehicles.

4.2.3.6 **Washing Facilities**

4.2.3.7 *Can Washing.* Wash all cans as often as necessary for sanitation. Garbage cans do not require sterilizing, but grease and food particles serve as a source of food for insects and rodents and must be removed to prevent a health hazard. Central can washing has generally proven to be an uneconomical operation both in manpower and trucks required to haul cans to and from the messing facility and the can-washing plant. Individual can-washing facilities are authorized for construction for mess halls, restaurants, service clubs, and exchanges. Can washing facility drain lines are connected to a sanitary sewer via a grit/grease trap.

4.2.3.8 Can-washing facilities at mess halls shall be conveniently located, in accordance with the following criteria: a concrete washing pad not less than 6 ft by 6 ft in size, surrounded by a low, raised curb to prevent overflow of wash water, and piped to the central drain having a grease trap and connected to the sanitary sewer. Hot water (not to exceed 140^{0}F) may be piped to the washing pad where the kitchen has sufficient heated water to meet all normal kitchen and can-washing needs. Suitable backflow and cross connection prevention shall be provided on all water lines.

4.2.3.9 *Multiple Container Washing.* Multiple containers cannot satisfactorily be cleaned by the use of personnel at mess halls and similar facilities. The multiple container cleaning facility shall be centrally located on the route between the disposal facility and the source of refuse materials. Locate the facility where water and sewerage are conveniently available. A high-pressure (1000-1200 psi) hot water source or steam cleaner can be provided with discharging the drainage directly to the sewer. For installations requiring them, this area is also a good location for a foreign garbage steam sterilization facility.

4.2.3.10 Provide a concrete slab with proper drainage and of adequate size for the intended service and number of vehicles that may use the washing facility at the same time. The wash water from the can-washing facility needs to be collected and treated as wastewater. Shelter for the washing facility is not required. Whether using hot or cold water, a booster pump to give high pressure will facilitate washing. Fittings to introduce liquid soap or detergent into the hose stream may be desirable. Since refuse containers are considered adequately cleaned when the food particles have been removed, they do not require sterilizing. Containers used for storage of putrescible materials shall be scheduled for regular cleaning, and other containers on an as-required basis.

4.2.3.11 The same washing facility may also be used at the end of the day for washing the collection vehicles.

4.2.3.12 *Portable Cleaner.* An option to the centralized cleaning facility is a portable high-pressure cleaning system. These units will minimize capital cost expenditures but might require more labor than the central cleaning location. Portable equipment that sanitizes dumpsters, washes heavy equipment, cleans latrines, and can be used to recover liquid spills is commercially available through several sources.

4.2.4 Collection of Solid Wastes

4.2.4.1 Collection equipment and associated costs can vary depending on whether the disposal fee is based on weight or volume. If the fee is based on $/ft^3$, then compaction equipment can frequently be justified. The specification of collection equipment shall be a cooperative effort among: (1) the base civil engineer, (2) the procurement office, (3) the contract office, and (4) the maintenance shop. The four parties will each have different but valuable facts on price and reliability of existing equipment. All inputs are needed to specify quality replacement items.

4.2.4.2 The primary federal guideline for solid waste collection is 40 CFR 243. It specifies the collection equipment requirements, design procedures, and operating procedures. Those items are excerpted below.

Collection Equipment Requirements

> All vehicles used for the collection and transportation of solid waste (or materials which have been separated for the purpose of recycling) which are considered to be operating in interstate or foreign commerce shall meet all applicable standards established by the

federal government including, but not limited to, Motor Carrier Safety Standards (40 CFR 390-396) and Noise Emission Standards for Motor Carriers Engaged in Interstate Commerce (40 CFR 202). Federally owned collection vehicles shall be operated in compliance with Federal Motor Vehicle Safety Standards (49 CFR 500-580).

All vehicles used for the collection and transportation of solid waste (or materials which have been separated for the purpose of recycling) shall be enclosed or adequate provisions shall be made for suitable cover, so that while in transit there can be no spillage.

The equipment used in the compaction, collection, and transportation of solid waste (or materials which have been separated for the purpose of recycling) shall be constructed, operated, and maintained in such a manner as to minimize health and safety hazards to solid waste management personnel and the public. This equipment shall be maintained in good condition and kept clean to prevent the propagation or attraction of vectors and the creation of nuisances.

Collection equipment of the following types used for the collection, storage, and transportation of solid waste (or materials which have been separated for the purpose of recycling) shall meet the standards established by the American National Standards Institute (ANSI Z245.1, Safety Standards for Refuse Collection Equipment) as of the effective date(s) established in ANSI Z245.1:

- rear-loading compaction equipment
- side-loading compaction equipment
- front-loading compaction equipment
- tilt-frame equipment
- hoist-type equipment
- satellite vehicles
- special collection compaction equipment
- stationary compaction equipment.

Whenever possible, enclosed, metal, leak-resistant compactor vehicles shall be used for the collection of solid wastes.

Safety devices, including, but not limited to the following shall be provided on all collection vehicles:

- exterior rear-view mirrors
- back-up lights
- four-way emergency flashers
- easily accessible first aid equipment
- easily accessible fire extinguisher
- audible reverse warning device.

If crew members ride outside the cab of the collection vehicle for short trips the vehicle shall be equipped with handholds and platforms big enough to safeguard against slipping.

Vehicle size shall take into consideration: local weight and height limits for all roads over which the vehicle will travel; turning radius; and loading height in the unloading position to insure overhead clearance in transfer stations, service buildings, incinerators, or other facilities.

Engines which conserve fuel and minimize pollution shall be used in collection vehicles to reduce fuel consumption and air pollution.

Recommended Operation Procedures

Collection vehicles shall be maintained and serviced according to manufacturers, recommendations, and receive periodic vehicle safety checks, including, but not limited to, inspection of brakes, windshield wipers, taillights, backup lights, audible reverse warning devices, tires, and hydraulic systems. Any irregularities shall be repaired before the vehicle is used. Vehicles shall also be cleaned thoroughly at least once a week.

No person shall work, walk or stand under elevated truck/containers.

Solid waste shall not be allowed to remain in collection vehicles over 24 h and shall only be left in a vehicle overnight when this practice does not constitute a fire, health, or safety hazard.

Solid wastes (or materials which have been separated for the purpose of recycling) shall be collected with frequency sufficient to inhibit the propagation or attraction of vectors and the creation of nuisances. Solid wastes which contain food wastes shall be collected at a minimum of once during each week. Bulky wastes shall be collected at a minimum of once every 3 months.

The minimum collection frequency consistent with public health and safety shall be adopted to minimize collection costs and fuel consumption. In establishing collection frequencies, generation rates, waste composition, and storage capacity shall be taken into consideration.

When solid wastes are separated at the point of storage into various categories for the purpose of resource recovery, a collection frequency shall be designated for each waste category.

The collection of solid wastes (or materials which have been separated for the purpose of recycling) shall be conducted in a safe, efficient manner, strictly obeying all applicable traffic and other laws. The collection vehicle operator shall be responsible for immediately cleaning up all spillage caused by his operations, for protecting private and public property from damage resulting from his operations, and for creating no undue disturbance of the peace and quiet in residential areas in and through which he operates.

Records shall be maintained detailing all costs (capital, operating, and maintenance) associated with the collection system. These records shall be used for scheduling maintenance and replacement, for budgeting, and for system evaluation and comparison.

The collection system shall be reviewed on a regular schedule to assure that environmentally adequate, economical, and efficient service is maintained.

Solid waste collection systems shall be operated in a manner designed to minimize fuel consumption, including but not limited to, the following procedures.

- Collection vehicle routes shall be designed to minimize driving distances and delays.
- Collection vehicles shall receive regular tuneups, tires shall be maintained at recommended pressures, and compaction equipment shall be serviced regularly to achieve the most efficient compaction.
- Compactor trucks shall be used to reduce the number of trips to the disposal site.
- When the distance or travel time from collection routes to disposal sites is great, transfer stations shall be used when cost effective.
- Residential solid waste containers which are serviced manually shall be placed at the curb or alley for collection.
- For commercial wastes which do not contain food wastes, storage capacity shall be increased in lieu of more frequent collection.

4.2.4.3 **Collection Equipment**

4.2.4.4 Solid waste collection and transportation to the disposal site accounts for 70% to 80% of the total cost of solid waste management

(Tchobanoglous, Theisen, and Eliassen 1977). To establish vehicle and labor requirements for various systems and methods, the unit time to perform each task must be determined. Details of critical definitions and calculation procedures are given by Tchobanoglous, Theisen, and Eliassen (1977). The analysis revolves around the concept of stationary container Systems (most common practice) versus hauled container systems. The conceptual differences become apparent after examination of Figure 4-2-4A. One example analysis showed that the hauled container system could save significant collection costs for round-trip haul distances less than 10 miles.

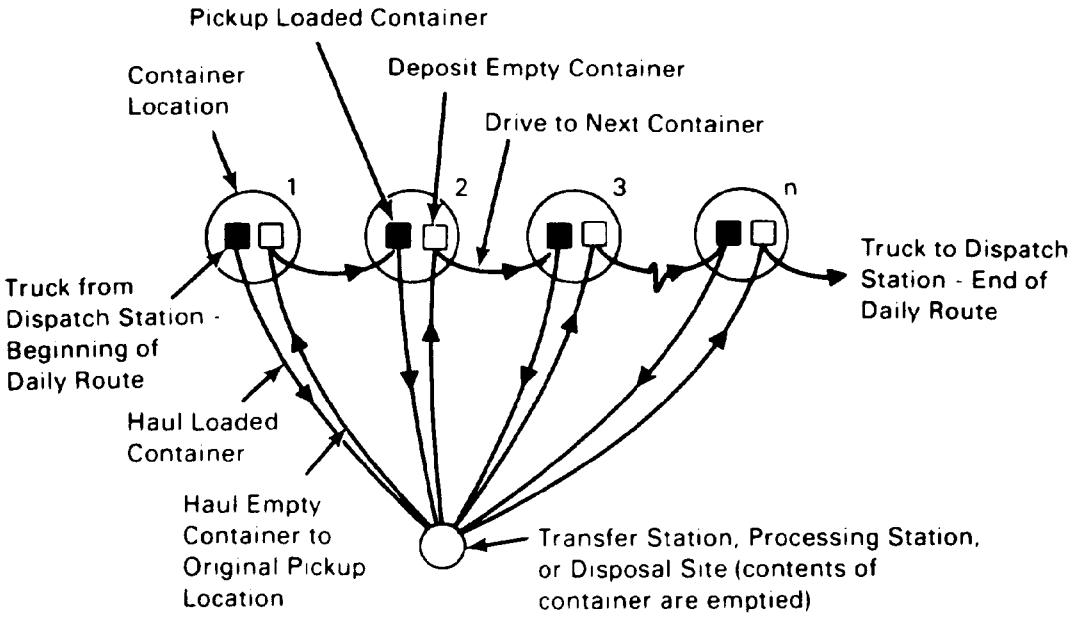
4.2.4.5 Table 4-2-4A gives size ranges for containers used in each scheme. Table 4-2-48 is a companion table and shows data on typical vehicles used in garbage collection. Figures 4-2-4B through 4-2-4G are sketches of some of the available garbage collection vehicles specified in Table 4-2-4B. The chain-lift type rear hoist truck (Figure 4-2-2G) is inefficient and is being phased out in the military. The fork-lift type, rear container hoist type truck is no longer being procured. For those remaining in service, replacement consists of ordering a cab and chassis to mount the lift mechanism on. Use of rear-loading compaction equipment depicted in Figures 4-2-2D and E is not recommended because the operation is expensive and labor-intensive. Instead, the automated side loader and container handling system in Figure 4.2.2F is recommended. Specifications for collection vehicles must be specific for the type of frame, transmission, engine, brake system, differential, and body and for specialty items such as rear-viewing TV, communications equipment, tires, and any special controls.

4.2.4.6 **Operating Records**

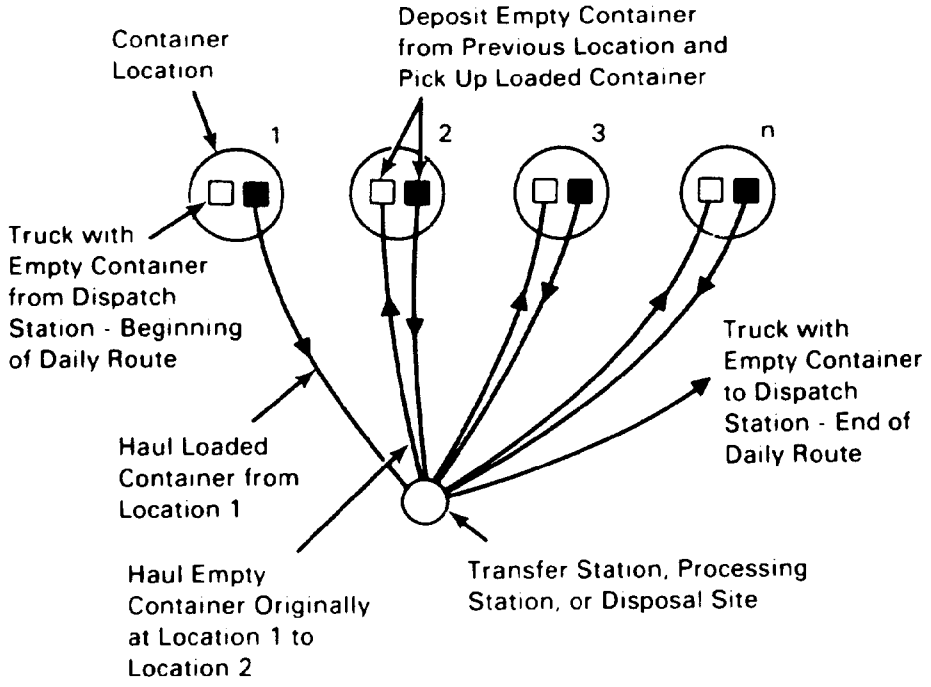
4.2.4.7 Keep accurate operating records for each collection truck assigned to the refuse collection system. Department of Army Form 3916 (Daily Log of Truck Trips for Refuse Collection and Disposal) has been designed for this purpose in the Army; Form 1453 (Refuse Collection and Disposal report) for the Air Force; the Navy does not have a standard form for this. Truck drivers fill in the form daily, noting the size of each load (full, three-quarters, one-half, or one-quarter) or number of 32-gal garbage cans carried on each trip. The supervisor collects the reports, converts the size of load to cubic yards, and makes a monthly consolidation of these data on DA Form 3917 (Refuse Collection and Disposal) for the Army, and the Air Force uses AF Form 1452, Daily Log of Refuse and Salvage Collections.

4.2.4.8 For reporting purposes, the standard workload unit for collecting refuse and salvage is the cubic yards of uncompacted material. The method for computing the quantities to be reported for each type of collection equipment is given below.

4.2.4.9 *Compaction Type.* Load the vehicle body with measured quantities of the loose refuse materials being handled at the installation, in a manner similar to the way it is loaded during the normal refuse collection operation. It is important that the materials and method be representative of the daily operations; otherwise, the compaction factor, and consequently the reported daily volumes of refuse, will be in error. The total quantity of uncompacted material that is placed in the truck body when divided by the rated (measured dimensions) capacity of the truck body will give a compaction factor for the specific materials collected and the



(a) Conventional Mode



(b) Exchange Container Mode

FIGURE 4-2-4A
Comparison of Hauled and Stationary Container Concepts

TABLE 4-2-4A
Typical Data on Container Capacities Available
for Use with Various Collection Systems

Collection		Typical Range of Container Capacities, yd^3
Vehicle	Container Type	
Hauled container systems		
Hoist truck	Used with stationary compactor	6-12
Tilt-frame	Open top, also called debris boxes	12-50
	Used with stationary compactor	15-40
	Equipped with self-contained compaction mechanism	20-40
Truck-tractor	Open-top trash-trailers	15-40
	Enclosed trailer-mounted containers equipped with self-contained compaction mechanism	20-40
Stationary container systems		
Compactor, mechanically loaded	Open top and enclosed top and side-loading	1-8
Compactor, manually loaded	Small plastic or galvanized metal containers, disposable paper, and plastic bags	20-55 (gal)

TABLE 4-2-4B
Typical Data on Vehicles Used for the Collection of Solid Wastes

Collection Vehicle			Typical Overall Collection Vehicle Dimensions				
Type	Available Container or Truck Body Capacities, yd^3	Number of Axles	With Indicated Container or Truck Body Capacity, yd^3	Width, in.	Height, in.	Length, (1) in.	Unloading method
Hauled container systems							
Hoist truck	6-12	2	10	94	80-100	110-150	Gravity, bottom opening
Tilt-frame	12-50	3	30	96	80-90	220-300	Gravity, inclined tipping
Truck-tractor trash-trailer	15-40	3	40	96	90-150	220-450	Gravity, inclined tipping
Stationary container system							
Compactor (mechanically loaded)							
Front loading	20-45	3	30	96	140-150	240-290	Hydraulic ejector panel
Side loading	10-35	3	30	96	132-150	220-260	Hydraulic ejector panel
Rear loading	10-30	2	20	96	125-135	210-230	Hydraulic ejector panel
Compactor (manually loaded)							
Side loading	10-37	3	37	96	132-150	240-300	Hydraulic ejector panel
Rear loading	10-30	2	20	96	125-230	210-230	Hydraulic ejector panel

(1) From front of truck to rear of container or truck body

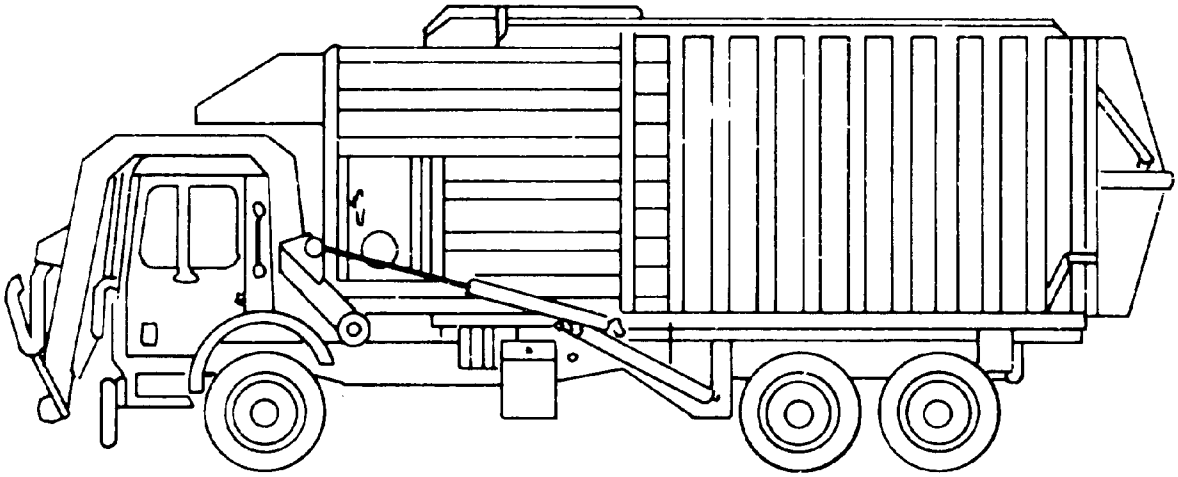


FIGURE 4-2-4B
Half/Pack Front Loader

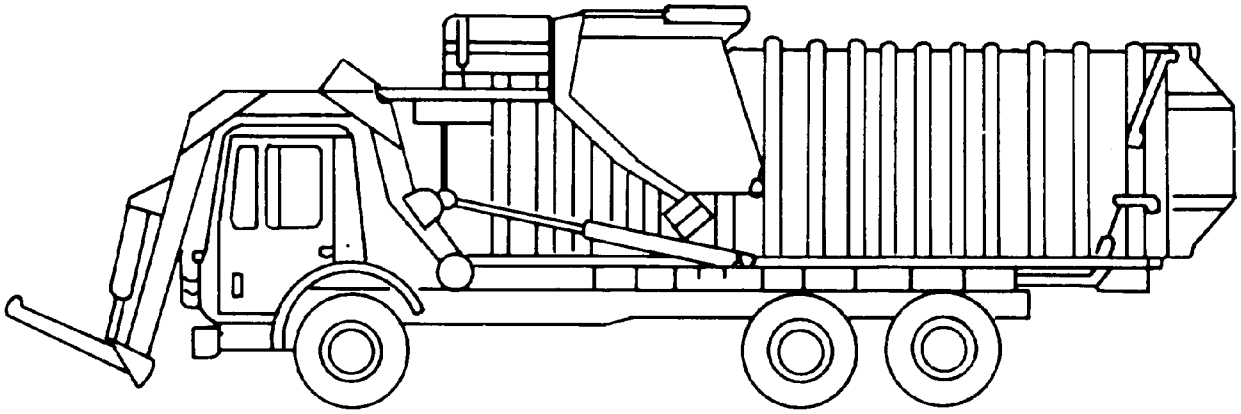


FIGURE 4-2-4C
Full/Pack Front Loader

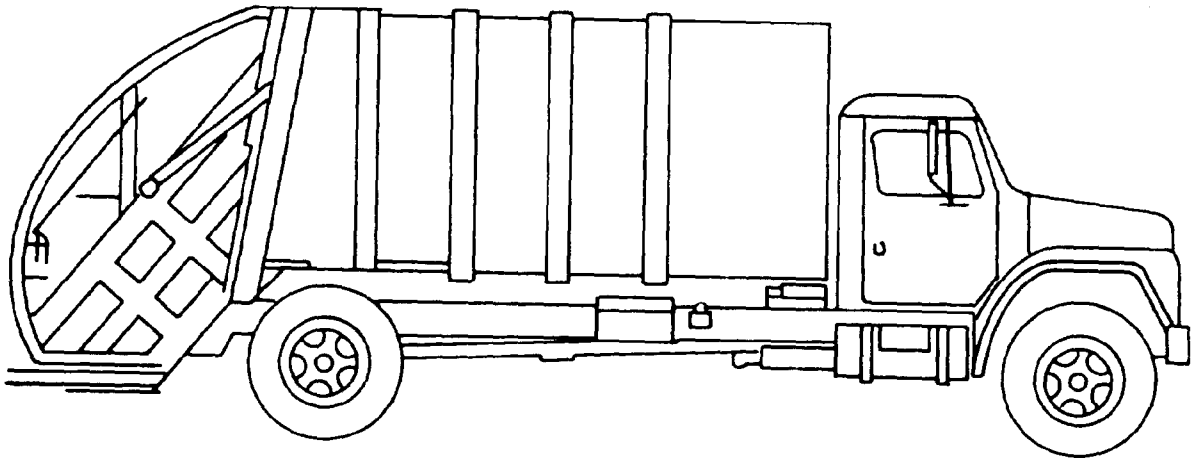


FIGURE 4-2-4D
Mid-Range Rear Loader

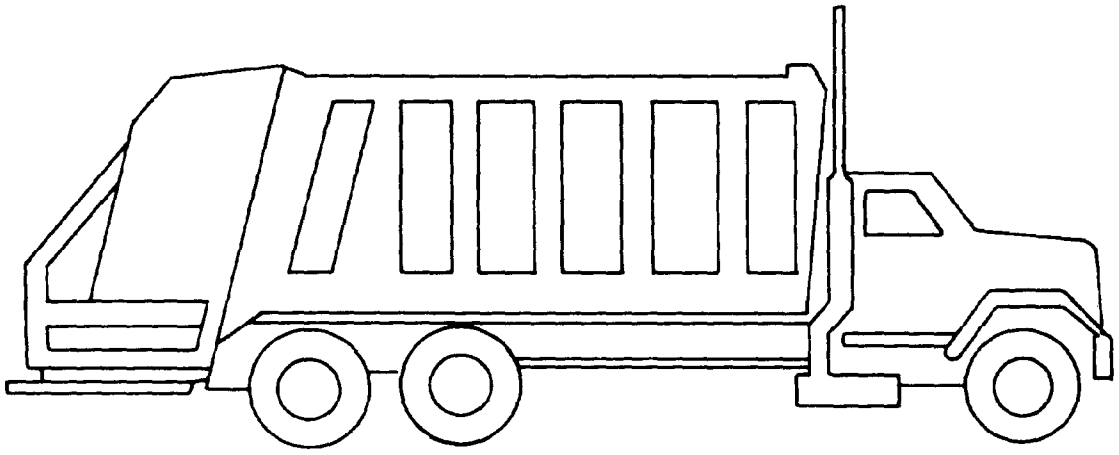


FIGURE 4-2-4E
High-Compaction Rear Loader

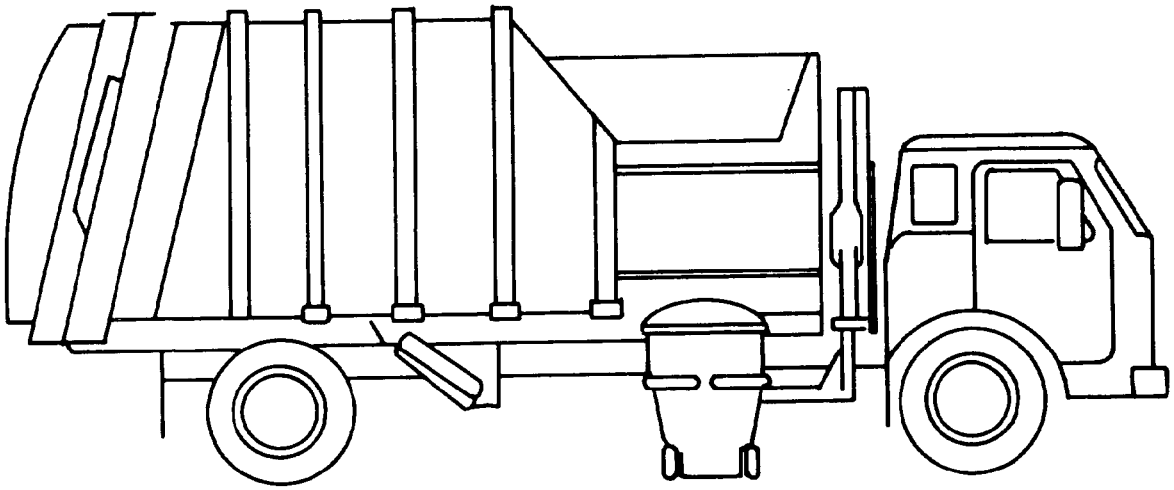


FIGURE 4-2-4F
Automated Side Loader and Container Handling System

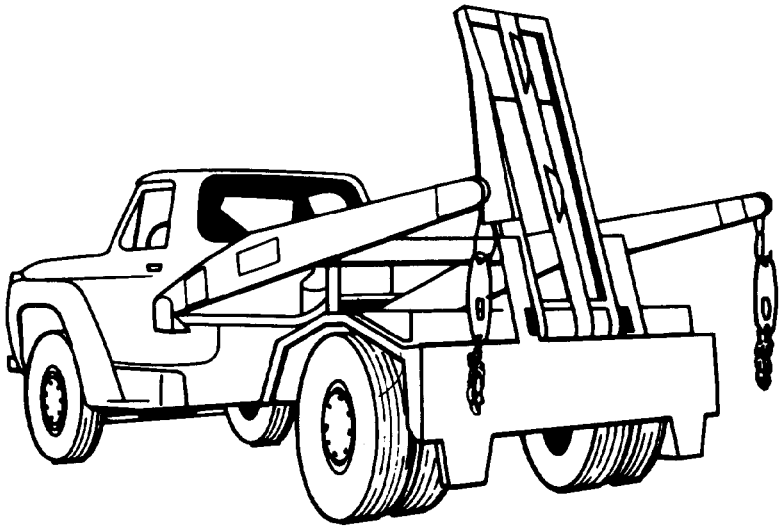


FIGURE 4-2-4G
Hoist Truck

particular truck body. This compaction factor when multiplied by the volume of material collected daily will give the cubic yards of uncompacted refuse and salvage to be reported. Obtain compaction factors for as many kinds of refuse materials as are being collected on the installation. Verify these factors periodically and as required by changes in proportions or composition of refuse and salvage materials.

4.2.4.10 *Dump trucks and multiple containers.* Since there is no compaction device on special purpose vehicles such as dump trucks or multiple containers, the measured size of each load delivered to a disposal facility or transfer station will be the reported cubic yards collected in these vehicles.

4.2.4.11 *Garbage cans, 32-gal size.* Approximately six full 32-gal garbage cans are equivalent to a cubic yard. The quantity collected in cans will be computed on the basis of the number of cans serviced and the degree to which the cans are filled.

4.2.4.12 *Periodic weighings.* Verify volumetric estimates and supply usable data when evaluating the resource recovery potential of the installation by periodically weighing containers.

4.2.4.13 **Frequency of Collection**

4.2.4.14 Depending on the rate of generation, type of waste, and other considerations, collection may be made on a scheduled route basis or on an unscheduled demand or call basis.

4.2.4.15 The following factors will be considered and evaluated to determine the frequency of collection from each pickup station:

- types of refuse materials to be collected (garbage, ashes, combustible or incombustible rubbish, or any combination thereof)
- methods of disposal (sanitary fill, incinerator, burning pit, off-post or contract disposal. and salvage collection and disposal)
- requirements of service at installations (mess hall, barracks, quarters, exchange or club, warehouse, shop, or storage facility)
- local geographical and climatic conditions (arctic, temperate, tropical, dry or humid, high or low elevation)
- season
- types of storage and collection equipment available and in use (compactor trucks or multiple container equipment).

4.2.4.16 Keep frequency of collection to the minimum possible and still maintain sanitary conditions. Recommended frequencies are

- dining facilities - daily
- family housing - once/week
- trash, ashes, debris - once/week
- industrial activities - on demand basis
- transfer stations - daily and on demand are both common.

4.2.4.17 **Collection Point**

4.2.4.18 A collection point consists of two elements: a container and a location for the container. The type, size, and location of containers shall be determined first when designing or modifying a collection system. The selection of the collection point is the responsibility of the base civil engineer.

4.2.4.19 Provide adequate and suitable containers at each pickup station. Suitable containers are cans, drums, bins, or similar portable receptacles with tight-fitting lids that contain the contents and odors. For manually hoisted containers, fully loaded container weight shall be limited to 75 lb. In selecting a site for storage containers, aesthetics is an important consideration.

4.2.4.20 Establish collection points easily accessible to collection trucks and not more than 300 ft from the source of refuse material. Provide separate stations at the following locations:

- mess halls, exchanges, clubs, and similar facilities where food is handled, stored, or dispensed
- temporary barracks
- separate family quarters
- multiple family quarters.

4.2.4.21 Curbside or service-drive solid waste collection will be used in family housing unless another system gives a cost or environmental advantage to the government. Use of other than curbside or service-drive collection must be supported by an economic or environmental analysis. It will be retained in installation records.

4.2.4.22 **Separate Collection**

4.2.4.23 When solid wastes are separated at the point of storage into various categories for recycling or resource recovery, collection frequency shall be designated for each waste category.

4.2.4.24 There are obvious advantages when all refuse can be collected at one time. Combined collections, which reduce handling and truck trips and permit maximum use of collection vehicles, are strongly recommended. The ultimate method of disposition, resource recovery potential, and the degree of separation dictate the need for separate collections. Separate collections are generally made for the following conditions:

- If incineration is used, bulky refuse items and noncombustible rubbish, such as glass, large quantities of computer cards, etc., shall be collected separately and not delivered to the incinerator.

- Solid waste that is recyclable or suitable for resource recovery shall be collected separately.

- After incinerator ashes have been quenched or sufficient time has elapsed to ensure cooling of the ashes, they shall be collected separately.

4.2.4.25 When segregation is required, materials are generally separated as follows:

4.2.4.26 *Hog-food garbage.* This operation must conform to state and local health authority requirements. Drained hog-food garbage is placed separately in covered 32-gal garbage cans. It includes kitchen leftovers, plate wastes, lettuce leaves, pea hulls, corn cobs, vegetable tops, and rinds and peelings from other than citrus fruits. This material is typically disposed of through the kitchen garbage grinder if not sold.

4.2.4.27 *Other garbage and rubbish.* All other garbage and rubbish are placed in covered 32-gal garbage cans or large multiple containers. They include drained coffee grounds, citrus fruit rinds, seafood and poultry wastes, food wrappings, carbon and stencil paper, rubbish from barracks, and similar unsalable items. When refuse is disposed of by incineration, such noncombustible materials as dirt, glass and crockery, metals, and other mineral refuse must be segregated and placed in separate containers.

4.2.4.28 *Spent cooking grease and trap grease.* These items are placed in separate covered 10- or 16-gal garbage cans. To eliminate the possibility of spilling when the cans are handled during collection, do not fill the cans more than 4 in. from the top.

4.2.4.29 *Bones and meat trimmings.* When meat cutting is performed at mess halls, bones and meat trimmings are placed in covered 32-gal garbage cans and are generally sold as salvage.

4.2.4.30 *Salvable paper, cardboard, and kraftboard.* Salvable paper items are tied and stacked at one end of the pickup station. They shall be protected from the weather because they lose salvage value once they have gotten wet.

4.2.4.31 *Separated solid waste materials.* Store so that they are not a fire, health, or safety hazard and do not provide food or harborage for disease vectors (flies, mosquitos, rodents). Contain or bundle wastes to prevent spills.

4.2.4.32 **Social Requirements**

4.2.4.33 Store solid waste containing food waste securely in covered or closed containers that are nonabsorbent, leakproof, durable, easily cleanable, and designed for safe handling.

4.2.4.34 Storage of bulky wastes shall include removing doors from large household appliances and covering the items to reduce:

- any problem of an "attractive nuisance"
- accumulation of other waste and water in and around the bulky items.

4.2.4.35 Reusable waste containers emptied by hand must not exceed 75 lb when filled. Collectors should not come in physical contact with the waste.

4.2.4.36 Procurement specifications for multiple containers shall establish conformance with DoD Military Specifications MIL-R-2395C unless such containers are unavailable or superior containers are desired.

4.2.5 Transfer and Transport

4.2.5.1 **Types of Transfer Stations**

4.2.5.2 There are several types of transfer station systems commonly employed. These are briefly described below:

4.2.5.3 *Direct Dump to Container.* This is the most basic and simple form of transfer system. This system is employed when small volumes (100 yd^3 or less) of solid wastes are handled. Container volumes range from about 15 to 55 yd^3. Full containers are replaced with empty ones, and the full container is transported to the disposal site by tilt-frame trucks. This type of system is advantageous because of low capital costs and simple loading methods. However, because of the low solid waste densities (about 200 lb/yd^3) obtained, spare containers may be required to handle incoming waste during peak periods. Also, there are potential hazards associated with this method, including leachate generation due to rainfall into the open box and the possibility of someone falling into the container while unloading the solid waste.

4.2.5.4 *Dump into Trailer.* With this method, solid waste is dumped from an elevated area into trailers instead of drop boxes. It is more commonly used than the drop box system. Trailers are available to handle up to and even over 130 yd^3. Open-top trailers are less expensive initially and require less maintenance than the alternative compactor trailer types. Disadvantages of trailer systems are the same as for the drop box systems except haul costs are less because of the larger payload. There are several methods commonly employed to feed waste into transfer trailers, including:

- *Direct Dump*. With this method, solid waste is dumped directly into the trailer from the collection vehicle from an elevated ramped area (see Figure 4-2-SA).
- *Dump to Storage Pit.* For this system, solid waste collection vehicles dump directly into a storage pit where the waste materials are crushed by crawler tractors and then pushed over

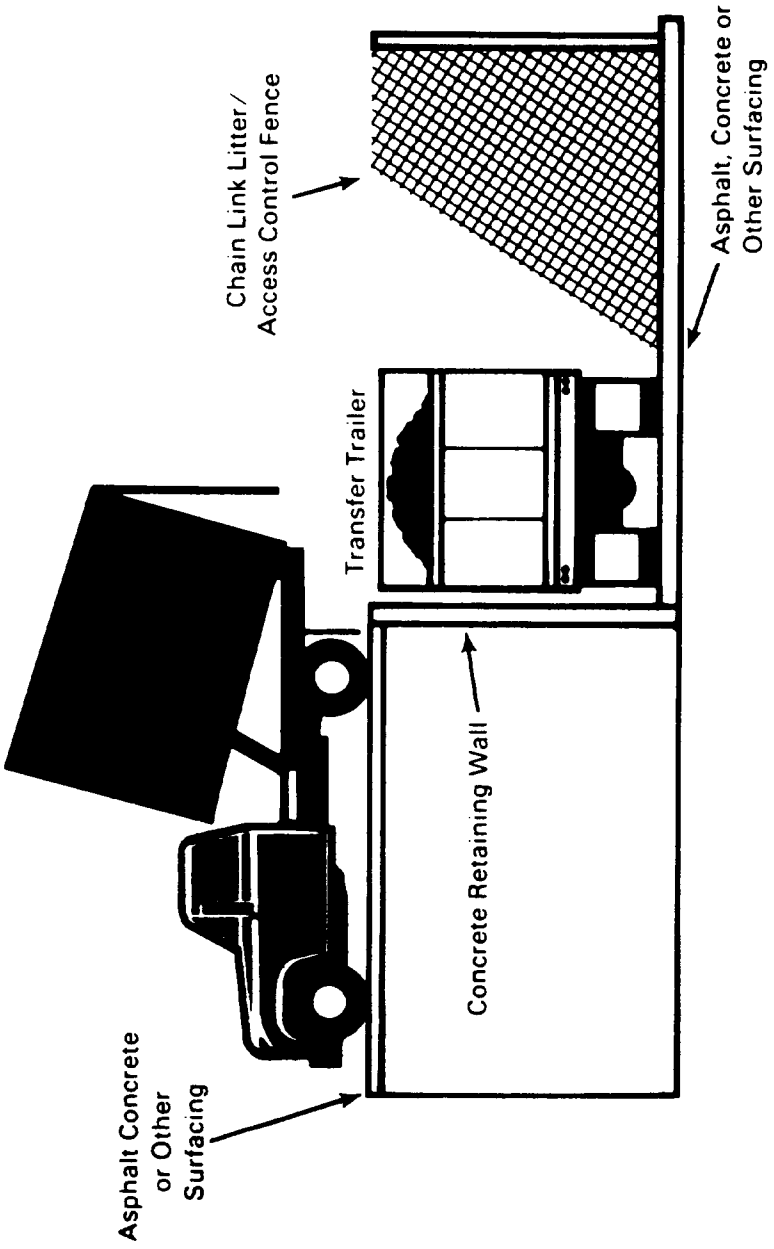


FIGURE 4-2-5A
Direct Dumping to Transfer Trailer Station

the ledge of the storage area into the trailer. This method is generally employed where solid waste quantities delivered exceed 500 yd^3 per day.

- *Dump to Tipping Floor.* This method is similar to the storage pit method, except solid wastes are dumped onto a tipping floor rather than a storage pit, crushed by crawler tractors, and pushed into the trailer (see Figure 4-2-5B). This method is used effectively when solid waste delivery rates range from 100 to 500 yd^3 per day.

4.2.5.5 Once the solid waste is in the trailer, it is generally leveled and further compacted by a backhoe or similar tamping device.

4.2.5.6 At the disposal site, various methods are used to unload the trailers, with the most efficient being the live bottom trailer. The floor of these trailers consists basically of a conveyor or other active type floorsystem which, when activated, automatically unloads the trailer.

4.2.5.7 *Dump into Hydraulic Compaction Units.* These systems are generally employed only at locations where solid waste delivery rates exceed 500 yd^3 per day. In a hydraulic compaction system, a transfer trailer is backed into position and locked to a stationary compactor firmly anchored in a concrete foundation. The compactors used are large, heavy-duty units capable of handling most materials and producing the waste densities necessary to obtain maximum legal payloads. During operation, solid waste is loaded to the compactor from a hopper and the hydraulically powered reciprocating ram of the compactor forces the refuse horizontally through the door in the rear of the transfer trailer. At the disposal site, the entire rear section of the transfer trailer is opened and the waste pushed out by an ejection ram. Because this system requires that the transfer trailer be attached to the compactor, any hydraulic compaction system prohibits the use of drive-through arrangements.

4.2.5.8 There are several methods of feeding waste to the compactor hopper:

- direct dump into the hopper
- dump into a hydraulic push-pit equipped with a hydraulically activated ram which automatically feeds waste into the hopper
- dump into a storage pit or tipping floor where waste is crushed and pushed into the hopper by a wheel loader or crawler tractor
- dump into an inclined conveyor which automatically feeds waste into the hopper.

4.2.5.9 Table 4-2-SA presents a summary of transfer station systems available for use at military installations, including advantages and disadvantages of each system.

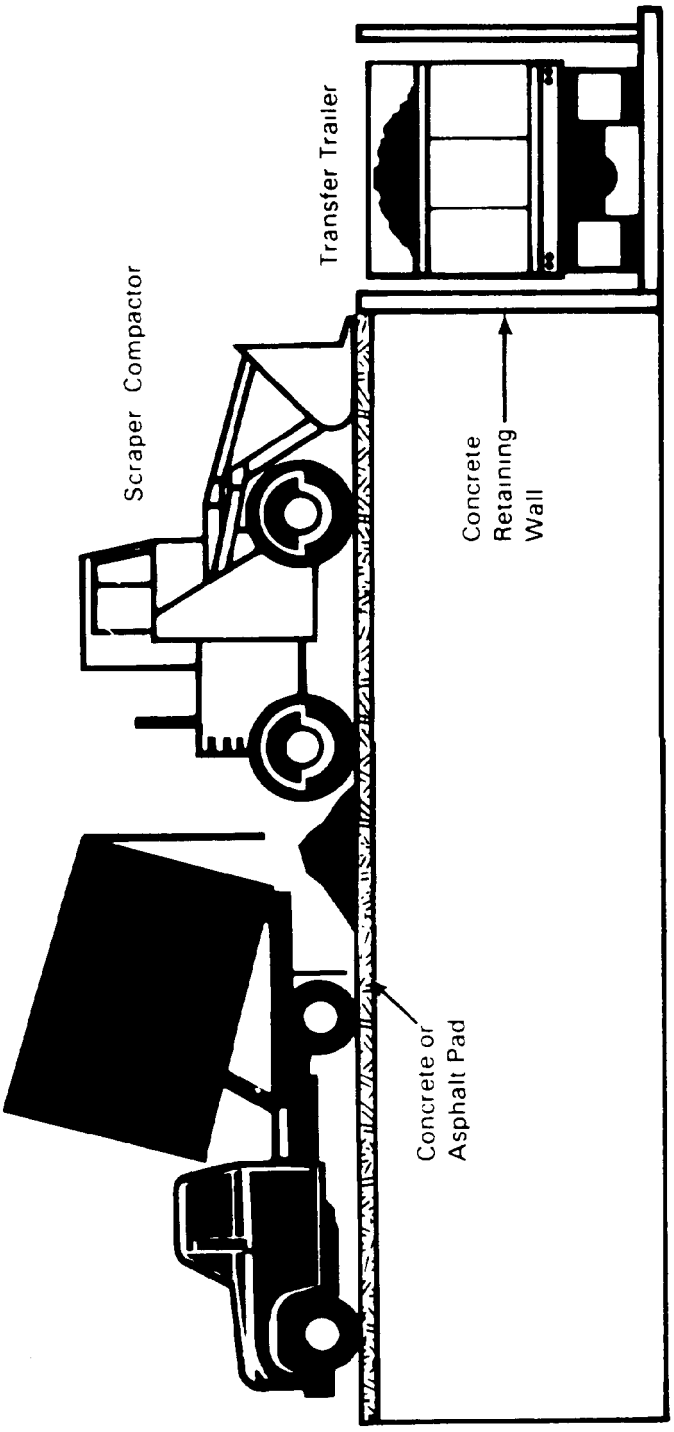


FIGURE 4-2-5B
Direct Dumping to Tipping Floor Transfer Station

TABLE 4-2-5A
Transfer Station Types

Type	Volumne of Solid Waste Most Economically Handled	Generally Applicable at Military Installations	Advantages	Disadvantages
Noncompacting:				
Direct Dump to Container	Up to 100 yd^3/day	Yes	Low capital costs, simple unloading, low operation and maintenance costs.	Low solid waste densities, potential leachate due to rainfall in open box.
Direct Dump to Trailer	Up to 100 yd^3/day	Yes	Same as for direct dump to container except costs are lower because of larger payloads.	Same as for direct dump to container.
Dump to Storage Pit	Over 500 yd^3/day	No	Can efficiently handle large volumes of solid waste; simple unloading, haul costs low because of large payloads,	Operation maintenance costs higher than above systems; potential for person falling into pit.
Dump to Tipping Floor	Over 100 yd^3/day	Yes	Same as dump to storage pit except capital costs are lower.	Same as dump to storage pit except there is no potential for falling into pit.
Compacting:				
Dump into Hydraulic Compaction Unit	Over 500 yd^3/day	No	Haul costs low because of compacted payloads, little or no exposure of waste to atmosphere.	If compactor fails no way to load trailers, high capital cost, someone could fall into compaction unit, no way to have drive-thru arrangements.
Dump to Inclined Conveyor	Over 500 yd^3/day	No	Can handle large volume of waste,	Same as direct dump to trailer and dump to compaction unit, except no one could fall into pit or compaction unit.

4.2.5.10 **Environmental Impacts.** The environmental impacts associated with the transfer and hauling of unprocessed solid waste include

- noise
- air quality
- odor
- traffic congestion
- litter
- insects and rodents
- water contamination.

4.2.5.11 *Noise.* Sources of noise at the transfer station include the operation of collection and transfer vehicles, and any loading and/or compacting/tamping equipment.

4.2.5.12 *Air Quality.* Air quality impacts include idling of collection vehicles during dumping operations, exhaust from operation of front end loaders or crawler tractors, and dust generated by the unloading of collection vehicles and haul vehicles. Site users/workers are exposed to dust especially when stations are enclosed; however, an enclosed station decreases the impacts on the surrounding community.

4.2.5.13 *Odors.* Objectionable odors can occur when mixed solid waste containing organic matter accumulates in an environment conducive to putrefaction. To minimize odors, the waste receiving area at the transfer station shall be designed and staffed to handle peak day loads with adequate time for a thorough daily cleanup.

4.2.5.14 *Traffic Congestion.* Traffic to and from the transfer station may cause congestion on nearby streets and intersections. Also, haul operations can cause significant congestion thereby slowing station operations. Scheduling of collection and transfer truck trips to avoid peak traffic hours can reduce this problem.

4.2.5.15 *Litter.* The site shall be fenced to contain any blowing litter, and a daily litter cleanup procedure shall be included in the operation plan. All solid waste transferred to and unloaded at the site shall be covered to minimize the problem. Haul trailers do not generally contribute to littering because the solid waste is usually compacted or completely contained inside the truck.

4.2.5.16 *Water Contamination.* Water pollution impacts stemming from rainfall into the transfer containers or washdown of the transfer station area and of the transport vehicles can be mitigated by collecting and channeling runoff waters to a sewer system, or by collecting and treating the runoff prior to disposal. The potential for water pollution during the haul operation is insignificant.

4.2.5.17 **Transfer Station Siting**

4.2.5.18 Factors to consider when evaluating alternative transfer station sites, include the following:

1. type of transfer system to be employed

2. collection and transfer vehicle access

3. availability of proposed site for use as a transfer station

4. size of site required for initial transfer station operations and for possible future expansion of transfer station operations or construction of resource recovery facilities

5. proposed future surrounding land use

6. existing facilities adjacent to proposed site

7. environmental impacts (e.g., visual, odors, etc.)

8. foundation conditions

9. central to existing and proposed future collection areas

10. proximity to existing or projected future disposal location

11. permitting requirements.

4.2.5.19 These factors can be used in establishing criteria for judging the relative merits of each alternative site.

4.2.5.20 **Permitting.** Items 2 and 9 are the most important considerations. Permitting requirements vary from state to state. In some states permits are not yet required. In others (e.g., New Jersey) transfer stations are viewed as waste disposal sites. Procedurally, permitting the transfer stations is no different than permitting a landfill, incinerator, or recycling center. Less total paperwork may be required for establishing a transfer facility, but the number of steps is the same.

4.2.5.21 **Transfer Station Costs**

4.2.5.22 The following cost factors must be considered:

Capital Costs

- building
- land
- transfer tractors and trailers
- wheel or track loader
- leveling and tamping equipment.

Annual Costs

- transfer vehicles
  - operation & maintenance (0&N)
  - taxes, licenses, and insurance

- labor
- building amortization
- transfer station 0&M (e.g., utilities, etc.)
- transfer station equipment 0&M (e.g., track dozer).

4.2.5.22 Once these costs are developed, a comparison between direct haul and collection vehicle can be made and the most viable system selected. Figure 4-2-SC presents a generic graph of a cost comparison between direct haul and transfer haul.

4.2.6 Sanitary Landfill Design and Operation

4.2.6.1 *General.* Sanitary landfilling is an engineered solid waste disposal process which minimizes the environmental hazards and nuisances of land disposal. Solid waste is delivered to a carefully selected and prepared site, deposited into a trench or controlled area, compacted, and covered with soil or other material daily. Landfills must conform to EPA and/or state requirements. Potential regulations at the state and federal level would require double liners with leachate collection and groundwater monitoring for all new landfills.

4.2.6.2 Sanitary landfills have advantages not common to most other methods of refuse disposal: they do not require large operating crews; they can receive all categories of solid wastes, except hazardous waste; they can accommodate large fluctuations in the daily accumulation of refuse without additional personnel or equipment; and they provide reasonable control of vectors and pollution.

4.2.6.3 The sanitary landfill is capable of accepting a wide variety of solid waste types. Nearly all rubbish, garbage, trash, ashes, solid organic waste, and miscellaneous solids may be disposed of safely. Most domestic-type solid waste can be disposed of without presorting, or in combination with the following solid waste reduction techniques: incineration, baling, compacting, or shredding.

4.2.6.4 Certain waste products are not appropriate for sanitary landfill operations. These include hazardous waste; toxic substances; liquids; untreated infectious waste; and volatile, explosive, or flammable wastes. Measures shall be taken to ensure that these solid waste products are not delivered to the landfill site. Plans for separation and removal of accidental deliveries shall be kept current.

4.2.6.5 *Sanitary Landfill Design.* The objectives of a landfill design are to (1) ensure compliance with pertinent regulatory guidelines/ requirements; (2) provide adequate present and long-term protection of the environment; (3) achieve cost-efficient utilization of site manpower, equipment, volume, and soil; and (4) direct and guide operators toward proper construction and operation of the landfill. This section provides guidance on design considerations for a sanitary landfill to achieve these objectives.

4.2.6.6 *Regulations and Permits.* Many regulatory and approving agencies require permits before a landfill can be constructed or operated. A conceptual landfill design is generally an integral part of the application

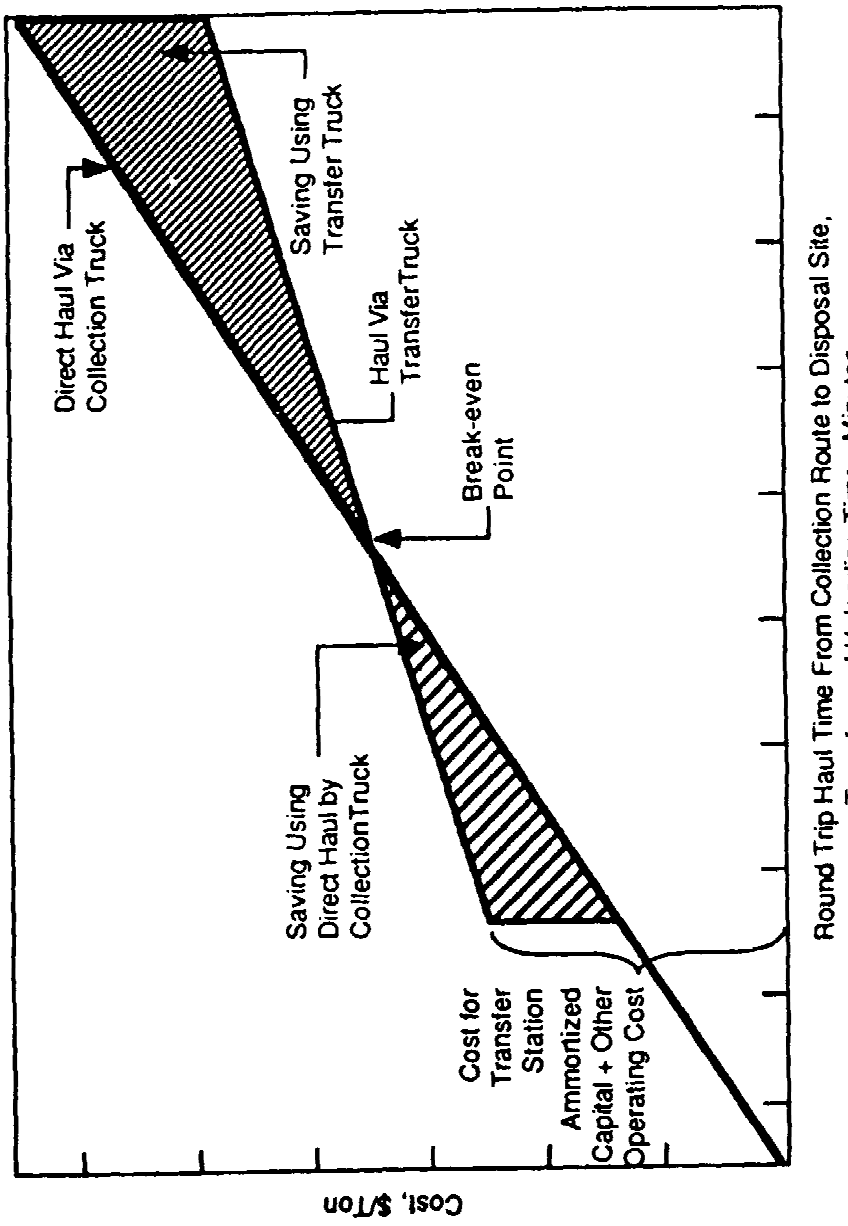


FIGURE 4-2-5C
Comparison of Direct Haul and Transfer Haul Costs

for such permits. Accordingly, all pertinent agencies shall be contacted early in the design phase to take the following steps:

- identify regulations impacting on the prospective landfill
- determine the extent, detail, and format of the application
- obtain permit application forms and other background information.

4.2.6.7 Two permits relevant to landfills are identified and mandated by these criteria:

1. NPDES (National Pollutant Discharge Elimination System) permit (402 and 404) required for location of a landfill in waters of the United States. It is also required for any point source discharges from sanitary landfills, such as from leachate collection systems.

2. Army Corps of Engineers permit required for the construction of any levee, dike, or other type of containment structure to be placed at a sanitary landfill located in waters of the United States.

4.2.6.8 Permit requirements of state and local regulations vary depending on jurisdiction. In some areas, only one permit is needed. Other states may require several separate permits or stipulate that a new sanitary landfill proponent coordinate with several agencies.

4.2.6.9 Sanitary landfill regulations can be the responsibility of one or more state agencies. Appendix D lists the various state agencies (including addresses and telephone numbers) responsible for solid waste disposal activities in those states.

4.2.6.10 Local regulatory agencies may include one or more of the following:

- environmental and health departments
- planning and/or zoning commissions
- board of county commissioners
- building departments
- highway departments
- fire departments.

4.2.6.11 The reviewing agency may require the submittal of information on standard forms or in a prescribed format in order to facilitate the review process. This process can take at least 1 month and usually 6 to 12 months or longer, depending on the degree of controversy and opposition. After a permit is issued, it can be valid for various durations, depending largely upon the submittal of monitoring results and performance reports and the results of periodic onsite inspections.

4.2.6.12 *Site Selection.* Selection of an appropriate site on the installation is the most critical step in establishing a sanitary landfill facility. Site selection criteria shall include cost, availability of land, availability of cover material, impact on natural resources (i.e., wildlife, endangered species, ecological sensitivities, etc.), topographic features and hydrogeologic considerations, environmental and pollution hazards, and social

and aesthetic consideration. The process of site selection shall involve specialists from military, local, state, and federal agencies as appropriate.

4.2.6.13 *Site characteristics.* Various sites on an installation may be available for sanitary landfill operations. These sites shall be screened by the facilities engineer to determine which is the most advantageous, using various site characteristics.

1. *Land availability.* Installation planning documents shall be consulted in order to screen the sites. Also, legal considerations, including the investigation of legal burdens, title restrictions, and other possible jurisdictional blocks to the use of various sites for landfill operations, shall be reviewed. Land area requirements vary significantly with the type of landfill operation and characteristics of land, compaction, and volume of waste generated by the installation. Figure 4-2-6A provides estimates of volume of compacted solid waste.

2. *Cover material availability.* Consider the availability and suitability of cover materials. Most well-graded soils are suitable for daily cover, but not for intermediate or final cover and should exist at the site or be immediately available to the site. The quantity of cover material will vary with the design characteristics of the site. Typical waste:cover ratios of 4:1 to 2:1 are used.

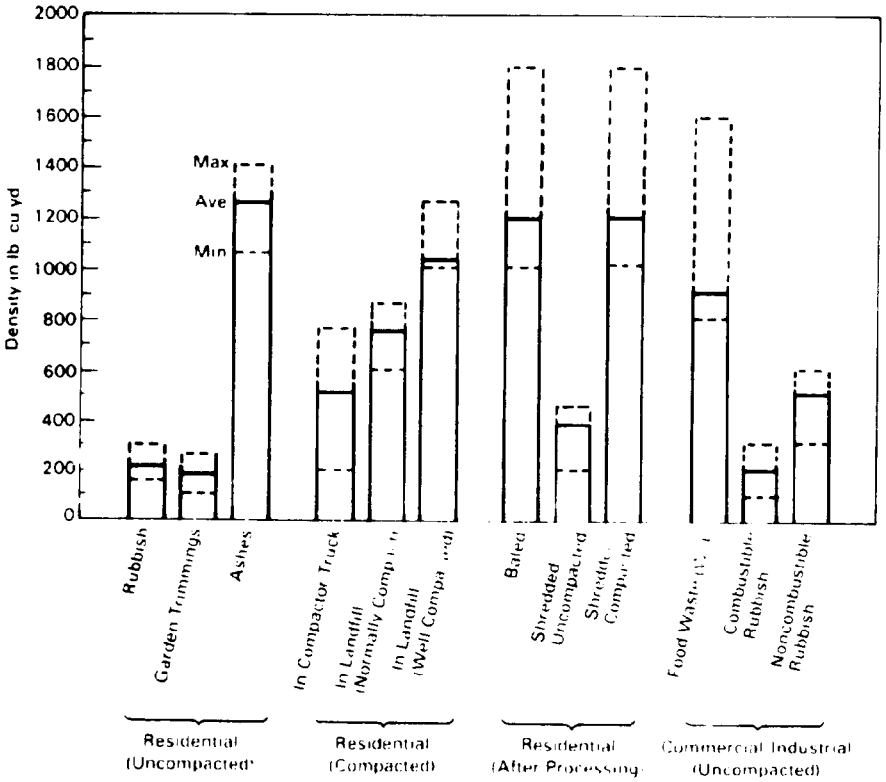
3. *Proximity.* Landfill siting shall constitute a balance between adequate distance from housing and work areas and economical hauling distances. The landfill shall be sited at least 750 ft from inhabited buildings and so that prevailing winds are away from living areas, where practical. Also, landfills must not be sited within 10,000 ft of any point of any airfield servicing jet aircraft or within 5000 ft of an airfield servicing only piston aircraft.

4. *Roads.* Sites shall be accessible to appropriate vehicles by all-weather roads leading from the public road system.

5. *Underground structures.* Sites traversed by pipelines or conduits for sewage, stormwater, etc., shall be rejected unless the relocation or protection of the pipelines or conduits is feasible. These pipelines may serve as pathways for gas and leachate. Plans for maintenance and repair of protected pipelines must be developed.

6. *Flood plains.* Landfills cannot be sited within the 100-year flood plain.

4.2.6.14 Topography. Specialists shall evaluate alternative sites from the viewpoint of pollution hazards and possible environmental degradation. Military agencies and laboratories such as the Facilities Housing Support Agency, U.S. Army Construction Engineering Research Laboratory, Naval Civil Engineering Laboratory, Naval Energy and Environmental Support Activity, U.S. Army Waterways Experiment Station, U.S. Army Environmental Hygiene Agency, Air Force Engineering and Services Center, and others can provide additional technical guidance in these areas.



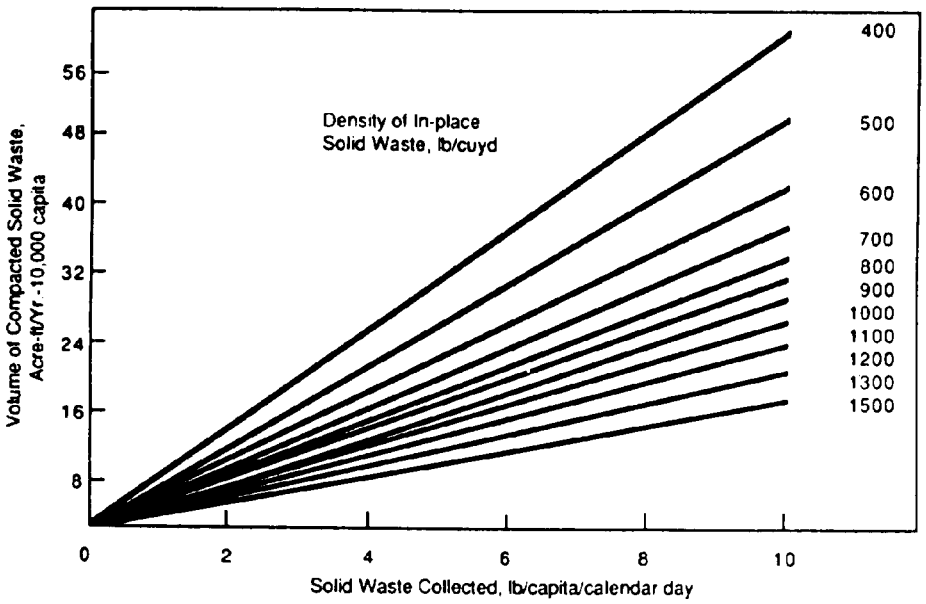


FIGURE 4-2-6A
Determining the Yearly Volume of Compact Solid Waste

1. *Surface water.* Surface water that infiltrates the cover soil can increase the rate of waste decomposition and eventually cause leachates to leave the solid waste and create water pollution problems. This problem can be minimized by rejecting sites containing surface water features, diverting upland drainage, and designing facilities with sufficient grade and slope to allow surface water runoff. Sites shall be selected on. the basis of a geohydrological evaluation of surface water problems.

2. *Terrain.* A sanitary landfill can be constructed on virtually any terrain; however, some land features require extensive site improvements and expensive operational techniques. The best terrain consists of flat or gently rolling land not subject to flooding. While depressions such as canyons and ravines are more efficient than flat areas, cover material may not be available. Also, special difficulties may occur in depressions and control of surface waters may be difficult. Such manmade features as strip mines, quarries, and open pit mines can often be safely and economically reclaimed by the government as sanitary landfills. Some offer excellent protection against leachate pollution, while others require more extensive improvements. Terrain features that shall exclude a site for consideration include the following:

   a. hilltops and other similar land forms

   b. highly permeable and porous areas such as gravel beds

   c. swamps and marshes

   d. natural drainage channels

   e. wildlife sanctuaries

   f. floodplains

   g. land having karst features such as limestone formations which can lead to the formation of sinkholes and depressions

   h. steep slopes.

4.2.6.15 **Hydrogeological Characteristics**

4.2.6.16 Liner Systems: Soil and Membrane (Robinson 1986). Both the need to protect the environment and regulatory agency requirements have resulted in the installation of liners at the base of many landfills. The liner's purpose is to limit the movement of leachate through the base of the landfill and into the underlying formations. Many materials and techniques have been tried in an effort to prevent leakage at a reasonable cost.

4.2.6.17 The liner must endure chemical and physical attack mechanisms. Many chemicals found in leachate have the potential to damage liner materials. Also, the liner must not fail structurally during installation or from the strain of the solid waste.

4.2.6.18 Liner materials include soils and, in particular, clay soil, admixed liners, flexible polymeric membranes, sprayed-on linings, soil sealants, and chemical absorptive liners. The purpose of the liner is to prevent the movement of water and its associated contaminants through the base of the landfill and into the underlying formations. The liner may be fabricated in one of two ways. It may be constructed onsite, such as when soil materials are placed and compacted, or it may be a manufactured flexible membrane placed on the site during construction.

4.2.6.19 Many landfills have had clay liners placed at their base. Clay minerals may be kaolinite, illite, or montmorillonite. A typical clay will contain one or more of these clay minerals and possibly will be mixed with other fine-grained soil materials such as silt. Clay minerals have a low hydraulic conductivity and therefore will significantly retard the movement of any leachate through them. Permeabilities for most soils containing greater than 25% clay are in the range of 10^{-8} cm/s to 10^{-5} cm/s.

4.2.6.20 Clay liner thicknesses of 5 ft (1.5 m) or greater have been required at some sites. The success of the clay liner will not only depend upon its original characteristics, but also upon the method of liner installation. Best results are achieved by placing several individual layers or lifts. Each lift is compacted before the next layer is placed. The degree of compaction achieved will be a function of the compacting equipment, the thickness of the lift, and the moisture content of the soil. The soil moisture content is a significant factor. Soil that is either too dry or wet will be less than optimum for compaction.

4.2.6.21 Admixed liners are formed-in-place liners. These include asphalt concrete, soil cement, soil asphalt, and bentonite clay liners. The liners are formed by mixing the lining material with the natural soil at the base of the landfill. The resultant mixture hardens or modifies the characteristics of the soil material to provide a low-permeability barrier. Each of these approaches has been employed successfully in the lining of impoundments.

4.2.6.22 Flexible polymeric membranes are manufactured materials that are 0.020 to 0.120 in. (0.51 to 3.0 mm) thick. The liner material is manufactured in rolls that are 48 to 96 in. (1.2 to 2.4 m) wide and hundreds of feet long. A uniform bedding material, such as sand, is placed at the base of the landfill prior to the installation of the liner. The particle size of the subgrade material usually should be less than 3/4 in. (19 mm). The base grade on the liner should be a minimum of 2% if gas release from materials beneath the liner is anticipated. Gas vents may also be necessary in order to adequately allow release. The liner is installed by unrolling the sheets of plastic and then using specialized equipment to form bonded seams between the individual sheets. The liner is usually extended up the side of the landfill to the ground surface where it is anchored.

4.2.6.23 Soil sealant and chemically absorptive liners are two other approaches that have been used on a limited basis for retarding the movement of the materials through the base of impoundments. These approaches are also being tested for use in landfills.

4.2.6.24 *Groundwater.* Groundwater pollution hazards are determined by examining annual fluctuations in the depth of the water table. A site

shall be rejected if the highest historical level of the water table is too close to the lowest point of the sanitary landfill. This condition is usually specified by state regulations/guidance or during permit review. Because the conditions affecting groundwater problems are so complex, it is essential that investigation of the landfill site include an evaluation by a qualified groundwater hydrologist.

4.2.6.25 *Soil.* Soil conditions must be suitable for preventing groundwater pollution, for excavating and covering the fill, and for vehicle access. Most soil types can be used for cover material; however, well-graded soils are preferable to other types because of better compactability and workability in all weather conditions. The most ideal soils are silt and clay soils, which restrict leachate and gas movement. Peat, granular, and highly organic soils shall not be utilized for landfills because they contain a large amount of voids and are difficult to compact. Types of materials used for cover material are dependent on the type of leachate control system used in the landfill. Final cover may consist of soils, natural or synthetic liners, or chemically or physically amended earthen materials underlying at least 6 in. of topsoil or other soil that will sustain the growth of vegetation. The cover material shall have a permeability of 1×10^{-5} to 1×10^{-7} cm/s. Federal and state regulations shall be consulted to determine the exact requirements for the specific state in which the landfill is located.

4.2.6.26 *Other considerations.* The relationship of the potential landfill site to other installation activities must be considered.

1. *Aircraft.* Sites shall not be located in the vicinity of military or civilian airfields, where birds attracted to the landfill facility could pose a hazard to aircraft. Birds are dangerous to aircraft because they can ruin jet engines and cause aircraft to crash. The proper distances from an airport runway can be obtained from federal/state regulations or guidance. A landfill shall not be located with 10,000 ft of the closest point of any runway at any airport subject to regulation by the Federal Aviation Administration (FAA) which may be used by turbo-jet aircraft or within 5000 ft of any runway of any such airport used only by piston engine type aircraft unless it has been determined by the FAA that the proposed landfill poses no safety hazard to aircraft in the vicinity. State regulations should also be consulted as they may be more restrictive than FAA regulations.

2. *Social consideration.* Potential socioeconomic effects of a site should be determined. Sites shall be selected away from human activity where possible to avoid odor and noise nuisances, litter, and public safety hazards associated with the landfill site and traffic.

3. *Utilities.* The site shall have access to electricity, sanitary services, and water. Telephone or radio communications are also desirable.

4.2.6.27 **Methodology**

4.2.6.28 Adherence to a carefully planned sequence of activities to develop a landfill design minimizes project delays and expenditures. A

checklist of design activities is presented in Table 4-2-6A, to aid in planning the design effort. These activities are listed in their general order of performance, but the order can vary considerably from site to site and from jurisdiction to jurisdiction, depending on specific conditions.

4.2.5.29 As shown in Table 4-2-6A, initial tasks consist of compiling existing information and generating new information on solid waste characteristics and site conditions. A listing of possible sources for existing information is shown in Table 4-2-6B. A summary of methods to obtain new information is shown in Table 4-2-SC.

4.2.6.30 Throughout the design phase, it is advisable to periodically contact regulatory agency representatives to ensure that the design will meet any new requirements and procedures for permit application submittals. (A sample of documentation requirements for the State of Virginia Is included in Appendix A.) Maintenance of close liaison with state and local regulatory officials throughout the design effort is normally helpful in securing a permit without excessive redesigns, especially at a time when environmental protection legislation and regulations are rapidly changing.

Two general types of design packages are prepared for a sanitary landfill:

1. Conceptual (preliminary) design plan

2. Construction design plan and specifications.

4.2.6.31 Conceptual design plans normally consist of the following elements provided in sufficient detail to describe proposed filling plans to regulatory agencies and the public. The conceptual design can also serve as a guide for landfilling operations in the event that design construction drawings are not required.

1. Conceptual design plans include:

   a. An installation map showing existing site conditions. The map shall be of sufficient detail, with contour intervals of 1 ft to 5 ft and a scale of 1 in. = 50 ft to 1 in. = 200 ft, depending on the steepness of the terrain and size of the landfill, respectively.

   b. A site preparation plan locating the areas and depths designated for cover soil excavation and soil stockpile deposits. Also shown are site facilities locations such as structures, access roads, and utilities.

   c. Development plans showing final filling and excavation contours. Development plans shall show interim (4- to 6-year) filling and excavation contours if a long-lived site is planned.

   d. Elevations showing cross sections to illustrate excavation and landfill surface development at several locations across the fill. Cross sections shall be prepared for each phase of the development plan (i.e., interim and final).

TABLE 4-2-6A
Solid Waste Landfill Design Checklist

Step	Task
1	Determine solid waste quantities and characteristics
	a. Existing
	b. Projected
2	Compile existing and generate new site information.
	a. Perform boundary and topographic survey.
	b. Prepare base map of existing conditions on-site and near-site:
	(1) Property boundaries
	(2) Topography and slopes
	(3) Surface water
	(4) Utilities
	(5) Roads
	(6) Structures
	(7) Land use.
	c. Compile hydrogeological information and prepare location map:
	(1) Soils (depth, texture, structure, bulk density, porosity, permeability, degree of compaction, moisture, ease of excavation, stability, pH, and cation exchange capacity)
	(2) Bedrock (depth, type, presence of fractures, location of surface outcrops)
	(3) Groundwater (average depth, seasonal fluctuations, hydraulic gradient and direction of flow, rate of flow, quality, uses).
	d. Compile climatological data:
	(1) Precipitation
	(2) Evaporation
	(3) Temperature
	(4) Number of freezing days
	(5) Wind direction.
	e. Identify regulations (federal, state, and local) and design standards:
	(1) Loading rates
	(2) Frequency of cover
	(3) Distances to residences, roads, and surface water
	(4) Monitoring
	(5) Roads
	(6) Building codes
	(7) Contents of application for permit.

TABLE 4-2-6A
(cont'd)

Step	Task
3	Design filling area: a. Select landfilling method based on: (1) Site topography and slopes (2) Site soils (3) Site bedrock (4) Site groundwater. b. Specify design dimensions: (1) Trench width, depth, length (2) Cell size (3) Cell configuration (4) Trench spacing (5) Fill depth (6) Interim cover soil thickness (7) Final cover soil thickness. c. Specify operational features: (1) Use of cover soil (2) Method of cover application (3) Need for imported soil (4) Equipment requirements (5) Personnel requirements (6) Asbestos burial area (7) Special waste disposal.
4	Design facilities: a. Leachate controls b. Gas controls c. Surface water controls d. Access roads e. Special working areas f. Structures g. Utilities h. Fencing i. Lighting j. Washracks k. Monitoring wells 1. Landscaping m. Debris control n. Methane collection and controls o. Liner and leak detection system p. Fire fighting q. Scales.

TABLE 4-2-6A
(cont'd)

Step	Task
5	Prepare design package:
	a. Develop preliminary site plan of fill areas
	b. Develop landfill contour plans
	(1) Excavation plans - including benches
	(2) Sequential fill plans
	(3) Completed fill plans
	(4) Fire, litter, vector, odor and noise controls.
	c. Compute solid waste storage volume, soil requirement volumes, and site life
	d. Develop final site plan showing:
	(1) Local area
	(2) Normal fill areas
	(3) Special working areas
	(4) Leachate controls
	(5) Gas controls
	(6) Surface water controls
	(7) Access roads
	(8) Structures
	(9) Utilities
	(10) Fencing
	(11) Lighting
	(12) Washracks
	(13) Monitoring wells
	(14) Landscaping
	(15) Debris or litter controls
	(16) Prevailing winds.
	e. Prepare elevation plans with cross sections of:
	(1) Excavated fill
	(2) Completed fill
	(3) Phased development of fill at interim points.
	f. Prepare construction details:
	(1) Leachate controls
	(2) Gas controls
	(3) Surface water controls
	(4) Access roads
	(5) Structures
	(6) Monitoring wells
	(7) Debris or litter controls.

TABLE 4-2-6A
(Cont'd)

Step	Task
5 (cont'd)	g. Prepare ultimate land use plan (take into account future use of land when filling is complete):
	h. Prepare cost estimate
	i. Prepare design report
	j. Prepare Environmental Assessment
	k. Submit application and obtain required permits
	1. Prepare operator's manual.

TABLE 4-2-6B
Sources of Existing Information

General Information	Specific Information	Source
Base Map	General	County road department
		City, county, or regional planning department
		U.S. Geological Survey (USGS) office or outlets for USGS map sales (such as engineering supply stores and sporting goods stores)
		U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), surveyors and aerial photographers in the area
	Topography and Slopes	USGS topographic maps
		USDA, ARS (Agricultural Research Service), SCS aerial photos
	Land Use	City, county, or regional planning agency
	Vegetation	County agricultural department
		Agriculture department at local university
Soils	General	USDA, SCS, district managers, Local Extension Service
		USGS reports
		Geology or Agriculture
		Department of local university
Bedrock	General	USGS reports
		State Geological Survey reports
		Professional geologists in the area
		Geology Department of local university
Groundwater	General	Water supply department
		USGS water supply papers
		State or regional water quality agencies
		USDA, SCS
		State or federal water resources agencies
		Local health department

TABLE 4-2-6C
Field Investigations for New Information General

Information	Specific Information	Method and Equipment
Base Map	Property boundaries	Field survey via transit
	Topography and slopes	Field survey via alidade
	Surface water	Field survey via alidade
	Utilities	Field survey via alidade
	Roads	Field survey via alidade
	Structures	Field survey via alidade
	Land use	Field survey via alidade
	Vegetation	Field survey via alidade
Soils	Depth	Soil boring and compilation of boring log
	Texture	Soil sampling and testing via sedimentation methods (e.g., sieves)
	Structure	Soil sampling and inspection
	Bulk density	Soil sampling and testing via gravimetric, gamma ray detection
	Porosity	Calculation using volume of voids and total volume
	Permeability	Soil sampling and testing via piezometers and lysimeters
	Moisture	Soil sampling and testing via oven drying
	Ease of excavation	Test excavation with heavy equipment
	Stability	Test excavation of trench and loading of sidewall or Hveem stabilimeter
	pH	Soil sampling and testing via pH meter
	Cation exchange capacity	Soil sampling and testing
Bedrock	Depth	Boring and compilation of boring log
	Type	Sampling and inspection
	Fractures	Field survey via alidade or Brunton
	Surface outcrops	Field survey via alidade or Brunton
Groundwater	Depth	Well installation and initial readings
	Seasonal fluctuations	Well installation and year-round readings

TABLE 4-2-6C
(cont'd.)

General Information	Specific Information	Method and Equipment
	Hydraulic gradient	Calculation based on permeability and hydraulic gradient
	Quality	Groundwater sampling and testing
	Uses	Field survey via Inspection
Climatology	Precipitation	Rain gauge
	Evaporation	Class A evaporation pan
	Temperature	Standard thermometer
	No. of freezing days	Minimum-maximum temperature thermometer
	Wind direction	Wind arrow

e. Groundwater monitoring well locations, depths, and configurations.

f. Details illustrating the types and locations for site facilities and nondimensioned configurations to be used, including draining structures, liners, gas control vents, and onsite roads.

g. Conceptual site closure plan indicating the types of vegetation to be used for final site landscaping, onsite appurtenances, and other improvements.

h. A conceptual design report, including a description of:

(1) Site conditions, including a description of existing site size, topography and slopes, surface water, utilities, roads, structures, land use, soil and groundwater, subsurface exploration data, bedrock, and climatology conditions.

(2) Design criteria including solid waste types and volumes expected, fill area dimensions, and site life.

(3) Operational procedures to be used to implement the design, including discussion of site preparation, solid waste unloading, handling, and covering procedures, as well as equipment and personnel requirements.

(4) Environmental safeguards including control of leachate, surface water, gas, blowing paper, odor, flies, etc.

(5) Initial site preparation and development steps.

(6) Site closure and post-closure monitoring/maintenance plan.

(7) Project cost estimates (generally prepared for in-house uses only).

2. Construction design plan and specifications:

Construction designs contain, at a minimum, all the elements of a conceptual design noted above. In addition, further details are provided to enable a bid package to be advertised for a contractor to fully construct all plan elements. For example, all drainage structures are completely sized; precise locations are noted by coordinates, bearing, and distance or other means; and environmental control systems, including those for leachate and landfill gas management, are fully designed. Also, a construction design package will include interim development plans showing fill surface and excavation contours, drainage structures, and road alignment at interim steps in the life of the landfill.

4.2.7 Landfilling Methods and Operations (Tchobanoglous, Theisen, and Eliassen 1977). To use the available area at a landfill site effectively, a

plan of operation for the placement of solid wastes must be prepared. Various operational methods have been developed, primarily on the basis of field experience. The methods to fill dry areas are substantially different from those used to fill wet areas.

4.2.7.1 **Conventional Methods for Dry Areas.** The principal methods used for landfilling dry areas may be classified as (1) area, (2) trench, and (3) depression. (See Figures 4-2-7A, B, and C.) In addition to these methods, which usually are used for unprocessed municipal solid wastes, landfilling using milled (shredded or compressed and baled) solid wastes is also discussed.

4.2.7.2 *Area Method.* The area method is used when the terrain is unsuitable for the excavation of trenches in which to place the solid wastes. Operationally (see Figure 4-2-7A) the wastes are unloaded and spread in long, narrow strips on the surface of the land in a series of layers that vary in depth from 16 to 30 in. Each layer is compacted as the filling progresses during the course of the day until the thickness of the compacted wastes reaches a height varying from 6 to 10 ft. At that time, and at the end of each day’s operation, a 6- to 12-in. layer of cover material is placed over the completed fill. The cover material must be hauled in by truck or earth-moving equipment from adjacent land or from borrow-pit areas.

4.2.7.3 The filling operation usually is started by building an earthen levee against which wastes are placed in thin layers and compacted. The length of the unloading area varies with the site conditions and the size of the operation. The width over which the wastes are compacted varies from 8 to 20 ft, again depending on the terrain. A completed lift, including the cover material, is called a cell (see Figure 4-2-7A). Successive lifts are placed on top of one another until the final grade called for in the ultimate development plan is reached. The length of the unloading area used each day shall be such that the final height of the fill is reached at the end of each day's operation.

4.2.7.4 If a small amount of usable cover material is available at the disposal site, the ramp variation of the area method is often used (see Figure 4-2-7B). In this method, solid wastes are placed and compacted as described for the area method and are partially or wholly covered with earth scraped from the base of the ramp. Additional soil must be hauled in, as in the area method. Because of increasing costs and the problems associated with obtaining usable cover material, the use of the ramp method must be based on a detailed economic feasibility study.

4.2.7.5 *Balefill Method.* Operation is similar to the area method except refuse is compressed and baled then stacked in the area prior to covering.

4.2.7.6 *Trench Method.* The trench method of landfilling is ideally suited to areas where an adequate depth of cover material is available at the site and where the water table is not near the surface. Typically, as shown in Figure 4-2-7C, solid wastes are placed in trenches varying from 100 to 400 ft in length, 3 to 6 ft in depth, and 15 to 25 ft in width. To start the process, a portion of the trench is dug and the dirt is stockpiled to form an

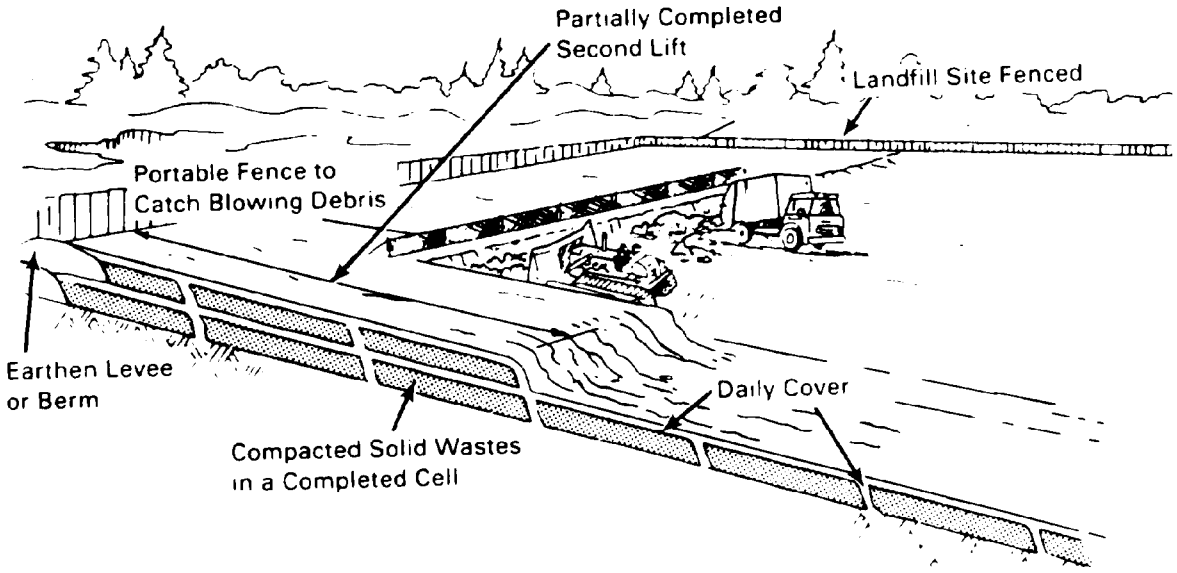


FIGURE 4-2-7A
Area Method of Operation for a Sanitary Landfill

embankment behind the first trench. Wastes are then placed in the trench, spread into thin layers (usually 18 to 24 in.), and compacted. The operation continues until the desired height is reached. The length of trench used each day shall be such that the final height of fill is reached at the end of each day's operation. The length also shall be sufficient to avoid costly delays for collection vehicles waiting to unload. Cover material is obtained by excavating an adjacent trench or continuing the trench that is being filled. The trench method, however, is not readily amenable to the proposed requirements for installation of liners and leachate collection and treatment systems.

4.2.7.7 *Depression Method.* At locations where natural or artificial depressions exist, it is often possible to use them effectively for landfilling operations. Canyons, ravines, dry borrow pits, and quarries have all been used for this purpose. The techniques to place and compact solid wastes in depression landfills vary with the geometry of the site, the characteristics of the cover material, the hydrology and geology of the site, and the access to the site.

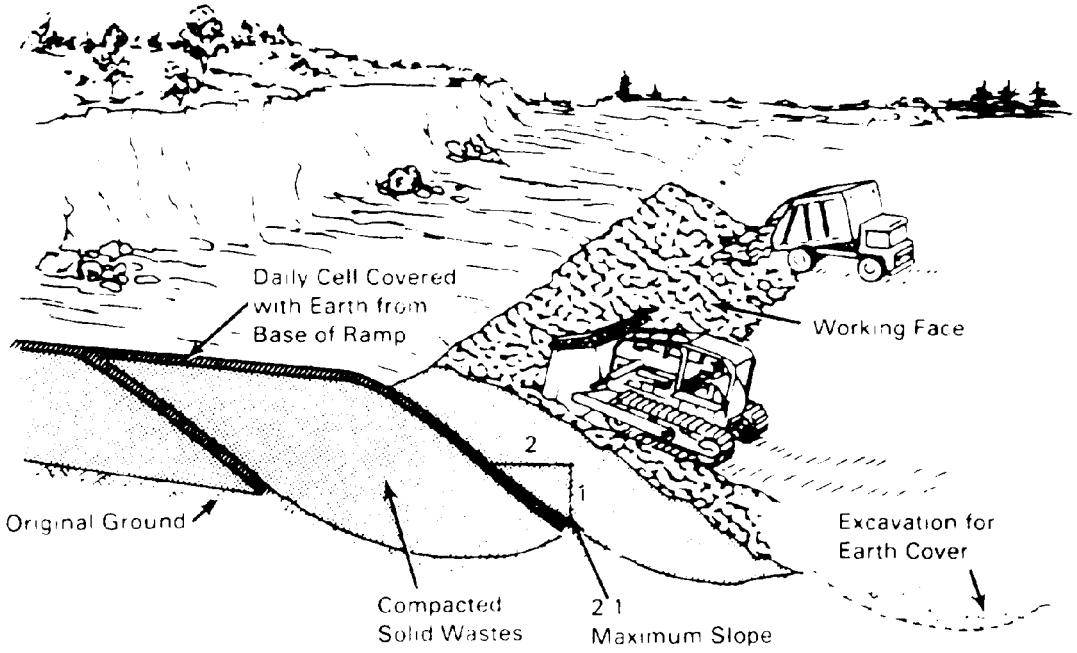


FIGURE 4-2-7B
Ramp Method of Operation for a Sanitary Landfill

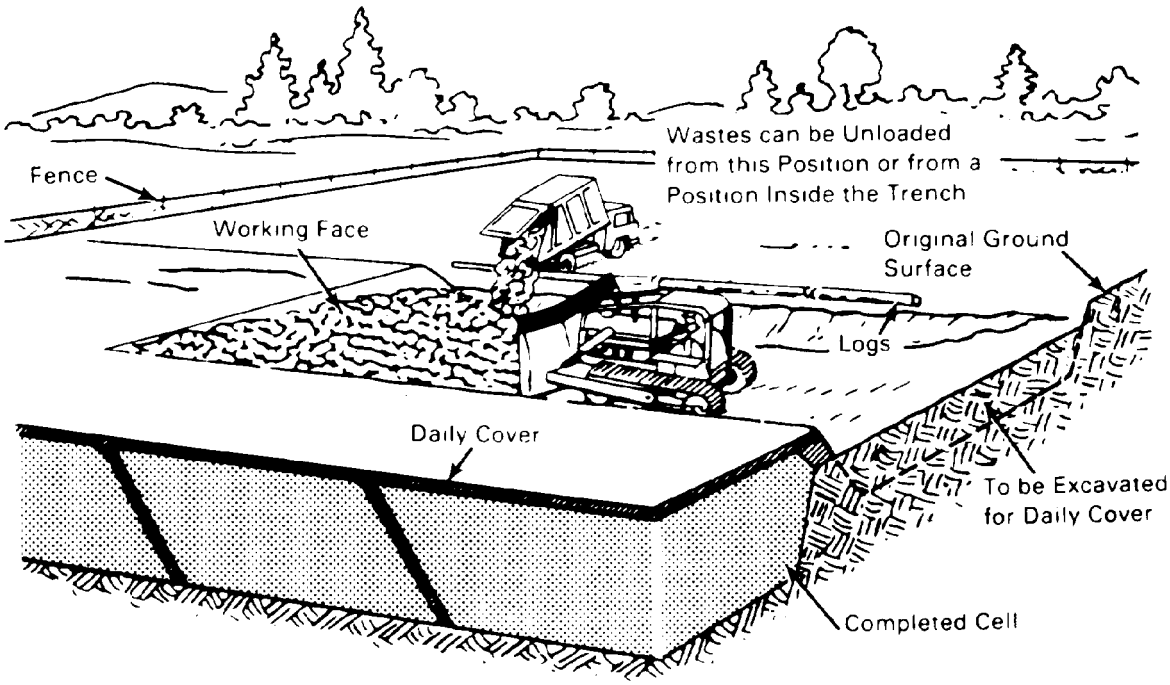


FIGURE 4-2-7C
Trench Method of Operation for a Sanitary Landfill

4.2.7.8 If a canyon floor is reasonably flat, the first fill in a canyon site may be carried out using the trench method operation discussed previously. Once filling in the flat area has been completed, filling starts at the head end of the canyon and ends at the mouth. An important consideration is that since the canyons and ravines are formed by water erosion, landfilling may involve a water course. This practice prevents the accumulation of water behind the landfill. Wastes usually are deposited on the canyon floor and from there are pushed up against the canyon face at a slope of about 2 to 1. In this way, a high degree of compaction can be achieved. Compacted densities as high as 1200 lb/yd^3 have been reported. Even higher densities have been recorded in the lower portions of the landfill as the height of the fill increases.

4.2.7.9 Pit and quarry landfill sites are always lower than the surrounding terrain, so control of surface drainage is often the critical factor in the development of such sites. Also, borrow pits and quarries usually do not have adequate soil or geological properties for landfilling because they display high permeability and fracturing. As with canyon sites, pit and quarry sites are filled in multiple lifts, and the method of operation is essentially the same. A key to the successful use of pits or quarries is the availability of adequate cover material to cover the individual lifts as they are completed and to provide a final cover over the entire landfill when the final height is reached. Because of settlement, it is usually desirable to fill pit and quarry sites to a level slightly above that of the surrounding terrain. The depression method is also not readily amenable to liners and leachate collection system.

4.2.7.10 *Evaluation of Seepage Potential* (Tchobanoglous, Theisen, and Eliassen 1977). Core samples must be obtained to evaluate the seepage potential of a site that is being considered for a landfill. Sufficient borings should be made so that the stratigraphic formations under the proposed site can be established from the surface to (and including) the upper portions of the bedrock or other confining layers. At the same time, the depth to the surface water table should be determined along with the piezometric water levels in any bedrock or confined aquifers that may be found.

4.2.7.11 The resulting information is then used to (1) determine the general direction of groundwater movement under the site, (2) determine whether any unconsolidated or bedrock aquifers are in direct hydraulic connection with the landfill, and (3) estimate the vertical seepage that might occur under the landfill site.

4.2.7.12 *Drainage and Seepage Control Facilities.* In addition to the seepage analysis , it is also necessary to develop an overall drainage plan for the area that shows the location of storm drains, culverts, ditches, and subsurface drains as the filling operation proceeds. In some cases it may also be necessary to install seepage control facilities.

4.2.7.13 To ensure the rapid removal of rainfall from the completed landfill and to avoid the formation of puddles, the final cover should have a slope of about 1%. Where relatively impervious cover material such as clay is used, lesser slope values may be feasible. The theoretical amount of water that could enter the landfill per unit area in a 24-h period for various cover

materials is given in Table 4-2-7A, assuming that (1) the cover material is saturated, (2)a thin layer of water is maintained on the surface, and (3) there is no resistance to flow below the cover layer.

TABLE 4-2-7A
Theoretical Volume of Water that Could Enter Completed Landfill Through 1 ft^2 of Various Cover Materials in 1 Day

Cover Material	Volume of Water, gal
Uniform coarse sand	9970
Uniform medium sand	2490
Clean, well-graded sand and gravel	2490
Uniform fine sand	100
Well-graded silty sand and gravel	9.7
Silty sand	2.2
Uniform silt	1.2
Sandy clay	0.12
Silty clay	0.022
Clay (30% to 50% clay sizes)	0.0022
Colloidal clay	0.000022

4.2.7.14 Clearly, these data are only theoretical values, but they can be used in assessing the worst possible situation. In actual practice, the amount of water entering the landfill will depend on local hydrological conditions, the characteristics of the cover material, the final slope of the cover, and whether vegetation has been planted.

4.2.7.15 Among the methods to control the seepage into and out of landfills are (1) the use of impermeable cover materials, (2) the interception of high groundwater before it reaches the fill, (3) equalization of the water levels within and outside the landfill, and (4) the use of an impervious layer of clay material or other sealants.

4.2.7.16 **Conventional Methods for Wet Areas**. Recently, because of concern over the possibility of groundwater contamination by leachate and gases from landfills and the development of odors, the direct filling of wet areas is no longer considered acceptable. Installation personnel need to consult with the state agency before considering disposal in wet areas because it may be illegal. If wet areas are to be used as landfill sites, special provisions must be made to contain or eliminate the movement of leachate and gases from completed cells. Usually this is accomplished by first draining the site and then lining the bottom with a clay liner or other appropriate sealants. If a clay liner is used, it is important to continue operation of the drainage facility until the site is filled in order to avoid the creation of uplift pressures that could cause the liner to rupture from heaving.

4.2.7.17 **Equipment**

4.2.7.18 A wide variety of equipment is available from which to select the proper type and size needed for an efficient operation. The size, type, and amount of equipment required at a sanitary landfill depends largely

on the size and method of operation and, to some degree, on the experience and preference of the operators (Tables 4-2-7B and 4-2-7C). The most common equipment used on sanitary landfills is the crawler tractor, which can be used with a dozer blade, trash blade, or front-end loader. A tractor is versatile and can normally perform all required operations: spreading, compacting, covering, trenching, and hauling the cover material. If a machine is required nearly full time for compaction, it is economically advisable to purchase a landfill compactor. Other types of equipment commonly used at large sanitary landfills, where specialized equipment increases overall efficiency, are scrapers, draglines, graders, rubber-tired loaders, and water trucks. Rubber-tired tractors are recommended for certain landfill operations. Use of this type of equipment, however, leads to a continuous tire maintenance problem and increased equipment downtime. Sketches of a crawler tractor, steel-wheeled tractors, and self-loading scraper are shown in Figures 4-2-7D, E, and F, respectively. Vehicles will have Roll Over Protection/Fall Protection without regard to age of vehicle. (29 CFR 1926.1000.)

4.2.7.19 These types of equipment are designed to perform the following major functions:

1. Waste Handling. This function includes the moving, spreading, and compaction of the waste.

2. Cover Material Handling. Cover material handling includes the excavation, transportation, distribution, and compaction of the cover material.

3. Support Functions. Support functions include the construction and maintenance of the access roads, the control of dust, and protection against fires.

4.2.7.20 Sanitary landfills that handle about 150 tons (136 metric tons), or less, of solid waste per day can normally operate efficiently with one piece of equipment; but provisions must be made for standby equipment. Large landfills that handle more than 300 tons (272 metric tons) of solid waste per day will require more than one piece of equipment. At these sites, specialized equipment can be utilized to increase efficiency and minimize costs.

4.2.7.21 Closure Plans

4.2.7.22 Site closure can be both expensive and difficult if it is not included as part of the initial landfill design.

4.2.7.23 Three basic goals need to be achieved. First, closure shall minimize the need for further maintenance at the landfill site. Second, closure shall place the landfill in a condition that will have the least possible detrimental environmental impacts in the future. Third, the closure plan should consider preparation of the site for future use.

TABLE 4-2-lB

Average Equipment Requirements

	Equipment			
Daily Tonnage	No.	Type	Size	Accessory(1)
0 to 41.7 metric tons	1	Crawler or rubber-tired tractor (0 to 46 tons)	4536 to 13,608 kg (10,000 to 30,000 lb)	Dozer blade Landf ill blade Front-end loader (0.9- to 1.8-rn) (1— to 2-yd)
41.7 to 140.6 metric tons (46 to 155 tons)	1	Crawler or rubber-tired tractor (30,000to	13,608 to 27,216 kg Front-end loader 60,000 lb)	Dozer blade Landfill blade (1.8- to 3.7-rn) (2- to 4-yd)
	(1)	Steel-wheeled		Multipurpose bucket
		compactor Scraper Dragline Water truck		
140.6 to 281.2 metric tons (155 to 310 tons)	1 to 2	Crawler or rubber-tired tractor	13,608 kg (30,000 lb) or more	Dozer blade Front-end loader (1.8— to 4.6-rn) (2- to 5-yd)
	(1)	Steel-wheeled		Multipurpose bucket
		compactor Scraper Dragline Water truck		
281.2 metric tons (310 tons) or more	2 or more	Steel-wheeled compactor	11,690 kg (39,000 lb) or more	Dozer blade Landfill blade Front-end loader
	(1)	Scraper Dragline Road grader Water truck		

(1) Specialized equipment that can improve operation efficiency.

TABLE 4-2-7C
Equipment Selection Guidance for Multiple Unit Sites
(from Eldredge 1974)

Equipment Function	Equipment									
	Loader	Dozer	Compactor	Scraper	Track	Rubber	Dragline	Backhoe	Truck	Motor Grader
Spread Refuse	A	A	A		0	0	0	0	0	0
Compact Refuse	A	A	A		0	0	0	0	0	0
Excavate Cover	A	A	0		A(1)	A(1)	A	A	0	0
Haul Cover										
91 m (300 ft) or less	A	A	B		A	0	C	C	C	0
91 m-305 m (300 ft-1000 ft)	C	0	0		A	B	C	C	C	0
More than 305 m (1000 ft)	C	0	0		0	A	C	C	C	0
Spread Cover	A	A	A		B	B	0	0	0	B
Compact Cover	A	A	A		0	0	0	0	0	0
Shape Cover	B	B	B		B	B	0	0	0	A

A = Excellent choice
B = Secondary choice
C = "In-Combination Only" choice
0 = Not applicable or poor choice
(1) = Scrapers may require loading assistance in tough soils and adverse weather conditions

Courtesy of Eldredge, R. W., "Selection of Sanitary Landfill Equipment," Waste Age, January/February, 1974.

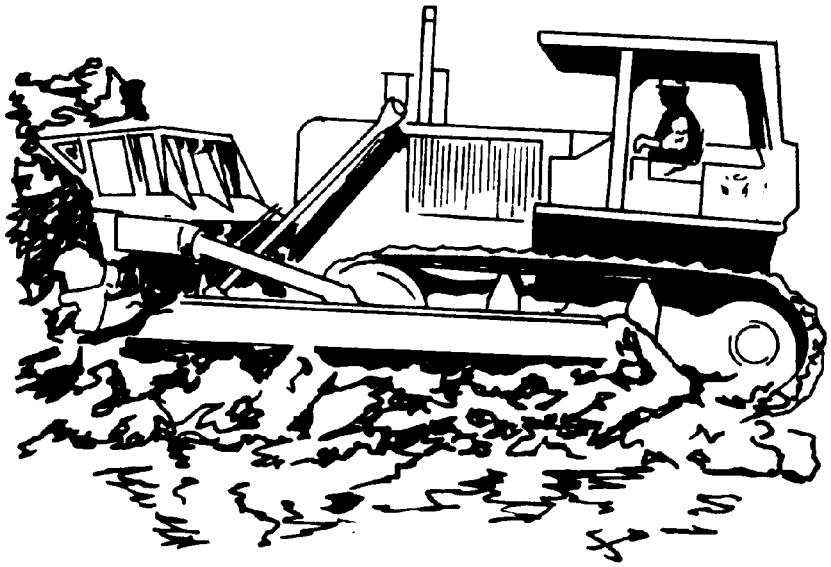


FIGURE 4-2-7D
Crawler Tractor

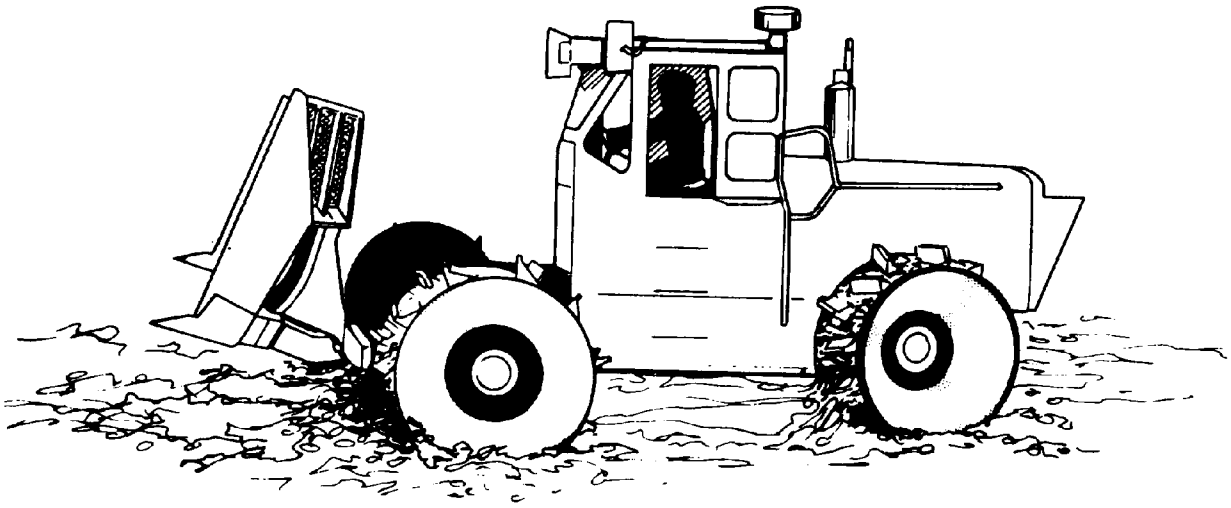


FIGURE 4-2-7E
Steel-Wheeled Compactor

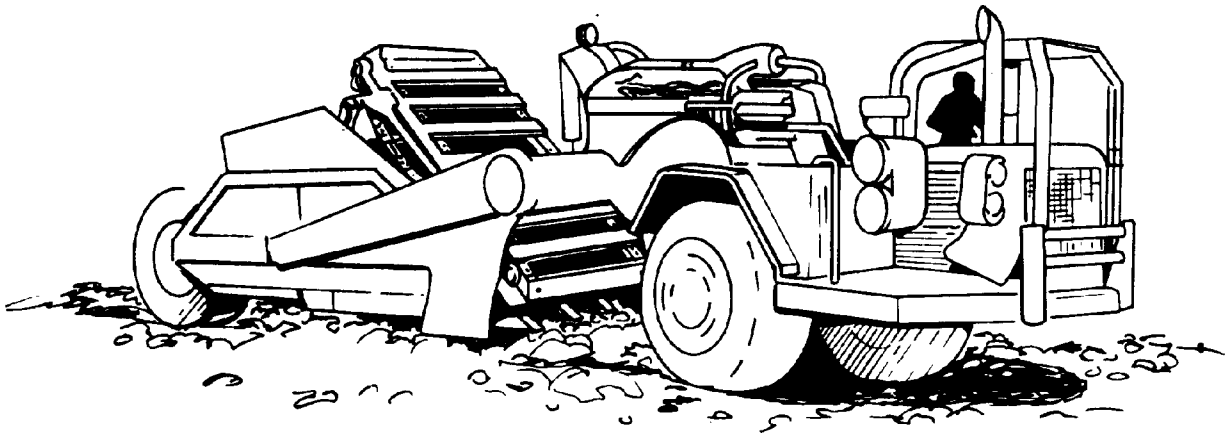


FIGURE 4-2-7F
Self-Loading Scraper

4.2.7.24 Table 4-2-7D (Robinson 1986) identifies tasks that must be accomplished during site closure. Some regulatory agencies are requiring that the developer prepare a closure plan as part of the initial plans for the landfill. If a closure plan has not been developed, the tasks identified in the table under “Preplanning” must be completed. Preplanning includes specifying the final topographical contours for the landfill and establishing procedures for storm water removal.

4.2.7.25 A source of cover shall be identified when the fill is designed. If additional cover material will be needed, it shall be brought to the site while the landfill is operating. This will ensure that cover is available when the landfill is closed, and the cost can be recovered from current landfill users. Another preplanning element is preparing a landscaping and vegetative cover plan for implementation upon closure. This is in addition to planning other features of the landfill such as gas vents, leachate collection facilities, or groundwater monitoring systems. A schematic of a closed landfill is shown in Figure 4-2-7G. Impermeable membranes are used to control movement of landfill gases and leachate.

TABLE 4-2-7D
Site Closure Checklist

Preplanning

Identify final site topographic plan.
Prepare site drainage plan.
Specify source of cover material.
Prepare vegetative cover and landscaping plan.
Identify closing sequence for phase operations.
Specify engineering procedures for the development of onsite structures.
Annotate base maps showing landfill area, time period, and source for further details.

Six Months Before Closure

Review closure plan for completeness.
Schedule closing date.
Prepare final timetable for closure procedures.
Notify appropriate regulatory agency.
Notify site users by letter if they are municipalities or contract haulers, and by published announcement if private dumping is allowed.

At Closure

Erect fences or appropriate structures to limit access.
Post signs indicating site closure and alternative disposal sites.
Collect any litter or debris and place in final cell for covering.
Place cover over any exposed refuse.

Three Months After Closure

Complete needed drainage control features or structures.
Complete, as required, gas collection or venting system, leachate containment facilities, and gas or groundwater monitoring devices.
Install settlement plates of other devices for detecting subsidence.
Place required thickness of earth cover over landfill.
Establish vegetative cover.

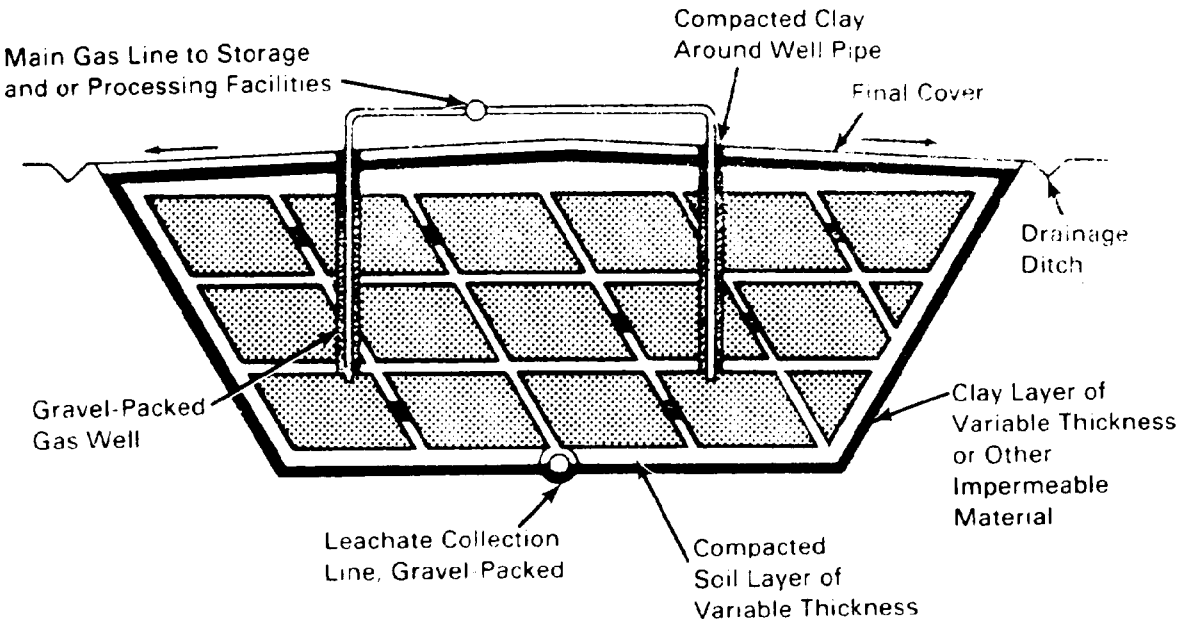


FIGURE 4-2-7G
Use of Impermeable Liners to Control Movement of Gas and Leachate

4.2.7.26 The long-term maintenance of a closed landfill site will be a function of the ultimate site use. Many current landfills have gas and leachate collection systems that will require continuous attention after closure. Groundwater monitoring devices may also be incorporated into the design to check the performance of the leachate control system. Other site features that will require a degree of attention on a continuing basis are drainage control structures and erosion control features.

4.2.7.27 Methane gas control systems may be either active or passive. Passive systems allow the gas to escape to the atmosphere by natural means. The blower and pumps in the active system require periodic maintenance. In addition, the withdrawal pipes and collection lines may need condensate removed and repairs of damage caused by differential settling.

4.2.7.28 Leachate collection systems installed at landfills will require continuous attention once the landfill is closed. The leachate collection system must be maintained to ensure effective operation. This work may include annual leachate collection pipe cleaning, collection tank cleaning, and inspection and pump cleaning and repairs. Collected leachate needs to be disposed of in the appropriate manner. Failure to withdraw leachate could allow it to seep out of the side of the landfill and possibly contaminate groundwater. Records shall be maintained that show the quantity of leachate removed. The leachate quantity will vary with the season of the year and shall be carefully monitored, possibly with automated signaling devices to ensure that it is being properly removed. The duration over which this must be practiced is somewhat uncertain. Regulations require that many

landfills have a groundwater monitoring system incorporated into their design. The purpose of these wells is to evaluate the performance and design of the facilities provided for leachate control.

4.2.7.29 Drainage control problems can result in accelerated erosion of a particular area within the landfill. Differential settling of drainage control structures can limit their usefulness and may result in failure to direct storm water properly off the site. Serious erosion problems can result from improper drainage control.

4.2.7.30 The site closure plan should consider that sites larger than 10 acres be prepared for the DoD forestry program if no more productive use is planned. Production of species with shallow root systems, such as Virginia pines or cedar, for Christmas trees may be a viable alternative.

4.2.7.31 The criteria for Solid Waste Disposal Facilities are currently undergoing revision by the EPA. The proposed (1988) revisions are included in Appendix A-I.

4.2.8 Volume Reduction

4.2.8.1 Reducing the volume of solid waste has the potential for cost savings when land costs are high or space is unavailable, or transfer and long-distance hauling are necessary. Several processes are available for consideration. All are expensive and shall be justified only when significant cost savings can be achieved in the disposal process. Table 4-2-8A summarizes advantages of common waste processing techniques. Resource recovery is discussed in Section 4.3. Incineration is the topic of Section 4.4.

4.2.8.2 Mechanical volume reduction by compaction is widely practiced. Shredding is less common because component wear (cost) is high. Table 4-2-8B lists several types of commercially available compaction equipment. Table 4-2-8C gives important design factors to consider in the selection of compaction equipment.

4.3 RESOURCE RECOVERY AND RECYCLING

4.3.1 *Resource Conservation.* Resource conservation is defined as the reduction of the amounts of solid waste that are generated, reduction of overall resources consumed, and utilization of recovered resources. DoD policy is that solid and other waste materials will be reduced at the source whenever possible.

4.3.2 *Reuse/Recycling.* Reuse is defined as the use of a waste material or product more than once without any change in form. For example, a soft-drink bottle is reused when it is returned to a bottling company and refilled. Recycling is the process by which reclaimed resources are transformed into new products in such a manner that the original products may lose their original forms. A market analysis is essential before instituting recycling programs. The material must be in a form that the market will accept (i.e., clean, segregated, etc.). For example, an aluminum can is recycled when it is returned to the smelter, melted, and reformed into sheet aluminum to be manufactured into a new can or another completely different product. The

TABLE 4-2-8A
Solid Waste Processing Methods

Processing Method	Description	Advantages	Disadvantages
Baling (mechanical volume reduction)	Compresses various raw solid wastes into uniform shapes	Extends life of land disposal site Can handle variety of solid wastes Bulk reduction makes long hauls more economic Bales are more convenient for rail hauling Minimal land settling and gas generation compared with other sanitary landfills Corrugated containers and paper can be baled for sale Potential for 50% volume reduction	High initial investment per ton Precludes resource recovery after bale is formed
Shredding (mechanical size reduction)	Breaks up wastes through crushing, grinding, chipping, or tearing (Reciprocating blades only. Hammermills are not to be used on military installations.)	Handles most types of wastes Significant volume reduction (25-60%) Ferrous metal can be recovered for recycling via magnetic separation	Not useful on large or high moisture wastes Component wear is high Explosive materials are a hazard when processed by the shredder Dust and debris discharge is high
Component Separation (Resource Recovery, see Section 4.3.1)	Manual or mechanical removal of salable materials from the waste stream	Recovers valuable resources Generates income Reduces ultimate refuse weight and volume	Labor intensive (even with mechanical systems) Requires local market for most recovered materials in order to be economic
Incineration (Chemical Volume Reduction, see Section 4.3.2)	Controlled burning of solid, liquid, or gaseous waste	Weight reduction of 60-70% is practical. Volume reduction of 80-90% achieved on most municipal wastes Adaptable to energy recovery processes such as steam generation Some waste products can be salvaged after incineration	Large capital expenditures High operating costs Requires skilled labor for operation Improper operation can result in air, water, and land pollution Cannot handle bulky, slow combustion, or high temperature burning materials

TABLE 4-2-8B
Compaction Equipment Used for Volume Reduction

Location or Operation	Type of Compactor	Remarks
Solid waste generation points	Stationary/residential	
	Vertical	Vertical compaction ram; may be mechanically or hydraulically operated; usually hand-fed; wastes compacted into corrugated box containers or paper or plastic bags; used in medium- and high-rise apartments.
	Rotary	Ram mechanism used to compact wastes into paper or plastic bags on rotating platform, platform rotates as containers are filled; used in medium- and high-rise apartments.
	Bag or extruder	Compactor can be chute-fed; either vertical or horizontal rams; single or continuous multibags; single bags must be replaced and continuous bags must be tied off and replaced; used in medium- and high-rise apartments.
	Undercounter	Small compactors used in individual residences and apartment units; wastes compacted into special paper bags; after wastes are dropped through a panel door into bag and door is closed, they are sprayed for odor control; button is pushed to activate compaction mechanism.
	Stationary/commercial	Compactor with vertical or horizontal ram; waste compressed into steel container; compressed wastes are manually tied and removed; used in low-, medium-, and high-rise apartments, commercial and industrial facilities.
Collection	Stationary/packer	Collection vehicles equipped with compaction mechanisms
Transfer and/or processing station	Stationary/transfer trailer	Transport trailer, usually enclosed, equipped with self-contained compaction mechanism.
	Stationary	
	Low pressure	Wastes are compacted into large containers.
	High pressure	Wastes are compacted into dense bales or other forms.
Disposal site	Movable wheeled or tracked equipment	Specially designed equipment to achieve maximum compaction of wastes.
	Stationary/track-mounted	High-pressure movable stationary compactors used for volume reduction at disposal sites.

TABLE 4-2-8C
Important Design Factors in the Selection of Conventional Compaction Equipment

Factor	Value		Remarks
	Unit	Range	
Size of loading chamber	yd^3	< 1-11	Fixes the maximum size of wastes that can be placed in the unit.
Cycle time	s	20-60	The time required for the face of the compaction ram, starting in the fully retracted position, to pack wastes in the loading chamber into the receiving container and return to the starting position.
Machine volume displacement	yd^3/h	30-1500	The volume of wastes that can be displaced by the ram in 1 h.
Compaction pressure	$lb/in.^2$	15-50	The pressure on the face of the ram.
Ram penetration	in.	4-26	The distance that the compaction ram penetrates into the receiving container during the compaction cycle. The further the distance, the less chance there is for wastes to fall back into the charging chamber and the greater the degree of compaction that can be achieved.
Compaction ratio		2:1-8:1	The initial volume divided by the final volume after compaction. Ratio varies significantly with waste composition.
Physical dimensions of unit	variable	variable	Affects the design of service areas in new building and provision of service to existing facilities.

Note: yd3 x 0.7646 m 3 ^{3}
yd3/h x 0.7646 = m^3/h
$lb/in.^2$ x 0.0703 = kg/cm^2
in. x 2.54 = cm

recycling of used oils and solvents is discussed in Section 4.4. The military specification (MIL-F-2495) that allows the reclamation of used oils and solvents is given in Table 4-3-2A. Both of these methods are resource conservation measures because the original products do not enter the waste stream and require disposal.

TABLE 4-3-2A
Specifications for Fuel Oil Reclaimed (MIL-F-2495)

Characteristics	Requirements	FED-STD 791 Test Method	ASTM Test Method
API Gravity @ 60°F (hydrometer range)	25-40		0 287
Viscosity at 1O4°F (40°C) range Kinematic Viscosity, cts	2.0-15.0		D 445
Viscosity @ 122°F (50°C) range Saybolt Universal Seconds	30-90		0 88
Flash Point (mm.)	130°F/55°C		D 93
Pour Point (max.)	20°F/-6.7°c		D 97
Sulfated Ash, Percent (max.)	0.15		D 874
Water & Sediment, Percent (max.)	2.0		D 1796
Neutrality	Neutral	5101	
Sediment Percent (max.)	0.5		0 473
Chlorinated Material 1.1)	No Green Flame		
Sulfur Content, Percent (max.)	2.0		D 129(2)
Explosiveness, Percent (max.)	50	1151.1	

(1) FOR (Fuel Oil Reclaimed) shall be essentially free of chlorinated material. To determine the presence of chlorinated material, a clean copper wire is heated in a clear blue gas flame (to red heat) until no green shows in the flame. The wire is dipped while still hot (into a sample of FOR) and then put back into the flame. No green shall show in the flame. (For practice, a blend of 1% trichloroethane in DFM or other distillate fuel *may* be used as a sample of an oil that fails this test. The oil should be purged of any sodium chloride by washing with fresh water.)

(2) (Or other approved ASTM method.) In the United States, sulfur limits shall be as specified by the EPA, state, or community where the fuel is to be used, whichever is more restrictive. In foreign countries, the sulfur limit shall conform to the limit established in the Status of Forces Agreement.

4.3.3 *Material Conservation.* Another method of resource conservation is to reduce the amount of material used to make certain products. Normally, this will have very little effect on military installations. However, there are three ways in which material conservation can be encouraged on military installations. (1) Encourage purchase of materials with a minimum amount of packaging. Many times the packaging in a shipment is larger or heavier than

the material it protects. This is unavoidable in the shipment of delicate instruments, computer components, etc; however, many times durable goods are shipped in the same manner. (2) Shipping and packaging specifications shall be written in order to avoid use of excess packaging. Military procuring agencies shall inventory shipping and packaging policies to determine if unnecessary packaging is being used or required. (3) Reuse of cartons and packaging materials may also be encouraged in some instances.

4.3.4 *Use of Recycled Materials.* The Resource Conservation and Recovery Act (PL 94-580) requires federal procuring agencies to "procure items composed of the highest percentage of recovered materials practicable consistent with maintaining a satisfactory level of competition." [Section 6002(c)(1)(a)]. This requirement applies to items with a purchase price in excess of $10,000 or where a quantity of items purchased in the preceding fiscal year was $10,000 or more [Section 6002(a), RCRA]. These policies have resulted in federal agencies being required to evaluate their procurement regulations and have helped create a market for recycled, and therefore recyclable, materials. Procurement of materials in such a manner to minimize the generation of wastes is required.

4.3.4.1 Careful planning by procurement agencies to order items containing recycled materials will result in their being ordered in large quantities. This practice will result in reduced per unit costs. Some items that regularly contain recycled materials and which are ordered by most federal purchasing agencies are paper products (especially office paper, packaging, paper towels, and bathroom tissue) and certain types of metals, plastics, and fabrics. Re-refined oil may also be purchased in bulk quantities by procurement agencies. Where it has been shown to be more economical than burning used oil in heating plants, make every effort to enter into a program in which waste oil generated by the installation may be sold to a re-refiner and re-refined oil purchased for a reduced price. Current military specifications allow for the use of re-refined oil in administrative vehicles. As these specifications are expanded to include tactical vehicles, procurement agencies shall in turn eliminate specifications requiring the purchase of virgin petroleum products and preventing the purchase of re-refined products.

4.3.5 *Minimize Waste.* Commanders shall ensure that waste of military items and property is prevented. One way is to conduct a survey to determine waste generated by shops and other facilities. The items found by the survey shall be evaluated to determine if waste could be minimized by substitution of materials, change of process, or elimination of material or process. Every effort shall be made to procure items so that the items or components of the items can be converted to other users when no longer suitable for their original use. Some examples of waste reduction applicable to military installations are:

- use of refillable beverage containers
- use of reusable food service plates, cups, and utensils
- use of both sides of paper in printing reports and documents
- use of recyclable packaging containers for procurements.

4.3.5.1 Military agencies shall make every effort to prevent overissue of expendable items. Procurement agencies shall make every effort

to ensure that the product ordered is the product actually required to accomplish the task. Using the product for which it was designed will help to extend its functional lifetime.

4.3.6 Recovery of Resources

4.3.6.1 **Why Establish a Resource Recovery and Recycling Program?** The Military Construction Codification Act (PL 97-214) became effective 1 October 1982. The provisions of this Act expanded the scope of recyclable materials and provided increased incentives for implementing recycling programs. Under appropriate departmental guidance, generators of recyclable materials can establish Qualifying Recycling Programs (QRP). Expenses of operating and improving recycling programs must be accumulated and reimbursed from proceeds of sales of recyclable materials prior to any other disposition of the proceeds.

4.3.6.2 Projects such as those described in Section 2577(b)(2) of the Act are not to be included in the normal military construction program if sufficient recycling program proceeds are available at the installations needing the projects. Accumulation of proceeds from sales of recyclable materials is authorized only for installations with qualifying recycling programs. The proceeds from the sale of recyclable materials must be deposited into **F3875 "Budget clearing account (suspense)" and segregated within that account to ensure proper accounting as to the amounts collected and their disposition. The accumulation of funds in **F3875 is not affected by fiscal year end, so proceeds acquired during one fiscal year may be carried forward and merged with proceeds of subsequent fiscal years. Reimbursements to operation and maintenance accounts to cover the expenses of recycling programs shall be made from **F3875 as needed within a fiscal year. Funds remaining in **F3875 after reimbursement of expenses may be used only for projects and activities as described in Section 2577(b)(2) or may be disbursed to the morale and welfare account of the installation pursuant to Section 2577(b)(3) or both. If the balance of an installation’s proceeds remaining in **F3875 exceeds $2,000,000 at the end of each fiscal year, the amount in excess of $2,000,000 must be deposited into the U.S. Treasury as miscellaneous receipts.

4.3.6.3 Successful recycling programs exist at many military installations. For example, for FY 87, four installations reported proceeds in excess of $500,000. Additionally, 19 other activities reported proceeds in excess of $100,000 for the same year.

4.3.6.4 Paper goods, including cardboard, are the materials most often recycled. At support or construction activities scrap metal and sometimes scrap wood are important sources of income for recycling programs. Recycling aluminum cans is best in areas where aluminum is produced. Otherwise transportation costs significantly decrease net income to the base.

4.3.7 Development of Resource Recovery and Recycling Program. A Resource Recovery and Recycling Program (RRRP) must be developed systematically and be justified economically. The main steps involved in establishing a new program are shown in Figure 4-3-7A.

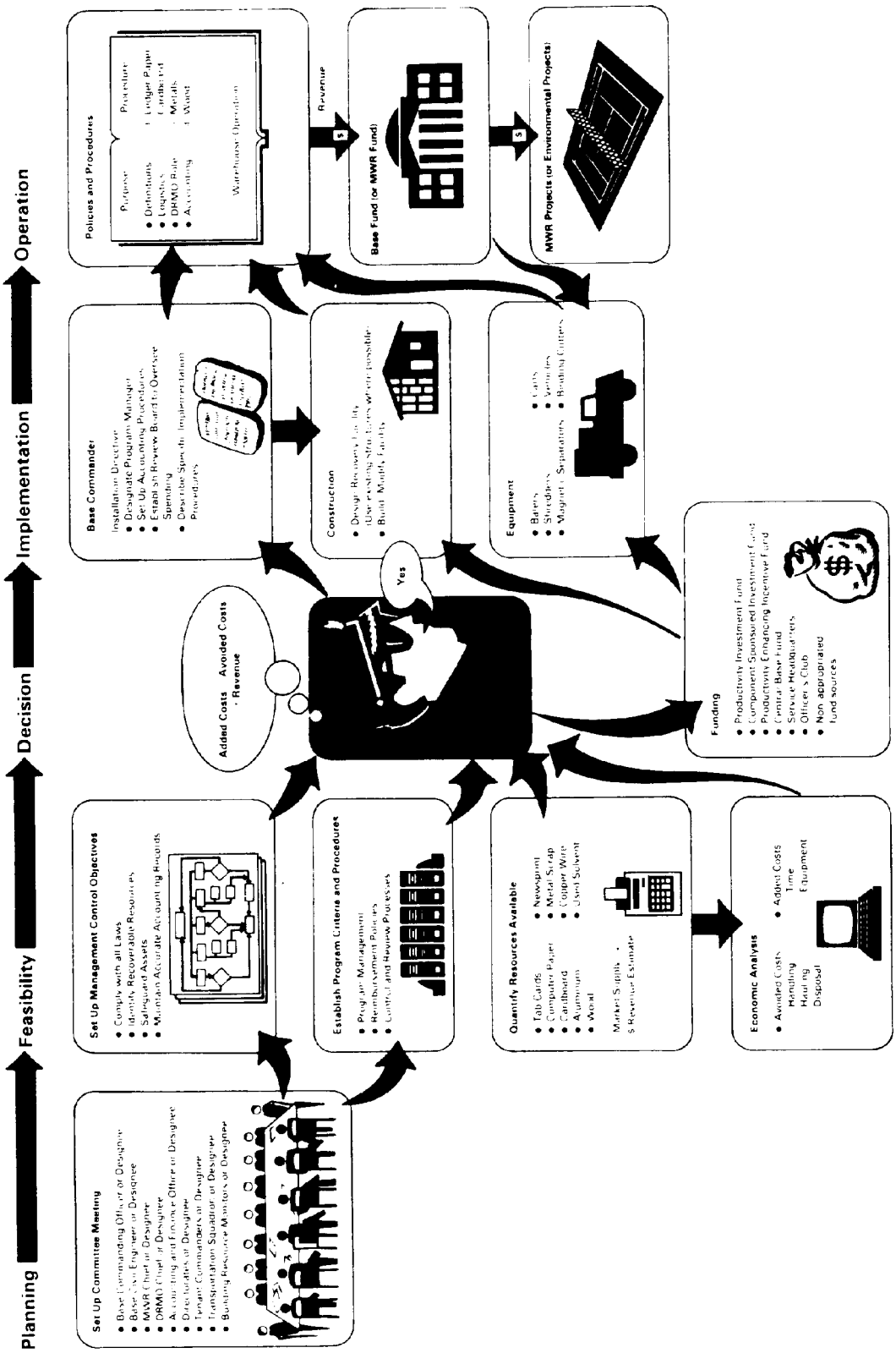


FIGURE 4-3-7A
Establishing a New RRRP

4.3.7.1 **Program Initial Steps**

4.3.7.2 A successful program requires an advocate who is willing to follow its development from conception to finalization. That person could be anyone from a civilian employee to the base commander.

4.3.7.3 The advocate must first start by calling together people who will eventually be involved in actual operation of. the program. Suggested participants are the Chief of Morale, Welfare, and Recreation (MWR), the Chief Civil Engineer, a representative from DRMO, a representative from fire and safety, and the base financial officer. The meeting should focus on procedures for actually setting up a QRP.

4.3.7.4 **Identification of Recyclable Materials.** Commanders and commanding officers of military installations are encouraged to strongly support the base RRRP. While industrial fund installations may be conducting individual programs to sell scrap generated in their operations, they may contribute to the installation program any materials that do not qualify for inclusion in their sales programs or any scrap that they cannot sell economically.

4.3.7.5 *Recyclable Materials.* Materials qualifying for sale under the program are materials that normally have been or would be discarded (i.e., scrap and waste) and that may be reused after undergoing some type of physical or chemical processing. Unless specifically excluded, any material that meets this definition may be sold under this program. Table 4-3-7A is an excerpt from program guidance listing some potentially recyclable materials. The definition of recyclable materials SPECIFICALLY EXCLUDES the following materials:

1. Precious-metal-bearing scrap.

2. Items that may be used again for their original purposes or functions without any special processing, e.g., used vehicles, vehicle or machine parts, bottles (not scrap glass), electrical components, unopened containers of unused oil/solvent, furniture, filing cabinets, etc.

3. Ships, planes, weapons, or any discarded material that must undergo demilitarization or mutilation prior to or as a condition of sale.

4.3.7.6 Dollar values fluctuate frequently and may vary signifi-cantly from the listed values based on various economic factors. Whether a waste may or may not be cost effectively recycled depends on local conditions. Some areas may not have a market for certain materials, or an installation may not have a large enough generation rate of a particular material to make recycling cost effective. Activities may have to pay for removal of some recyclable materials but could save money through avoided cost for disposal in a landfill or incinerator. Prices listed in the table may vary greatly depending on location and quality of the material. The DRMD market analysis shall identify which wastes are marketable in any areas.

4.3.7.7 The quality of the waste material also plays a major role in determining its value. DRMO will not segregate materials for an

TABLE 4-3-7A

Potentially Recyclable Materials

Material	Value[1]	Comments
Tab cards	$47-210/net ton	If cards are colored, values drop.
Computer paper	$50-200/net ton	Cannot contain carbon or staples.
Cardboard	$5-45/net ton	Must have efficient baler to be feasible.
Aluminum	$0.12-0.40/lb	Includes aluminum cans. Value increases if aluminum is clean and does not contain iron.
Rubber	$0.01-0.05/lb	Does not include usable tires.
Glass cullet	$0.01-0.02/lb	Markets are scarce.
Used oil	$0.10-0.40/gal	May fall under reutilization Program. (2)
Used solvents	$0.l0-0.36/ gal	As permitted by Used Solvent Elimination Programs
Newsprint	$4-15/net ton	Although it is rare, values of $151/net ton have been obtained.
Metal scrap (light)	$10-67/gross ton	
Metal scrap (heavy)	$45-70/gross ton	
Copper wire (bare)	$0.25-0.50/lb	
Copper wire (insulated)	$0.20-0.22/lb	
Scrap wood	$0.01-0.10/lb	
Hydraulic fluid	$0.22-0.50/gal	
Used coolants	$0.45-0.50/gal	
Items which have exceeded shelf-life		Some require chemical or physical (i.e., recontainerization) processing
Acids		
Bases		
Cooking grease, bones and fat	$0.02-0.16/lb $0.04-0.09/lb	

(1) All values were obtained during a September 1984 survey.
(2) Commands are authorized to sell contaminated fuels or waste oils through DRMO only after it has been determined that the material is excess of the military's needs.

but they will advise on the degree of segregation necessary for the most cost-effective operation. Quality control of source separation techniques is essential. For example, when recycling mixed paper, it is important that employees do not throw paper clips, carbons, and other trash into collection boxes.

4.3.7.8 Table 4-3-7B shows how detailed the price structure breakdown can be for paperstock materials. The table also illustrates that prices will vary depending on markets. The end consumers for many recycled goods on the West Coast are the Pacific Rim countries. This market is just developing now, but future growth looks good.

4.3.7.9 Packaging is also important; for example, because of bulk storage and transportation problems, cardboard cannot be economically recycled unless it is baled. Some materials also need to be packaged according to certain specifications.

4.3.7.10 Remember, if the item needs to be chemically or physically processed before reuse, then it is properly defined as a recyclable item. As examples, for expired shelf-life items, recontainerization is physical processing; chemical processing could mean increasing the concentration of a chemical that has become insufficient to do the job [calcium hypochlorite with a chlorine level that has dropped from 17% (MILSPEC levels) to 10% could be reblended with chlorine to bring up the chlorine content].

4.3.7.11 Plastics recycling is not yet widely practiced at military installations. Concern over pollution caused by plastics during incineration and environmental concerns about longevity in landfills may force increased activity in that area.

4.3.7.12 In the commercial sector plastics recycling is beginning to increase (Basta and MacKerron 1988; Crawford 1988). Potential end uses include decorative beams, railroad ties, and other shapes for landscaping. Shredding plastics and using them as fiberfill is another end use.

4.3.7.13 Preparing Criteria and Procedures. General criteria and procedures for establishing a recycling program are summarized below but must be adapted to fit particular installations.

4.3.7.14 *Program Criteria.* A qualifying recycling program is defined as an organized operation that requires concerted efforts to divert or recover scrap or waste from waste streams, as well as efforts to identify, segregate, and maintain or enhance the marketability of the materials.

4.3.7.15 A prerequisite for setting up an installation program is to ascertain that the program is both feasible and cost effective by identifying potentially recyclable materials, estimating generation rates, determining if adequate markets exist, and conducting an economic analysis for each material. (Details of the economic analysis are given later in this section.)

4.3.7.16 An installation program must be formally established with provisions for program management, reimbursement for program expenses, administration, accounting, and proper control and review of projects to be funded.

TABLE 4-3-78
Paperstock Markets and Prices[1]
(Nominal Prices in $/Ton, Feb. 1988)

Paper Types	New York	Chicago	Atlanta	West Coast
Hard white envelope cuttings	250-260	275-285	285-295	265-275
Hard white shavings	230-240	240-250	250-260	205-215
New colored envelope cuttings	110-120	105-115	120-130	95-105
Coated soft white shavings	125-135	160-170	160-170	120-130
New brown Kraft envelope cuttings	95-105	100-110	120-130	115-125
White ledger (Manifold)	100-110	110-120	110-120	85-95
White ledger (post consumer)	70-80	30-40	40-50	40-50
New colored ledger (Manifold)	50-60	65-70	30-40	35-45
Colored ledger (post consumer)	20-25	20-30	30-40	10-15
White newsblanks	100-110	105-115	115-125	95-105
Coated sulphite books	40-50	35-45	45-55	45-55
Manila tab cards	200-210	175-185	195-205	195-205
Colored tab cards	135-145	120-130	140-150	115-125
Kraft multi-wall bag waste	105-115	105-115	115-125	145-155
Flyleaf shavings no. 1	30-35	30-35	45-50	50-60
Mixed groundwood shavings (nom.)	10-15	10-15	10-15	30-40
New DLK cuttings	90-100	90-100	95-105	85-95
No. 1 news	20-25	35-40	50-55	30-40
Corrugated containers	25-35	25-35	40-50	20-30
Boxboard cuttings	20-25	25-30	20-30	20-30
Computer printout (laser free)	85-95	85-95	85-95	155-165
Computer printout (laser 10-15%)	65-75	70-80	70-80	110-120
Mixed paper prices (dep. on grade)...nom.	2-5	2-5	2-5	2-5

(1) From Mill Trade Journal, February 29. 1988, pg. 3.

4.3.7.17 *Procedures.* Proceeds from the sale of recyclable materials are deposited into a special account (**F3875). This account is not affected by fiscal year end, so proceeds may be carried forward from one year to the next. However, if the balance of an installation's net proceeds remaining at the end of any fiscal year exceeds $2,000,000, the excess must be deposited into the U.S. Treasury.

4.3.7.18 The proceeds are first applied to cover the costs of operating the program, including the cost of any equipment purchased for recycling purposes.

4.3.7.19 If a balance remains after reimbursement of program expenses, not more than 50% of that balance may be used at the installation for projects for pollution abatement, energy conservation, and occupational safety and health activities. A project funded under the program may not exceed 50% of the amount established by law as the maximum amount for a minor construction project (i.e., the cost of a funded project at this time may not exceed 50% of $200,000, or $100,000).

4.3.7.20 Any part of the balance remaining after reimbursement of program expenses may be transferred to a local nonappropriated fund instrumentality supporting military MWR activities.

4.3.7.21 The Defense Reutilization and Marketing System (DRMS), represented locally by the DRMO, supports the recycling program by

1. conducting market research to provide estimates on proceeds from the sale of materials

2. providing advice on procedures for collecting, segregating, and storing materials to optimize sales proceeds

3. assuming accountability for materials made available for sale

4. determining whether materials turned in under the recycling program shall be diverted to a higher priority program [through the reutilization, transfer, donation, and sale (RTDS) cycle per DoD 4160.21-M)

5. conducting sales and depositing the proceeds to the program account.

4.3.7.22 *Management Control Objectives.* Management control objectives in operating the recycling program are as follows:

- to comply with legal restrictions on uses of funds. The provision for program budgets and prior authorization of expenditures will ensure that funds are used only in compliance with the law.

- to comply with legal limitations on the accumulation of funds and percentages of fund balances that may be used to finance projects. The Base Comptroller will adopt appropriate accounting controls to ensure compliance with these restrictions.

- to identify valuable resources now being lost in the waste stream and to divert these resources to the recycling program. The Recycling Planning Board(1) will foster an awareness of the value of resources and investigate the feasibility of recycling materials of any potential value.

- to identify recyclable wastes which are currently being disposed of in a landfill, incinerator, or other solid waste management facility and which could be disposed of at a lower cost through recycling or resource recovery.

- to safeguard assets, and to the degree warranted by their value, establish custody and access controls on select items collected for recycling. In developing bulletins on specific materials, the Board will consider the value and pilferability of the items and prescribe appropriate controls.

- to maintain accurate accounting records. The Base Comptroller will adopt appropriate operating procedures to ensure the accuracy of accounting records.

- to use the net proceeds on approved projects that will provide the maximum benefit to the maximum number of people.

4.3.7.23 **Economic Evaluation.** Economic analysis to justify an RRRP may be based on revenues from sale of recyclable materials or cost avoidance for disposal of wastes in a solid waste management facility.

4.3.7.24 Before any recycling activity can be approved, an economic analysis must be performed. Service directives provide details for making such an assessment. Most of the main points are summarized below. The example economic analysis is based on a source separation program. It is also specific to recycling of TAB cards only. The procedure for evaluating other materials would be quite similar.

4.3.7.25 Factors for Economic Analysis and Implementation Schedule Format

1. Determine the approximate quantity of materials that will be source separated, locations where each type of material would be stored for pickup, and frequency of required pickup as influenced by economic, environmental, hygienic, aesthetic, and safety requirements.

2. Request from DRMO a determination of local markets for high-grade paper, corrugated containers, and/or newspapers, as applicable. Information to be obtained from DRMO includes the following:

   - market price
   - prognosis of price future
   - pickup point changes
   - any preparation required, such as baling, special tying, etc.

(1) Described in Section 4.3.12.

3. If there is no market, no further analysis is required.

4. After receiving the market analysis report and the estimated sales revenue from DRMO, the installation conducts an economic analysis to determine if a QRP would be cost effective.

4.3.7.26 **Determining Economic Feasibility.** Selling recyclable material raises revenue, but it may not always be economical. Costs of running the program may exceed savings or revenue. Therefore, do not undertake a QRP without an economic analysis. An economic analysis will help decide the feasibility of establishing a qualifying recycling program.

4.3.7.27 *Economic Analysis Handbook.* Figure 4-3-7B provides a worksheet for documenting an economic analysis. A sample economic analysis is shown in Figure 4-3-7C. For more information on methods for performing economic analyses, see NAVFAC Publication P-442, Economic Analysis Handbook.

4.3.7.28 *Assumptions.* Added costs are the increased time, effort, and possibly equipment associated with removing a recyclable material from the waste stream and subsequently preparing it for sale. Avoided costs are decreases in the costs of waste handling, hauling, and disposal by removing a recyclable material from the waste stream.

4.3.7.29 *Determining Avoided Costs.* Estimate avoided costs by determining the weight or volume of each recyclable material diverted from the waste disposal stream by the QRP. Calculate tipping fees, surcharges, labor, prorated maintenance, hauling fees, permit fees, and generator "taxes" that are saved by recycling that quantity of material instead of disposing of it. This may or may not be a significant factor, depending on the material.

4.3.7.30 *Determining Revenue.* For each recyclable material, estimate annual sales revenue. Use DRMO market survey data for these estimates.

4.3.7.31 *Is a Recycling Program Economically Feasible?* The qualifying recycling program is economically feasible if

added costs < avoided costs + revenue

4.3.8 Qualified Recycling Program (QRP). Upon completion of the economic analysis, the base commander of the installation shall decide whether or not to establish a QRP. Such a decision may be obvious when the added costs are less than or much greater than the avoided costs and revenue. If only a marginal difference exists, however, the decision may be more involved and need consideration of intangible benefits like aesthetics, employee morale, pollution abatement, availability of funds to meet the deficit, and future outlook. Any activity should be able to establish a QRP based on capturing proceeds from recyclable materials already being turned in to the DRMO.

Installation:_____
Preparer:_____
Location:_____ Date:_____
Target recyclable material:_____
Tons-lb-gal/yr:_____

ESTIMATED
ADDED COSTS

1. Source separation and material preparation
   a. Equipment (amortize over life of equipment) $_____/yr
   b. Labor
      (1) Procurement (amortize over life of equipment) $_____/yr
      (2) Operations $_____/yr
      (3) Maintenance $_____/yr
   c. Other (materials, supplies) $_____/yr
   Subtotal: ($_____/yr)
2. Collection and storage
   a. Equipment and facilities (amortize over life of equipment or facility) $_____/yr
   b. Labor
      (1) Procurement (amortize over life of equipment or facility) $_____/yr
      (2) Operations $_____/yr
      (3) Maintenance $_____/yr
   c. Other (materials, supplies) $_____/yr
   Subtotal: ($_____/yr)
3. Program administration
   a. Instructions and operating procedures $_____/yr
   b. Fiscal management $_____/yr
   c. Publicity $_____/yr
   Subtotal: ($_____/yr)
   TOTAL ADDED COSTS: $_____/yr)

ESTIMATED AVOIDED COSTS AND REVENUE

1. Savings resulting from reduced volume of waste going to disposal facilities $_____/yr
2. Sales revenue (tons-lb-gal/yr) x ($/ton-lb-gal) $_____/yr

TOTAL AVOIDED COSTS + REVENUE: $_____/yr

Estimated Return

(Total Avoided Costs + Revenue) - (Total Added Cost) = $_____/yr

FIGURE 4-3-7B
Worksheet for Determining Waste Sales Economic Analysis

Installation: Example
Location: Nowhere, USA
Target Recyclable Material: TAB Cards

Preparer: John Doe
Date: 18 September 1984
Quantity: 200 net tons/yr

ESTIMATED ADDED COSTS

1. Source separation and material preparation	
a. Equipment-none necessary	
b. Labor	
(1) Operations (0.2 manyr/yr)($25,000/manyr)(1.12-overhead)	$ 5,600/yr
c. Other (Misc. packaging materials)	$ 1,000/yr
SUBTOTAL	$ 6,600/yr
2. Collection and Storage	
a. Equipment	
(1) Flatbed truck ($25,000)(1 day/wk)/20 yr	$ 250/yr
(2) Front-end loader ($30,000)(1 day/wk)/20 yr	$ 300/yr
(3) Warehouse (1300 ft^2)($25.10/$ft^2$)/20 yr	$ 1,631.5/yr
b. Labor	
(1) Procurement (0.2 manyr)($25,000/manyr)(1.12-overhead)/20 yr	$ 280/yr
(2) Operations (1 manday/wk)($25,000/manyr)(1.12-overhead)	$ 5,600/yr
(3) Maintenance (0.1 manyr)($25,000/manyr)(1.12-overhead)	$ 2,800/yr
c. Other (pallets, shelves, fuel)	$ 2,000/yr
SUBTOTAL	$12,861.5/yr
3. Program Administration	
a. Instructions and operating procedures (0.1 manyr/yr)($25,000/manyr)(1.12)	$ 2,800/yr
b. Fiscal management (0.05 manyr/yr)(25,000/manyr)(1.12)	$ 1,400/yr
c. Publicity (0.05 manyr/yr)($25,000/manyr)(1.12)	$ 1,400/yr
SUBTOTAL	$ 5,600/yr
TOTAL ADDED COSTS:	$25,061.5/yr

ESTIMATED AVOIDED COSTS AND REVENUE

1. Tipping Fee Savings ($10/ton)(200 tons/yr)	$ 2,000/yr
2. Sales Revenue (200 net tons/yr)($180/net ton) =	$36,000/yr
TOTAL AVOIDED COSTS AND REVENUE:	$38,000/yr

ESTIMATED RETURN

Estimated Return = $38,000/yr - $25,061.5/yr = $12,938.5/yr

FIGURE 4-3-7C
Sample Economic Analysis

4.3.9 Implementation

4.3.9.1 To establish a QRP, the base commander issues an installation directive or instruction identifying the following program requirements:

1. Designate the program manager. Generally, this shall be the department already functionally responsible for the collection and disposal of the waste material.

2. Identify means for maintaining fiscal accountability of funds received and disbursed.

3. Provide for maintenance of records on quantity and types of materials sold for recycling.

4. Provide for review of projects funded with the proceeds of sales. This shall be done by the same people who would review such projects if funded from normal appropriations.

5. Describe specific implementation procedures of the program. Copies of the directive shall be sent to the DRMO and higher Headquarters.

6. Establish procedures for tracking recycling expenses.

4.3.9.2 An installation that does not conduct its own waste disposal program may establish a QRP either by dealing with DRMO or through an agreement with the installation handling its waste disposal. The QRP is to be set up for the entire installation, not separate activities, with the installation as a whole receiving the proceeds from sales. If another installation is handling the waste collection, that installation may or may not be willing to also provide this service for recyclable materials. In any case, in order for a generating installation to be credited directly by DRMO with the proceeds from waste sales, the turn-in document (DD Form 1348-1) must contain a reimbursable fund site specific to that installation. If several generators with QRPs have a centralized collection process and wish to be reimbursed separately, a Form 1348-1 must be submitted for each installation, specifying the amount of material originating from each installation. DRMO will then determine equitable distribution of sales proceeds. A sample DD Form 1348-1 is shown in Appendix G.

4.3.9.3 *Equipment and Facilities*

1. Equipment for establishing of recycling programs shall be procured through the appropriations normally available for equipment acquisition. The acquisition of new or replacement equipment related solely to recycling of solid and other waste is eligible for financing from net proceeds generated by the sale of waste materials. Annual programs for the acquisition of such equipment shall be coordinated with the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics (MRA&L).

2. The financing of equipment that is used jointly or shared with such activities as the DRMO or Army and Air Force Exchange Service (AAFES)

facility shall be governed by the procedures applicable to the installation that owns or is accountable for the equipment of facility.

3. Use of existing facilities and equipment shall be given priority consideration in planning and establishing a recycling program.

4. Equipment, such as balers and shredders, available at a DoD installation or through Government Services Administration (GSA) shall be shared whenever possible to reduce costs.

5. Construction of holding bins and sorting platforms or other recycling facility improvements can be paid for with recycling money.

4.3.9.4 *Supplemental Funding Sources.* Within an installation, "seed" money for a QRP may come from the Central Base Fund, Service Headquarters funds, or other nonappropriated funds. The money can be in the form of a loan or a direct allocation.

4.3.9.5 Several funds are available through DoD's Productivity Enhancing Capital Investment (PECI) Program for a wide range of cost- and labor-saving capital investments which could include equipment or facilities in support of a QRP. Three funds are available that cover a broad spectrum of activities and functions. These funds operate under DoD Instruction 5010.36, which provides uniform project documentation formats and criteria for project selection and military post investment appraisal. The Fast Payback Capital Investment (FASCAP) is probably most applicable to a QRP. Each of the funds is briefly described below.

4.3.9.6 *Productivity Investment Fund (PIF).* PIF focuses on long-term investments with a payback period of 4 years or less. Investments are limited to projects with costs greater than $150,000.

4.3.9.7 *Component Sponsored Investment Program (CSIP).* The CSIP fund complements PIF but is more flexible. Investment limits and availability of funding vary depending on the annual budget allocation within each service.

4.3.9.8 *Fast Payback Capitol Investment (FASCAP).* Investments are limited to opportunities with costs ranging between $3,000 and $150,000. Projects selected for FASCAP financing must be expected to return costs within 2 years.

4.3.9.9 Projects are submitted on a year-round basis. See DoD Instruction 5010.36 for submittal procedures. Each project is reviewed to ensure that it conforms with restrictions established by public law or by DoD or service policies. It is then considered for financing in competition with other proposals. Since people are one of the Department's most costly and constrained resources, PIF projects promising personnel savings are given the highest priority in the selection process. However, other projects that produce significant savings in energy, material, or dollar resources are also financed through PECI funds.

4.3.9.10 *Transfer of Accountability and Custody.* Upon transfer of the waste to DRMO by an installation, the turn-in document (DD Form 1348-1)

must indicate that the material is recyclable, with funds to be deposited in a Budget Clearing Account. Account numbers exist for each installation and can be obtained from the base comptroller.

4.3.10 Resource Recovery and Recycling Program (RRRP) Operations. Once an RRRP has been justified and established, policies and procedures must be developed for operating the program. Although specifics may vary from installation to installation, many of the Policies & Procedures will be similar. A sample outline of policies and procedures is given below and shall be used for guidance only.

1. General Policies

   a. The purpose of an RRRP is to process recyclable material and to ensure participation by base personnel.

   b. Recyclable materials are defined as those products having no value other than their basic material content but which can be altered through chemical or physical processes. These materials include, but are not limited to, wood, metal, paper, glass, grease, petroleum products, and cardboard.

   c. The recycling plant (a designated building) serves as a staging area, warehouse, pickup and delivery point, and base of operations.

   d. Recyclable materials will be marketed and sold by the DRMO.

   e. RRRP will supply DRMO with pertinent information concerning type, quantity, and grade of recyclable material for sale.

   f. RRRP personnel will attend any local training or safety briefings relating to RRRP conducted by DRMO or any other base organization.

2. Procedures: Collection, segregation, processing, delivery, and shipment of recyclable materials by RRRP staff will be in accordance with procedures outlined herein and under the guidance of the local RRRP manager.

   a. Collection of ledger-grade paper:

      (1) RRRP will maintain a current list of Recycling Building Monitors, by facility, as supplied by the various Directorates, Commands, and Tenant organizations.

      (2) The local RRRP manager and Building Monitors will identify generating facilities and locate collection points within each facility.

      (3) All grades of recyclable paper will be segregated at the generating source by employees, military and civilian, of that facility according to current contract requirements, as

instructed by RRRP. Building Monitors will ensure compliance.

(4) RRRP staff will place canvas mail carts, or other suitable conveyances, at predetermined locations within those facilities that require them. Generators will store recyclable paper in said containers while awaiting pickup.

(5) The local RRRP manager develops regularly scheduled pickup routes for collection of ledger paper. The minimum frequency will be once a week. Generators whose volume of recyclable paper does not warrant a weekly collection will get a pickup when they have accumulated a minimum of 200 lb of material. RRRP staff will remove collected material within 3 days of notification by Building Monitors.

(6) RRRP paper collection teams, consisting of one motor vehicle operator (MVO) and one laborer each, will follow established collection routes in picking up recyclable paper:

(a) Team will ensure that all collection carts within a facility are accounted for.

(b) Team will empty all carts that are at least 1/2 full. Carts less than 1/2 full need not be picked up, at the discretion of the MVO.

(c) Team will roll, or otherwise carry, those carts which need to be emptied to the RRRP truck, or other assigned collection vehicle.

(d) MVO will ensure that paper is properly segregated.

(e) Improperly segregated or contaminated carts must be segregated and cleaned by the RRRP team. Properly segregated material will be emptied into Gaylord-type boxes carried upon the collection truck. MVO will ensure that sufficient boxes are on board the truck, and that said boxes are marked according to the proper classification of paper which they are to contain, in compliance with existing contracts.

(f) Carts that are contaminated by foreign materials to an extent greater than 25% are to be returned to their original location, unemptied. The building number, location number of office, and symbol of area where returned carts are located will be reported to the local RRRP manager.

(g) Carts that are soiled or damaged shall be replaced by new or clean carts. Soiled or damaged carts are to be returned to the recycling plant.

(h) MVO will keep a daily log using established format. Problem areas, i.e., contamination, lack of segregation, missing carts, are to be indicated on log. The local RRRP manger will contact appropriate Building Monitor in order to correct and prevent future deficiencies.

(i) Teams will pick up from bulk quantity generators and small volume generators according to procedures established and agreed upon by the RRRP manager and the Building Monitors.

(j) Gaylord boxes and bulk pickups will be delivered to the recycling plant at the end of the regularly scheduled route, immediately after bulk pickup, or when Gaylord boxes or truck is full, as good judgment and common sense would determine.

(k) Routes are to be complete within specified time limits as determined by the RRRP manager.

(l) MVO will unload Gaylord boxes with forklift and stack in assigned area according to established procedures. Partially full boxes are to be capped off before stacking.

(m) Team will unload bulk pickups and store on pallets in proper area of warehouse.

(n) Upon completion of daily routes, collection team will pack Gaylord boxes for shipment or perform other duties as assigned.

(o) MVO is responsible for daily maintenance and cleanliness of vehicles.

b. Cardboard Collection and Baling Operation:

(1) Cardboard will be delivered to the warehouse by RRRP personnel or other means according to established procedures.

(2) One sorter will be assigned to operate the cardboard baler.

(3) Sorter will separate trash and foam from cardboard and dispose of in trash dumpster provided.

(4) Clean, uncontaminated cardboard will be baled according to procedures outlined in baler operation manual.

(5) Sorter is responsible for baling all cardboard delivered to the baling pad on any given day, provided it is received no later than 1 h before quitting time.

(6) Sorter must broom sweep pad prior to leaving for the day and pick up any trash, paper, or cardboard not contained within the fenced-in area.

(7) Sorter is responsible for cleanliness of baling pad and equipment.

(8) Sorter is responsible for daily maintenance check of all equipment. Any potential problems shall be reported to the local RRRP manager.

(9) Sorter must follow all safety procedures established for baler operation.

(10) Upon completion of baling and cleaning, laborer is to assist in the wood grinding operation, shipping of paper, or other duties as assigned.

c. Metals Recycling:

(1) RRRP personnel will follow procedures outlined in DoD 4160.21 H, Defense Scrap Yard Handbook.

(a) Upon arrival in the scrap yard, RRRP personnel will remove material from trailers and place in the segregation area.

(b) RRRP personnel will identify material according to DoD scrap classification codes which are determined by proper application of one or more of the following listed tests:

1. magnet
2. visual
3. spark
4. chemical spot testing
5. electronic metal analyzer.

(c) Hoppers or engine cans bearing various scrap codes are provided to facilitate the segregation of metals. When a hopper is filled, it is weighed and dumped. Weight is recorded and forwarded to sales writers through the purchasing office. Also, shipping documents DD 1348-1 are coded with appropriate scrap class code and RRRP's financial accounting code when removed from the item during the identification process. Said documents are forwarded to the Documentation Section through the purchasing office.

(d) Sorters will perform first echelon maintenance on fork lifts and equipment used in the scrap yard.

d. Warehouse Operation:

(1) (Designated Building) will serve as warehouse and storage area for recyclable materials.

(2) The local RRRP manager or designated Work Leader will plot areas for storage of specific grades or other recyclable materials, as required, and identify certain areas for the segregation, shipping, and receiving of materials.

(3) Work Leader will ensure that all employees adhere to the warehouse planned functional layout diagram when receiving, loading, or shipping materials.

(4) Work Leader is responsible for daily maintenance and cleanliness of warehouse, equipment, and all plant facilities and grounds.

(a) Warehouse will be broom swept daily and mopped as needed.

(b) Outside perimeter of building is to be picked up and maintained on a daily basis. Trash, scrap, and debris are to be removed and deposited into an approved trash receptacle.

(c) Grounds adjacent to the warehouse, baler, and grinder pads are to be cleaned and maintained on a daily basis. No trash or debris is to be allowed to accumulate or scatter about the RRRP property nor be allowed to scatter or be carried by the wind beyond the confines of the fenced-in area.

(d) The local RRRP manager sets the standards for cleanliness.

(5) One laborer will be assigned to work on a prorated basis within the warehouse for the purpose of segregating recyclable materials.

e. Scrap Wood:

(1) The local RRRP manager will survey base collection points and identify wood scrap by the following categories:

(a) usable lumber for resale
(b) usable scrap for wood grinder
(c) unusable scrap.

(2) Collection personnel will deliver material to designated areas adjacent to the wood grinder located near the warehouse.

(3) Sufficient labor will be assigned to cut, break up, and segregate wood scrap according to Paragraph la.

(4) Laborers will operate the wood grinder according to Engineering Operating Procedures and existing safety regulations. Laborers must disassemble, cut, or otherwise break up usable scrap into sections conforming to the wood grinder specifications.

(5) Work Leader, or assigned MVO, will operate front-end loader, fork lift or other equipment, as needed, to assist laborers at the wood grinder.

(6) Wood grinder operators are responsible for daily maintenance check and continual observation of grinder operation to ensure that mechanical failures due to improper operation are avoided, thus minimizing equipment breakdown time.

(a) Operators will continually check metal separator for blockage or wood chip buildup.

(b) Operators will ensure that all wood fed into the grinder is free of any metal contamination other than nails, screws, and bolts less than 114 in. in diameter.

(c) Operators will report any problems, breakdowns, excessive reversal time, blockages, jam-ups or other mechanical difficulty to the local RRRP manager.

(7) No RRRP employee is to climb the conveyor belt or enter into the feed hopper of the wood grinder without expressed permission of the local RRRP manager and only when all power to the grinder has been disconnected and at least one other employee is on hand.

(8) Grinder operators are responsible for routine maintenance, such as greasing the grinder assembly and tightening or replacing drive belts.

(9) Operators are to maintain wood chip scrap in a controlled and neatly stacked manner to prevent chips from being spread throughout work area. All chips ground for resale on term contract are to be ground into the contractor's conveyance according to current contract obligations.

(10) Operators will clean and sweep the work area daily and dispose of any trash or debris in an approved trash receptacle.

(11) Laborers are responsible for the maintenance of all tools and equipment and are to return all tools and equipment daily to the tool box or tool storage area located at the warehouse.

3. Personnel: Manpower requirements are listed on the current Position Authorization Listing (PAL) on file at Naval Air Facility (NAF) Personnel. The RRRP manager determines manpower requirements and

includes same in NAF Income and Expense Budget in accordance with SSOI 176-3. If appropriated fund personnel are used, the manpower requirements will be identified by the RRRP manager and authorizations listed in the Unit Manpower Document.

4.3.11 Operational Checklist. Several approval requirements are necessary to officially establish and operate an RRRP. A checklist follows:

1. Has a Qualifying Recycling Program been established?

2. If appropriated fund personnel (military or civilian) are used to operate and/or manage the RRRP, is the proper account being repaid out of RRRP profits?

3. If MWR is selected to run the RRRP, have they been identified in writing as the Office of Operating Responsibility (OOR) for the base?

4. Has the appropriate personnel been appointed as the operational manager of the RRRP?

5. Has an operating instruction been established to cover the RRRP operation?

6. Are proceeds from sale of recyclable material deposited into the finance office?

7. Are accounting procedures being properly administered for RRRP funds?

8. Are DD Form 1348's being properly documented so the funds from sale of recyclable material are deposited to the base budget clearing account?

4.3.12 Strategies for Success. Generally, successful recycling programs will begin based on one or two profitable commodities. Then, as organizational and operational details get worked out, the program expands to include others. To be successful, any recycling program needs the attention of the base commander, at least initially. The programs require widespread publicity and support. Base newspapers and bulletins are essential media for publicizing the programs. Some lessons learned from successful service programs are listed below.

1. The key to a successful recycling program is education. People need to be convinced of the merits of the idea and must see some reward before they will participate. New family housing orientation sessions shall stress recycling. Contests with monetary rewards for the best participating unit generate and sustain interest in recycling.

2. Education should really begin at the grade school level so people are conditioned at an early age to appreciate the merits of recycling.

3. The recycling efforts should receive frequent publicity in the post's newspaper and through bulletin notices.

4. The procedure for recycling should be as painless as possible for participants. The higher the degree of separation requested at the source, the less volume of wastes one can expect to collect.

5. Sole source segregation is the optimum. However, source separation activity coupled with final separation, if necessary, at a resource recovery center for quality control is a good combination.

6. Refuse collection and resource recovery operations should be well-coordinated and cooperative activities.

7. A well-run recovery center can support its own key staff and still generate revenue for MWR and other approved projects.

8. Excess equipment from printing shops such as book binding cutters can pay for themselves in a few months. (Glued paper cannot be recycled so bindings must be removed from books and pamphlets.)

9. Carbon paper removal from multipart forms is quickly done with mechanical devices. Again, surplus warehouses are possible sources for such used equipment.

4.3.13 Financial Constraints. Most RRRPs will encounter cash flow problems at least during startup. Figure 4-3-13A shows a typical time cycle for submitting goods to DRMO and actually getting money back to the installation.

4.3.13.1 *Computerized tracking.* Several installations have learned to live with the payment delays by using a computerized tracking system. Personal computers are used to track dates, items, and quantities of materials sent to DRMO. The same system tracks bid prices and reimbursement dates from ORMO. This system ensures accurate reimbursement from DRMO and provides good predictions of income to the installation for periods 3-4 months in the future.

4.3.14 Recvcle Planning Board. At large installations, a Recycle Planning Board shall be established to:

1. identify potentially recyclable materials, gather data on sources and volume for use in feasibility and cost analysis, establish contact points within an entire installation, and monitor collection and segregation efforts.

2. consider and make recommendations on proposed expenditures for equipment required to segregate and/or store recyclable materials and for services such as material pickup.

3. promote and publicize the program.

4. collect nominations from the installation for projects to be funded by the program (projects submitted to the board must have been reviewed by the same local command echelons that would normally review such projects for funding from normal appropriations).

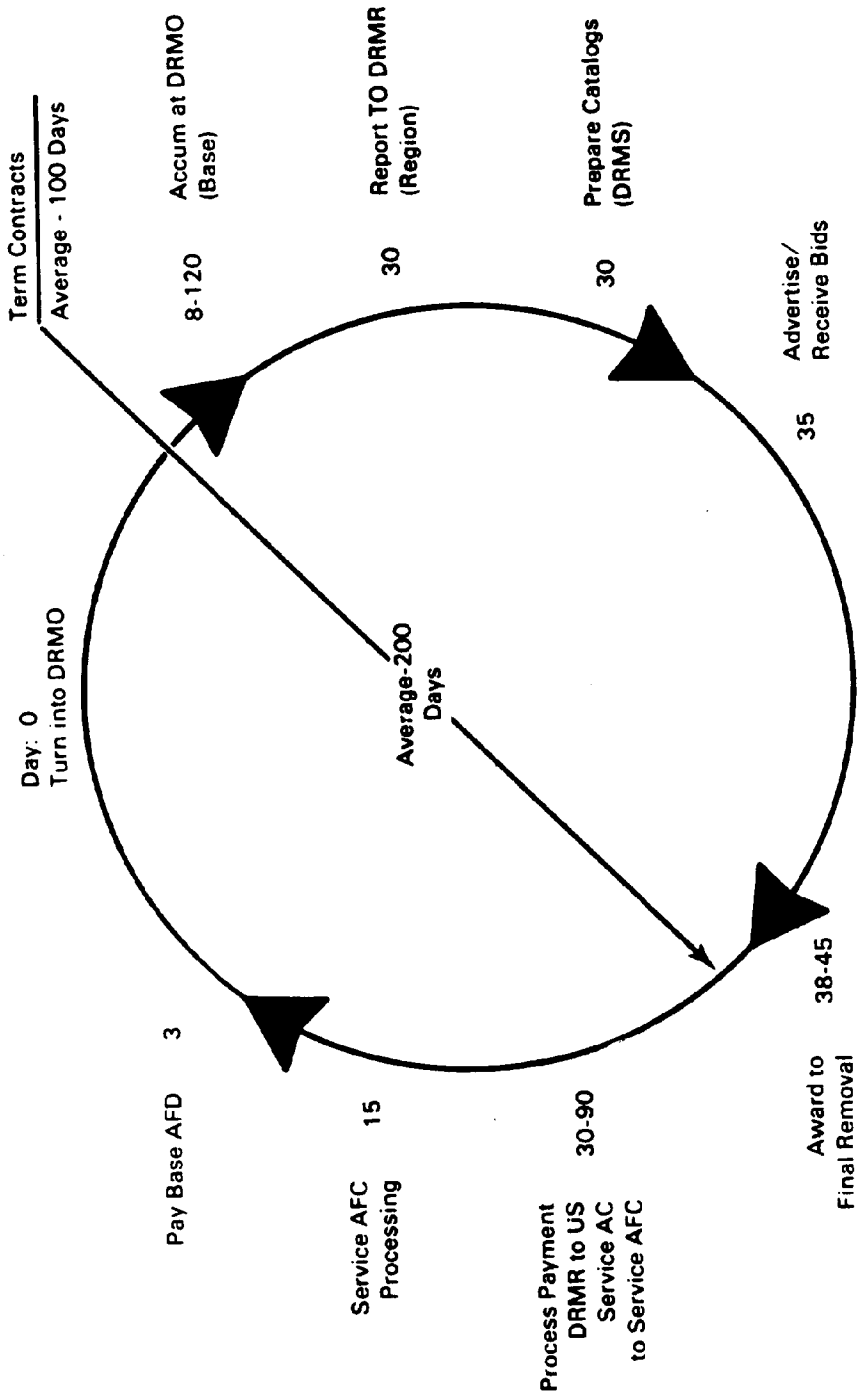


FIGURE 4-3-13A
Cycle Time for Submitting Goods to DRMO

5. prioritize projects for consideration in an annual program.

4.3.14.1 *Sharing ideas.* Lessons learned at one installation will save time and effort at other installations. An annual Tri-Service meeting on the sole subject of RRRPs would be an excellent way of presenting useful information, especially to new programs. Such a meeting should show a high return on investment simply by warning inexperienced bases about common pitfalls.

4.3.15 Audits

4.3.15.1 Any RRRP can be subject to an internal service audit or an audit by the Government Accounting Office.

4.3.15.2 The overall objective of an audit is usually to evaluate MWR participation in the RRRP and the internal controls in place to manage the funds generated by the program. Specifically the audits will

1. determine whether sound business practices were followed in establishing the RRRP.

2. evaluate the effectiveness and efficiency in managing the RRRP to determine whether procedures promote revenue maximization and cost minimization.

3. evaluate procedures to account for RRRP revenue to determine whether accountability is maintained from sale to receipt of cash and whether income reporting is consistent throughout the military.

4. determine whether all costs incurred in generating RRRP revenues are reimbursed prior to project funding and whether RRRP funds are being used in accordance with the intent of Public Law 97-214.

5. determine whether any abuses of Public Law 97-214 are occurring. The intent of the law is clearly to allow only revenues from the sale of scrap to accumulate in RRRP accounts. Reusable personal property is NOT to be sold as scrap.

6. determine whether installations with qualified RRRP's are receiving goods from installations without RRRP's. This practice is not recommended. Each installation shall establish its own RRRP even if some support is required from another installation.

4.3.16 Waste Segregation Options

4.3.16.1 *Segregating Wastes.* The mechanics of segregating recyclable materials falls between two extremes: source separation and disposal site separation. Source separation is defined as the setting aside of one or more recyclable materials, such as paper, cans, or glass, from refuse. This must be done at the point of generation by the discarding unit before the materials become mixed into the solid waste stream.

4.3.16.2 *Disposal Site Separation.* Disposal site separation generally uses mechanical equipment to separate recyclable materials from other

post consumer wastes. The simplest form is a conveyor belt manned by laborers who do the actual separation.

4.3.16.3 Separation of materials at final disposal sites generally requires a large investment in equipment and a large, steady supply of raw material to justify the equipment. Likewise, markets for the recovered materials must exist. For these reasons, few military installations practice disposal site separation. Techniques are mentioned here because some bases will utilize them in some form and future trends may show more extensive use because of increased costs for landfilling and incineration.

4.3.16.4 Recovery of Materials at Final Disposal Sites. This type of recovery is distinguished from source separation in that recoverable materials enter the waste stream and are mixed with nonrecoverable solid wastes. This method will generally require the use of specialized equipment or machines not normally found in the military supply system.

4.3.16.5 The overall success of a mechanized material recovery facility depends on the technologies utilized. Ferrous metal recovery has been proven effective at several locations, whereas aluminum recovery has achieved a less successful track record. For economic and health reasons, mechanically recovered paper is currently used almost exclusively for the production of refuse-derived fuel (RDF) rather than fiber recovery. As a result, technologies designed to recover fiber have received relatively less attention. Glass recovery technologies have achieved limited success; more than aluminum, less than ferrous metal.

4.3.16.6 The technology for separation of materials from military post consumer solid waste is generally used in conjunction with energy recovery systems. Several techniques are listed in Table 4-3-16A. The more common ones are discussed below.

4.3.16.7 Hand picking of recyclables from conveyors prior to discharge into transfer trailers or processing machinery is frequently practiced.

4.3.16.8 Magnetic separators usually consist of a belt, drum, or pulley with a magnet used to attract and remove magnetic materials from refuse or other materials (Figure 4-3-16A). At military industrial installations, cranes with electromagnetic hooks (Figure 4-3-16B) can be used to separate magnetic materials into large sorting bins.

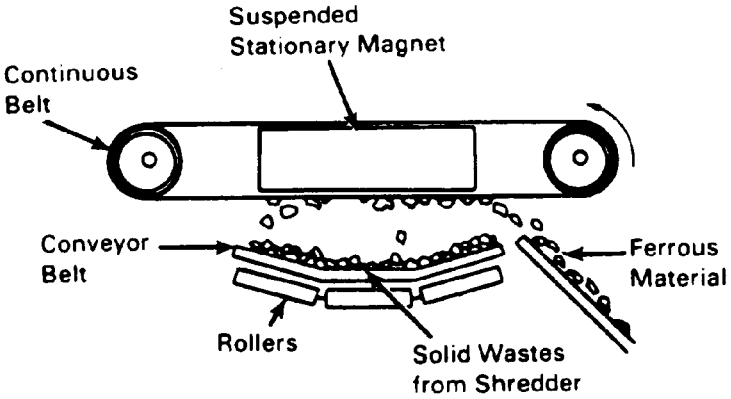
4.3.16.9 Eddy current separators are used to separate aluminum and other nonmagnetic metals using the properties of a magnetic field as a method of sorting. An alternating current is passed through a piece of metal causing it to become temporarily magnetic and thus deflected and separated.

4.3.16.l0 Heavy media separators use a suspension of finely ground, dense minerals in water. When the mixture of glass, aluminum, and other nonferrous metals is immersed in the liquid, the fluid density can be controlled so that the aluminum and glass float while the other metals sink.

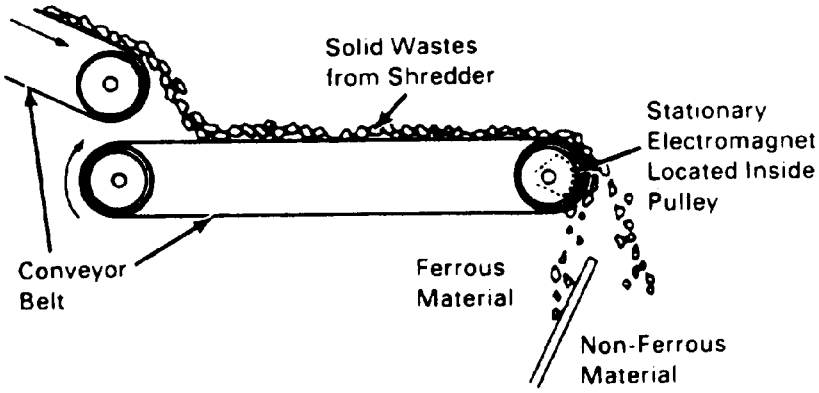
4.3.16.11 Equipment used in the paper industry can pulp waste paper and separate foreign matter. Hot water and agitation are used for pulping

TABLE 4-3-16A
Solid Wastes Separation Technique and Application Information
for Centralized Separation Facilities

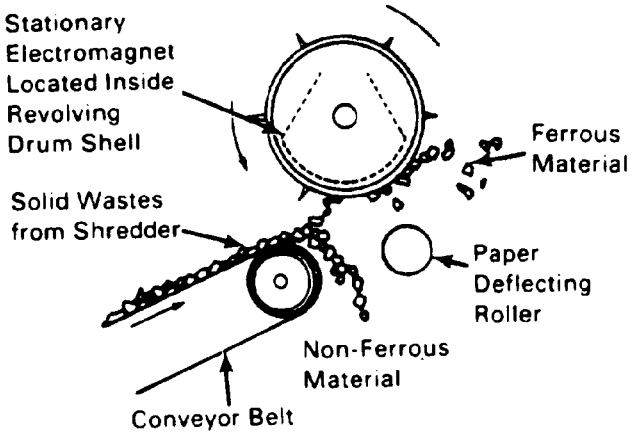
Technique	Material Involved	Preprocessing Required	Remarks
Handpicking and handsorting	Newspaper, corrugated paper	None	May be economical alternative to source separation, depending on labor costs.
Air separation	Combustible materials	Shredding	Used to concentrate metals and glass in a heavy fraction as well as combustible materials in a light fraction.
Inertial separation	Combustible materials	Shredding	Same as air separation.
Screening	Glass	None or shredding, air separation	May be used prior to shredding to remove glass and prior to air separation for similar reasons. May be used to concentrate glass-rich fraction from heavy fraction.
Flotation	Glass	Shredding, air separation	Water pollution control may be expensive.
Optical sorting	Glass	Shredding, air separation and screening	May be used as an alternative to flotation to separate glass from materials; also used to separate flint from colored cullet.
Electrostatic separation	Glass	Shredding, air separation, magnetic separation, and screening	Experimental.
Magnetic separation	Ferrous metal	Shredding or wet pulping	Proved in numerous full-scale applications.
Heavy media separation	Aluminum, other nonferrous metals	Shredding, air separation	May be used to separate a number of materials by adjusting specific gravity of media; separate units are required for each material to be separated.
Linear induction separation	Aluminum, other nonferrous metals	Shredding, air separation, magnetic separation, and screening	Individual units are required to separate aluminum and other nonferrous metals.



(a) Suspended Magnet



(b) Magnetic Pulley



(c) Suspended Magnetic Drum

FIGURE 4-3-16A
Magnetic Separator Designs

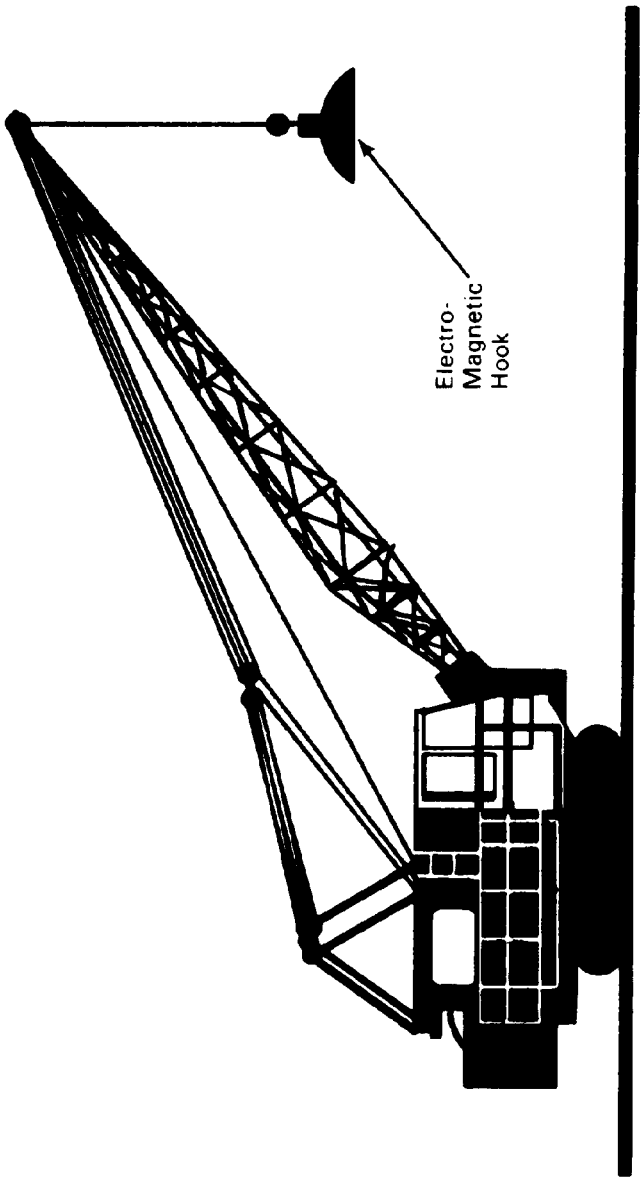


FIGURE 4-3-16B
Crane with Electromagnetic Hook

rather than chemicals. This process has been incorporated into certain resource recovery systems to recover paper fibers from municipal solid waste.

4.3.16.12 Source separation is usually preferred over separation of materials at the final disposal site because it is easier, less expensive, requires limited equipment, and generally results in a higher grade of recovered material. Disposal site separation does, however, yield concentrated recycle streams and shows reduced transportation costs over source separation/collection options.

4.3.16.13 *Source Separation.* DoD Directive 4165.60 (Dec 1986 Draft version) "Solid, Hazardous and Petroleum Waste Management" requires the recovery and recycling of solid and other waste materials to the maximum extent practicable. Source separation is one of the simplest methods of compliance with this requirement. Separation of other materials for which there is a market may be accomplished and is encouraged. A source separation program may be instituted at an installation only after the DRMO determines that markets exist for the separated materials. If markets do not exist, source separation is not required. The minimum requirements for source separation considerations are:

1. High-grade office paper -- any installation employing over 100 office workers.

2. Newspapers -- installations with more than 500 family housing units.

3. Corrugated containers (cardboard) -- installations where commercial establishments collectively generate more than 10 tons per month.

4.3.17 Recovery of Energy

4.3.17.1 General. Energy recovery is now becoming a very popular method for disposal of solid waste. The cost of disposal can vary substantially. An economic study must be done at each installation to determine if waste to energy is feasible. Sale of steam or electricity and tipping fees can provide income for large installations. This income must offset operating costs including maintenance. Maintenance costs are typically very high in large RDF units. For small incinerators (more typical at military installations), waste volume reduction is usually the primary goal. Here the cost of the incinerator (operating and depreciation) must be offset by savings in other waste disposal practices (e.g., landfill). (Some installations use incinerators to provide supplementary building heat especially in winter months.) At military installations, small incinerators are good candidates to supplement steam or hot water heating requirements. Generation of electricity usually requires large capacity furnaces such as those shown in Figures 4-3-17A and B to be economical. Few military installations are large enough to support an incinerator that produces primarily electricity. Table 4-3-17A lists processes for recovering energy from solid wastes either as thermal energy or stored chemical energy.

4.3.17.2 Energy recovery by incineration typically takes one of four different methods. The large-sized waterwall mass burning systems (Figure 4-3-17A) are generally preferred in smaller cities. The prepared fuels of RDF systems are favored where materials recovery is an important

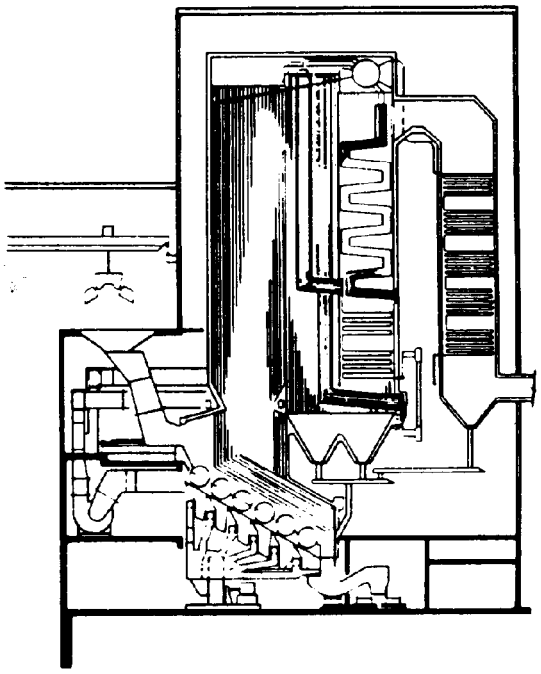


FIGURE 4-3-17A
Typical Waterwall Furnace Convention Boiler Systems Arrangement

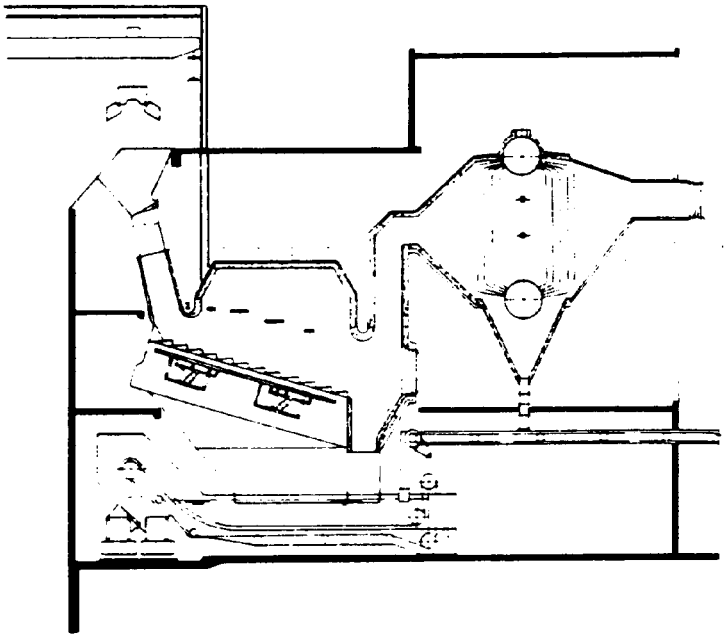


FIGURE 4-3-17B
Refractory Furnace, Convection Boiler Incinerator

TABLE 4-3-17A
Processes Used for the Energy Recovery from Solid Wastes

Process	Conversion Product	Preprocessing Required	Comment
Incineration with heat recovery	Energy in the form of steam	None	Markets for steam must be available; proved in numerous full-scale applications; air-quality regulations require extensive gas cleanup.
Supplementary fuel firing	Energy in the form of steam	Shredding, air separation, magnetic separation	If least capital investment desired, existing boiler must be capable of modification; air-quality regulations require extensive gas cleanup.
Fluidized bed incineration magnetic separation	Energy in the form of steam	Shredding, air separation,	Fluidized bed incinerator can also be used for industrial sludges.
Pyrolysis	Energy in the form of gas or oil	Shredding, magnetic separation	Technology proved only in pilot applications; even though pollution is minimized, air-quality regulations require gas cleanup -- different problems from incineration.
Hydrolysis	Glucose, furfural	Shredding, air separation	Technology on laboratory-scale only.
Chemical conversion	Oil, gas, cellulose acetate	Shredding, air separation	Technology on laboratory-scale only.

local issue. The modular mass burning combustion units with waste heat recovery are also popular (Figure 4-3-17B). LaRoc (1988) provides a good description of technologies currently available in the U.S. Modular mass burning units are probably the best choice for military installations. They provide flexibility to meet the changing needs of a base.

4.3.17.3 Much design and operating experience on municipal solid waste (MSW) combustion has been gained in Japan and Western Europe over the past decade as the volume reduction of wastes has been stimulated by the declining availability and increasing cost of landfills (Brna 1988). Nearly 2000 MSW units in Japan and several hundred in Western Europe are now operating, with the trend now being waste-to-energy conversion rather than simply incineration to reduce volume. Technology developed in Japan and Western Europe has been beneficial to the U.S., where over 100 MSW combustion systems are now operational, and a similar number are in the construction or conceptual development phase.

4.3.17.4 The reduction of waste volume by combustion results in air pollution, including pollutants not currently regulated by the EPA. Pollutants/emissions and methods of control require analyses in Environmental Assessments. Table 4-3-17B shows the U.S. standards along with those of several states and countries (Brna and Sedman 1987). However, the EPA has announced its intention to further regulate emissions from MSW combustors and proposes promulgation of these regulations in December 1990. Currently, studies are under way to determine which pollutants to regulate and to what extent. As indicated in Table 4-3-17B, classes of pollutants currently regulated by one or more of the entities listed include: trace organics (dioxins, total organics), acid gases (HCl, $S0_2$), trace heavy metals (Hg, Cd, Tl), and particulate matter. The listing in Table 4-3-17B is not intended to be complete. For example, West Germany regulates the emissions of more trace metals, and some U.S. states, as well as Japan and West Germany, have NO_x requirements/guidelines.

4.3.17.5 Noting the classes of pollutants that are currently regulated and their potential for regulation in the U.S.--on a national, state, or local level--the air pollution control strategy selected for a given plant shall have the potential for multi-pollutant control, if costly retrofitting or upgrading is to be minimized in meeting future regulations. Residues, although small in volume relative to unburned wastes, contain concentrated pollutants requiring environmentally safe disposition.

4.3.17.6 **Emission Control Technologies**

4.3.17.7 Historically, emission control on incinerators has focused on particulate removal. Tables 4-3-17C and D (Tchobanoglous, Theisen, and Eliassen 1977) show several equipment types and rate their relative performance in removing particles.

4.3.17.8 Recent developments and perceived trends have switched the emphasis to removal of acid gases, trace organics, and trace heavy metals.

4.3.17.9 Wet or dry scrubbers are effective for controlling pollutants (acid gases, trace organics, trace heavy metals, and particulate

TABLE 4-3-17B
Selected Emissions Standards for Municipal Waste Incinerators (Brna and Sedman 1987)

Emissions	U.S.(1)	California	Connecticut	Michigan	Japan	Sweden(2)	West Germany
Solid particulate matter, gr/dscf (mg/m^3)	0.046 (113)	0.01(3) (25)	0.015 (37)	0.015 (37)	0.061(4) (150)	0.008 (20)	0.012 (30)
Carbon monoxide, ppm	--	--	--	113 (24-h avg)	--	--	80
Hydrogen chloride	--	30 ppmv (scrubbers required)	90% reduction	90% reduction	430 ppmv (700 mg/m^3)	63 ppmv (100 mg/Nm^3)	31 ppmv (50 mg/Nm^3)
Sulfur dioxide, ppm	--	30 (6)	170 (0.32 lb/ 10^6 Btu) (7)	80	Varies(5)	New SO_2 limits reduce all acids	35 (200 mg/Nm^3)
Dioxins measured as 2,3,7,8 - tetrachlorodibenzo-p-dioxins (TCDD)	--	--	--	--	--	Existing plants: 0.5-2.0 ng/Nm^3 New plants: 0.1 ng/Nm^3	--
Total organics, mg/m^3	--	--	--	--	--	--	20
Mercury+Cadmium+Thallium, mg/m^3 (includes vapors)	--	--	--	--	--	0.05 (Hg only)	0.2
Gas correction	12% CO_2 dry	12% CO_2 dry	12% CO_2 dry	12% CO_2 dry	12% CO_2 dry	10% CO_2 dry	11% O_2 dry

(1) Revised pollution standards scheduled to be proposed in 1989.

(2) Swedish Environmental Protection Board's "Temporary Emission Goals," July 1986.

(3) California regulations permit more stringent local limits. Two state guidelines are reported: 0.1 gr/dscf (25 mg/m^3) for total solid particulates (TSP) and 0.008 gr/dscf (20 mg/m^3) for particles less than 2 μm.

(4) Based on continuous gas flows > 25,200 scfm (40,000 m^3/h). For flows ≤ 25,200 scfm, the particulate matter standard is 0.20 gr/dscf (500 mg/m^3). For new plants in special areas, this standard is 0.033 gr/dscf (80 mg/m^3) for plants having > 25,200 scfm and 0.061 gr/dscf for those having ≤ 25,200 scfm.

(5) Based on formula related to stack height and plant location. Typically, plant sulfur dioxide emissions range from 60 to 100 ppm so that control is not required except for new plants in special areas.

(6) Pollutant control requires use of the Best Available Control Technology (BACT), but no technology is specified.

(7) The use of dry gas scrubbers and baghouses is expected to improve removal over electrostatic precipitators alone.

TABLE 4-3-17C
Emission Control Facilities and Equipment for Municipal Incinerators

Item	Description
Settling chamber	A large chamber usually located immediately after combustion chamber for removal of large fly ash particles and as pretreatment operation for subsequent removal processes.
Baffled collectors	Baffles constructed of brick or metal that can be operated in wet or dry mode. Usually located after combustion chamber. Particles 50 µm or larger can be removed by impingement, velocity reduction, or centrifugal action. Efficiency depends on design and placement.
Scrubber	Fly ash is impacted on water droplets and subsequently removed. Method of removing wetted fly ash depends on equipment to be used and design of incinerator.
Cyclone separator	Dry separation of fly ash particles by means of centrifugal action in which particles are thrown or impinged against walls of collector.
Electrostatic precipitator	Fly ash particles are charged by means of an electrode. Charged particles are removed on collecting surfaces placed in an electrical field of high intensity. Once on the collecting surface, particles lose charge and adhere lightly. Can be moved by light tapping.
Fabric filter	Combustion gases are filtered through filter bags made of various materials.

TABLE 4-3-l7D
Comparative Air Pollution Control Data for Municipal Incinerators

Collector	Relative Capital Cost Factor, FOB	Relative Space %	Collection Efficiency, %	Water to Collector, gal/min/ 1000 ft /min	Pressure Drop, in. water	Relative Operating Cost Factor
Settling chamber	Not applicable	60	0-30	2-3	0.5-1	0.25
Multicyclone	1	20	30-80	None	3-4	1.0
Cyclones to 60-in, diameter	1.5	30	30-70	None	1-2	0.5
Scrubber	3	30	80-96	4-8	6-8	2.5
Electrostatic precipitator	6	100	90-97	None	0.5-1	0.75
Fabric filter	6	100	97-99.9	None	5-7	2.5

(1) Gases usually are cooled with water-spray scrubber before going to electrostatic precipitator.

Note: gal/mm x 0.0631 = L/s
ft^3/min x 0.028 = m^3/min
in. x 2.54 = cm
FOB = Free on board at the factory

matter) produced in burning MSW waste. The choice of scrubber type depends on the pollutants to be controlled and the degree of control required. Dry sorbent (lime) injection with an electrostatic precipitator (ESP) is used extensively in Japan for acid gas control, but wet scrubbing is preferred where high metals control is needed. The ESP/wet scrubber combination appears to be favored in West Germany for plants started up in the past decade and those expected to start up in the next several years. In the U.S., the lime spray absorption/fabric filter system is now frequently being selected for multi-pollutant control.

4.3.17.10 Acid gas removals of 90% or more have been achieved with a lime circulating fluid bed or lime spray dryer absorber preceding a fabric filter or ESP. Wet scrubbing preceded by an ESP is at least as effective as the systems noted when used to control acid gases. These systems are also effective for controlling organics and trace heavy metals, with mercury control appearing to be improved at lower temperatures and when a fabric filter rather than an ESP is used. Both the ESP and fabric filter can meet current particulate control requirements, but the fabric filter may have the edge for multi-pollutant control. More data, especially from commercial units under long-term operation, are needed to more fully quantify the performance of scrubbers designed to remove trace organic compounds and trace heavy metals.

4.3.17.11 Although stack gas cleanup is one answer to pollutant control, minimization of pollutants can also be achieved by careful combustion control. This has been shown to be true for control of the dioxins polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF).

4.3.17.12 There can be many reasons for the formation and destruction of dioxins. Dioxins can enter in the MSW, be created in cold regions of a furnace, be destroyed in combustion, form in the cooler outlet sections of the boiler, and “all of the above" (Hasselnis 1988).

4.3.17.13 Vogg, Metzger, and Steiglitz (1987) have found from extensive laboratory research as well as field tests on an MSW incinerator that

- Formation of PCDD and PCDF takes place at temperatures ranging from 390^{0}F to 750^{0}F. No effect on dioxins and furans occurs at temperatures below 390^{0}F; a sharp peak in both dioxins and furans occurs at 570^{0}F, and they are destroyed at 750^{0}F.

- In this temperature range, formation of PCDD and PCDF leveled off after about 6 h, but in 30 mm about 20% conversion had taken place.

- Oxygen concentration influenced formation of PCDD/DF linearly: zero oxygen resulted in decomposition or no formation; increasing oxygen levels resulted in a reduction in the fraction of dioxins and furans having the more toxic 4-chlorine forms (congeners) and an increase in fraction of less toxic forms having 6 to 8 chlorine molecules attached.

- Moisture strongly influenced dechlorination, causing formation of the highly toxic penta and tetra (4- and 5-chlorine) isomers.

- Only trace PCDD/DF was detected in boiler fly ash deposits in the second and third passes of the boiler as the gases cooled from 1470^{0}F to 750^{0}F, but substantial amounts were found in the fourth pass where the gases cooled from 750^{0}F to 425^{0}F.

- Copper chloride ($CuCl_2$), together with the alkali/alkaline chlorides in the fly ash, appears to play an important catalytic role, releasing free chlorine in reactions which take place on carbon surfaces.

- The hydrochloric acid (HCl) is oxidized from alkali and alkaline earth chlorides (such as KCl), also releasing chlorine to react with carbon.

- The amount of carbon in the fly ash appears to affect formation of PCDD/DF directly by the well-known Deacon process in which HCl is oxidized to $C1_2$ with airborne oxygen. Carbon can be reduced by good combustion, and is probably a useful indicator for dioxins and furans.

Vogg, Metzger, and Stieglitz (1987) conclude that good combustion, reduction of precursors such as carbon, and cleaning of the boiler surfaces are the primary measures that can be used to minimize dioxins, and suggest that ammonia could be used to poison the catalysts for the PCDD/DF reaction.

4.3.17.14 Guidelines

4.3.17.15 The following guidelines apply to incineration of military solid waste:

- Solid wastes will be incinerated only in facilities specially designed for that purpose.

- Design and operation of incinerator facilities shall be in accordance with the EPA guidelines for Thermal Processing of Solid Wastes (40 CFR 240).

- Design and construction of new incinerator facilities will be preceded by an assessment of the environmental impact of that facility in accordance with the National Environmental Policy Act, Council on Environmental Quality Regulations (EPA regulations 40 CFR 1500-1509) and agency regulations of each Military Department.

- The collection system and operation of the incinerator shall be planned so that toxic materials, bulky wastes, flammable or explosive wastes, or other materials not suitable for incineration are disposed of by other means. Wastes requiring special handling are discussed in Section 4.4. Highly flammable or explosive materials, such as gasoline, oil, tar roofing, photographic film, and ordnance, shall only be incinerated in an incinerator specifically designed for that purpose. Violations of this rule will subject incinerator personnel and equipment to unacceptable risks. Disposal of pesticides and pesticide containers is discussed in Section 4.5.

4.3.17.16 Some materials are unsuitable for incineration because they would cause damage to the incinerator. Where refuse is disposed of by incineration, installation regulations will specify the various segregations of refuse. The following materials are not suitable for incineration and will be rejected by the operator with the proper authority notified.

- *Hazardous refuse.* Reject all hazardous refuse of the types described in Section 4.5. Fine dust, flour, and powdered sawdust are also potentially hazardous when charged into the incinerator in large compact quantities. If care is exercised, they can be charged safely in small quantities.

- *Noncombustibles.* Metal, glass, ashes, and the like do not burn readily at normal incinerator temperatures. They form a slag, foul the grates, increase stoking requirements, reduce burning capacity, and finally must be removed from the furnace. Small quantities of tin cans and wire bindings will not materially affect incineration; operations shall not be delayed to sort them out.

- *Excessive moisture.* Refuse containing a high percentage of liquid shall be rejected. Excessive liquid will slow combustion and damage hot refractories and castings.

- *Lumber.* Burning lumber releases more than four times as much heat as ordinary combustible rubbish. Heavy construction lumber and crating shall not be charged in large quantities into a Type I[1] or Type II incinerator. An operator can mix this material in small quantities with Type I and Type II wastes. Type III or an industrial destructor can also be designed to incinerate this material.

4.3.17.17 Incinerator facilities must provide for receiving, weighing, unloading, storage, charging, combustion, emission control, and removal and handling of residues. Principal components in the design of an incinerator are shown in Table 4-3-17E.

4.3.17.18 Safe incinerator operation and maintenance shall be a primary concern. Personnel shall have a short safety meeting just before the commencement of maintenance work.

- Dampers in the ducting shall be closed during servicing of induced/forced-fans to prevent downdraft/updraft from turning the fans and causing injury.

- Materials handling equipment (MHE) shall be inspected daily by operator and load tested at least annually.

- Storage tanks, silos, manholes, and process equipment shall be checked by a gas-free engineer before personnel enter. Personnel inside a confined space shall have a lifeline and a buddy with visual contact at all times.

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[1] See Table 4-3-17G.

TABLE 4-3-17E
Principal Components in the Design of Incinerators

Component	Purpose/Description
Scales	Required to maintain accurate records of the amount of wastes processed.
Storage pits	Design of pits depends on furnace capacity, storage requirements (approximately 1-day capacity), collection schedules, and truck-discharge methods.
Cranes	Used to transfer wastes from storage pit to charging hoppers to mix and redistribute wastes in storage pit.
Charging hoppers	Constructed of metal or concrete, used to introduce wastes to furnace grates.
Furnace grates	Used to move wastes through furnace. Traveling, reciprocating, rocker arm, and barrel grates have been used successfully. Burning rate of 60 to 65 $lb/ft^2/h$ has been adopted as a “generally allowable" standard for mass firing.
Combustion chamber	Depends on capacity of unit and fuel characteristics.
Heat-recovery system	Types of systems vary. Typically, two boiler sections are used: convection and economizer.
Auxiliary heat	Need depends on moisture content of wastes as delivered.
Air pollution control facilities	Used to control particulate and gaseous emissions.
Auxiliary facilities and equipment	Normally includes residue handling facilities, air supply and exhaust fans, incinerator stacks, control building, etc.

4.3.17.19 Recommended facility safety features are shown in Table 4-3-17F.

4.3.17.20 Table 4-3-17G shows a range of incinerator sizes that might be considered by military installations. Many installations benefit from small capacity incinerators which might operate only 8 h/day. Rarely would a military installation consider a 1000-ton/day plant unless it was operating as a partner with municipalities. An example of such a cooperative effort is an RDF plant built by the Southeastern Public Service Authority (SPSA) (Masley 1987). Here the Norfolk Naval Shipyard participates both by supplying garbage and purchasing steam energy. Eight other communities are involved in this combined facility which consists of nine transfer stations, an ash landfill, and a refuse-only landfill in addition to the incinerator to serve a fast growing area. This incinerator capacity is roughly 2000 tons/day.

4.3.17.21 Operation Procedures

4.3.17.22 Maximum incinerator efficiency is obtained with continuous operation. However, military installations usually do not generate enough waste to justify this schedule. Except at the largest installations, one person, working an *8-h shift, can operate an incinerator that has sufficient capacity to burn all installation refuse during the working day. Cleanup is mandatory before and after firing. If the workload is too heavy, additional operators can be assigned. A staggered schedule will provide an adequate crew during peak delivery hours. The following typical staggered schedule allows 2 h for morning and evening cleaning and 9-1/2 h for incineration at full burning capacity.

1. 0700 - 1530: The first operator cleans the furnace and builds a fire from 0700 to 0800, then supervises the unloading and charging of refuse.

2. 0900 - 1730: The second operator stokes the fire and controls the rate of charging. From 1630 to 1730 the same operator accomplishes incinerator shutdown and ensures that the facility is left in a safe configuration.

4.3.17.23 Any furnace manufacturer will supply detailed technical operating instructions for the equipment. General plant procedures shall ensure that

- Personnel are provided with face shields or safety goggles, heavy gloves, respirators, safety shoes, and hard hats. OSHA Standard 1910.133 is the requirement for eye and face protection.
- Safety belts are worn when personnel are working on ladders.
- Fly ash is removed from the flues only when the ash temperature is below 38^{0}C (100^{0}F).
- Procedures for operation during emergency situations, such as power failure, air or water supply failure, equipment breakdowns, and fires, are developed and posted. These procedures shall be practiced so that personnel become familiar with them and able to apply them when necessary.

TABLE 4-3-17F
Facility Safety Features

1. Shredder to reduce size of lumber and other combustible refuse being charged to the furnace. Oversized wood or lumber causes bridging in the charging hopper, which may cause flame propagation and combustion of solid waste outside the furnace.

2. Automatic or manual sprinkler systems for storage pits and charging floors.

3. Fire-hose stations and fire extinguishers at strategic locations for fire protection. Sprinklers in the charging hoppers are needed to put out fire backlash.

4. Good lighting.

5. First aid kits in dumping and furnace areas.

6. Adequate drains and sloping floors.

7. Building ventilation using outdoor suction intakes to prevent the possibility of creating a vacuum on the stoking floors.

8. Stacks equipped with aircraft warning, lightning rods, and safety ladders.

9. Stack sampling ports as required by air pollution control regulations.

10. Intercom system between charging and stoking floors.

11. Provide TV monitors in the control room for the charging hoppers, dumping area of the refuse pit, end of the furnaces, and the stack. The monitors will help the operators control various plant operations.

12. Access ladders to storage pits.

13. Forced-air ventilation in storage pits.

14. Drains to allow hosing of the storage pits.

15. A method of quickly removing an injured person from the storage pit.

16. Chimney screens.

17. Guardrails to prevent personnel from falling into the incinerator equipment. At the charging opening of top-fed incinerators, toe boards as well as guardrails will be provided. OSHA Standard 29 CFR Part 1910.23 refers to guarding openings in floors.

18. Permanent, fixed backing bumpers to prevent vehicles from backing into the storage pit.

TABLE 4-3-17F
(cont'd)

19. Overhead cranes equipped with an alarm to indicate that the crane is in motion.

20. Safety valves in any facility designed to generate steam or hot water.

21. Provide a quench tank for ash to put out embers and prevent re-ignition of unburned solid waste. Building ventilation shall be designed so that foul air from the refuse pit, segregation areas, etc. is conveyed to the furnace as part of the primary combustion air for sanitation and odor control.

TABLE 4-3-17G
Types and Capacities of Incinerators

Type	Solid Waste Type	Capacity
Army 1[1] (most used)	100% combustible to 65% dry rubbish + 35% wet garbage	0.6 ➜ 1.2 tons/h
Army 11[1]	35% dry combustible rubbish + 65% wet garbage	3, 5, 10 tons/8-h shift
Army 111[1]	Special handling of unique disposal problems, usually waste with <15% moisture	Varies
Packaged Controlled	Waste with heating value ~6500 Btu/lb; usually have auxiliary burners fired with oil, gas, or both.	➜ 1.5 tons/h
Commercial municipal Continuous feed a. traveling grate b. reciprocating grate c. rotary kiln d. barrel grate e. waste heat recovery	Designed to fit waste stream -- need a steady supply of waste within narrow composition limits.	➜ 1000 tons/day

(1) tm 5-814-4 (Incineration)

- Safety valves are removed and checked at least once a year by qualified mechanics.

- Electrical equipment such as forced-draft motors, switches, and wiring, is serviced and maintained by qualified electricians

- Good housekeeping is practiced at all times.

- Appropriate warning signs and instrumentation are conspicuously posted. Charts and signs serve to familiarize personnel with correct operating practices. An incinerator operating chart can be used as a visual guide for stokers and chargers. Warning signs shall be posted as reminders to keep personnel outside guardrails. Prominent posting of the notices to collection crews will alert truck drivers and helpers to safe, orderly procedures. For timely maintenance, a schedule shall be displayed, giving desirable frequency for inspecting refractories and cleaning ash pits, fire chambers, combustion chamber, stack base, floors, sumps, and floor drains.

4.3.17.24 **Maintenance procedures.** Components subject to rapid wear or damage shall be inspected weekly at a time when they are not in operation. After each weekly inspection a report shall be made. It shall include the condition of the furnace, repairs performed, and the expectation of future repairs. When repairs are being made, the units remaining in operation should not be overloaded. Some incinerators are equipped with maintenance shops. Spare parts (those not readily available as shelf items) for cranes, stokers, fans, and motors are sometimes kept on hand. Most operational maintenance is performed by regular staff employees. Preventive maintenance should be practiced to prevent serious problems. Weekend shutdowns provide an excellent opportunity to inspect for future problem areas. Refractory maintenance, boiler care, slag removal, and grate maintenance are some of the important areas that shall be serviced frequently. In addition to the control of odor, dust, and litter, the work space shall be kept clean. Misuse of employee facilities, such as accumulating salvage items, shall not be permitted. Poor housekeeping creates fire or safety hazards. Lighting fixtures and bulbs shall be kept clean to provide effective illumination at all times.

4.3.17.25 **Disposal of Residue.** From 5% to 25% by weight of the refuse charged into an incinerator remains as residue after combustion. The percentage for a given facility depends upon the composition of the waste stream, preincineration resource recovery, and operation of the incinerator itself. Devices to handle this residue differ, depending on the type and design of the incinerator. The residue contains all of the solid materials remaining after burning such as ash, cinders, unremoved metals, glass, rocks, and unburned organic substances. Incinerator residue is permeable and contains water-soluble inorganic and organic compounds. Incinerator residue must be analyzed to determine if it is regulated as a RCRA waste or by state or local regulations. Batch-feed incinerators usually have ash hoppers located directly below the grates. The hoppers are large enough to store the refuse from several hours' burning. The residue is quenched or sprayed with

water to reduce fire hazards and to control dust. Many incinerators are designed to allow dump trucks to load the residue directly from the hoppers. The residue from continuous-feed furnaces falls from the burning grate into automated ash removal devices. The residue is also quenched in a bath for dust and fire control. A drag or apron pan conveyor then carries the wet residue to dump trucks. The quench water requirements will vary considerably depending on the specific design and operational requirements of a given incinerator. Ash after quenching is then disposed of according to federal, state, and local regulations.

4.3.18 Composting. Composting is another resource conservation method. It is the process whereby microorganisms are utilized to convert most organic matter to humus. The resulting humus is generally used as an agricultural soil conditioner or potting soil. Composting could theoretically have a wide application to many military installations since they are frequently located in wooded areas. Composting operations at installations located in areas possessing an abundance of leaves can significantly reduce the volume of wastes to be disposed of.

1. Leaves can be bagged by residents and set out at the curb for pick-up on specified days. Leaves from parade grounds and other nonresidential areas can be raked into large piles and loaded directly into dump trucks or other general purpose vehicles. All leaves can then be hauled to a central composting point. An excellent location for the composting point is the installation sanitary landfill. The composting operation can be placed on a completed and filled section in the landfill site. Once at the composting site, leaves shall be arranged in rows and turned frequently in order to promote rapid decomposition. The resulting humus can be utilized on the installation as a soil conditioner or potting soil.

2. Pine straw is considered a forestry product and specific regulations apply to its disposal. Pine straw is available in large quantities at many military installations, particularly in the southeastern United States. The pine straw may be composted, but it can also be used as is without further processing. It has excellent usage as the top cover in flower beds and in forming "pine islands." Pine straw may also be given to civilian communities for use in community beautification projects. Pine straw with commercial value cannot be given away.

3. Solid waste can also be composted. The waste is usually shredded, and most of the nonorganic materials removed. The remaining organic material is generally arranged in windrows and turned frequently to promote decomposition by microorganisms. The resulting humus can be utilized in the same manner as that generated from leaves. This operation shows limited applications to military installations. The Navy and the city of Key West jointly constructed a 50-ton/day aerobic composting facility in Key West, Florida. Solid waste is mechanically composted and windrowed onsite (one turn every week for 90 days). The product is a soil conditioner used on city parks and sold to the public.

4. Composted leaves and pine straw are generally utilized at the generating installation, and marketing is not a consideration. However, there are several disadvantages to the composting of solid waste. The processing required for its preparation is similar to that for RDF, and it is unlikely that composting will be able to compete with energy recovery as a solid waste management tool. Also, compost is considered to be a very low grade fertilizer and as such cannot economically compete with available chemical fertilizers. Finally, only a very few areas of the U.S. are so sandy that there is a great need for this type of soil conditioning. The high processing costs and lack of suitable markets will frequently result in making the composting of military solid waste economically unfeasible.

4.4 WASTES REQUIRING SPECIAL HANDLING

4.4.1 Many solid wastes may not be disposed of as normal municipal refuse and require special handling and/or disposal. Check with the installation environmental specialist for information regarding special handling and disposal requirements. The RCRA defines a solid waste as "any solid, liquid, semi-solid or contained gaseous material which has served its purpose or has been discarded." Materials that are recycled, reclaimed, or reused may be considered a solid waste under RCRA. Hazardous wastes, a subset of solid wastes, are wastes that pose "a substantial hazard (present or potential) to human health or the environment when improperly managed or disposed." Waste generators are responsible for determining which wastes are considered hazardous by regulation and which wastes shall be prudently managed as such. State and local regulation pertaining to solid waste disposal must be examined because RCRA allows the EPA to authorize individual states to operate their own hazardous waste management programs. The state programs must be equivalent to or exceed the federal regulations. Some states have adopted regulations that exceed certain portions of the federal regulations. For example, seven states have chosen to regulate infectious wastes as a hazardous waste. Other states may not recognize the "small quantity generator" status defined in the federal regulations.

4.4.2 Examples of solid wastes that may be regulated or require special handling are presented below:

- used oils and solvents
- asbestos wastes
- radioactive wastes
- infectious wastes
- PCB wastes.

The management of RCRA-regulated "Hazardous Wastes" is discussed in further detail in Section 4.5 of this document. Solid wastes considered to be hazardous wastes have been introduced in this section because they may be regulated by local, state, or federal regulations other than RCRA.

4.4.3 Used Oils and Solvents

4.4.3.1 Used oil includes all used petroleum products and lubricants, hydraulic fluids, preservatives, metal-working fluids, waxes, and insulating fluids. Used oil recycling and disposal activities are presently regulated under RCRA and various state authorities. The burning of used oil in nonindustrial boilers is prohibited if fuel specifications cannot be met because of contamination (chlorinated solvents; heavy metals; or polychlorinated biphenyls, PCBs), characteristics (flash point below 140^{0}F), or total halogens. Industrial burners of off-specification used oil fuel must comply with various notification, certification, and record-keeping requirements.

4.4.3.2 Used solvents are defined as all organic fluids contaminated as a result of use for cleaning or thinning or use as a solvent, antifreeze, or for a similar purpose. Most used solvents are regulated by RCRA as hazardous wastes. The recycling, reclaiming, or reuse of used oil or solvent may also be regulated. The Used Solvent Elimination Program (USE) requires the minimization of solvent wastes. Guidance for the management of used oils and solvents can be found in "Used Oil and Solvent Recycling Guide," prepared for NEESA in June 1985, and in NEESA 20.3-013. PCB-contaminated oils must be handled and disposed of as described later under PCB wastes.

4.4.4 Asbestos Wastes. Friable asbestos wastes must be handled and disposed of in accordance with the provisions of Subpart M of 40 CFR 61 and any other state or local regulations. Asbestos removal and disposal on military installations must be performed by a licensed contractor or specifically trained and equipped civilian/military personnel. The material must be placed in sealed, impermeable bags and disposed of by burial at a state-approved sanitary landfill.

4.4.5 Radioactive Wastes. The handling and disposal of radioactive wastes is strictly controlled by the U.S. Nuclear Regulatory Commission (NRC) in accordance with 10 CFR 20. Medical and research installations may produce wastes contaminated with radioactivity. Many of the short half-life radioactive isotopes used in medical activities can be decayed for 10 half-lives and then disposed of as infectious waste. Radioactive wastes containing regulated hazardous chemicals are considered "mixed wastes" and must be handled and disposed of as a "hazardous waste" and a "radioactive waste." For example, waste liquids used from scintillation counting may contain toluene or xylene, which are regulated hazardous chemicals wastes.

4.4.6 Infectious and Medical Wastes. Hospitals and other health care facilities generate solid wastes, of which 10% to 15% are considered infectious waste. Facility Engineers/Public Works Officers/Base Civil Engineers are not responsible for the collection and disposal of infectious waste. Commanders of medical department installations are responsible for the disposal of infectious waste in coordination with facility engineers/public works officers/base civil engineers. The regulation of infectious waste varies widely from state to state. The Medical Waste Tracking Act of 1988 required EPA to develop infectious waste regulations, which were issued under Subpart J of RCRA. Effective 22 June 1989, hospitals, clinics, medical offices, and other handlers of potentially infectious medical wastes in the states of Connecticut, New York, New Jersey,

Pennsylvania, Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota must adopt a tracking program to trace the wastes from generation to disposal for the next 2 years. Any of the Great Lakes states may "opt out" of the program, and other states may "opt in" to the program.

4.4.6.1 Generators and handlers of more than 50 lb of medical waste a month are required to complete a tracking for each waste shipment for offsite treatment or disposal. Generators of less than 50 lb of medical waste a month must keep logs at the generating site. All regulated medical waste managed offsite must be labeled and packaged in rigid leak-resistant containers in accordance with the regulations. Medical wastes are defined by the Act to include:

- cultures and stocks of infectious agents and associated biologicals
- cultures and infectious agents from research and industrial labs
- discarded live and attenuated vaccines
- culture dishes and transfer devices
- human blood and blood products
- organs and tissues removed during surgery and autopsy
- sharp instruments used in patient care
- contaminated animal bodies and parts exposed to agents in research and production of biologicals and drugs
- other lab wastes and equipment that may have come into contact with infectious agents.

4.4.6.2 The disposal of surplus medical supplies (FSC 6505) must also be considered. Some items contain silver, which can be recycled. Others such as outdated drugs and vaccines must be disposed of according to prescribed procedures. Procedures for disposal of surplus medical items are currently under development and revision.

4.4.6.3 *EPA Guidance.* Regulations for infectious waste management can be found in Environmental Quality, Preventative Medicine for Medical Services (e.g., AR 40-5). The EPA Office of Solid Waste has also published a document that provides guidance on the management of infectious waste, "EPA Guide for Infectious Waste Management," 1986, 530-SW-86-014. This document outlines procedures for designation, segregation, packaging, storage, transport, treatment, and disposal of infectious waste. The categories of wastes listed in Table 4-4A are recommended by EPA to be designated as infectious waste. EPA believes that the decision to designate the miscellaneous contaminated wastes presented in the table as infectious shall be made by a responsible authorized person or committee at the facility. EPA recommends that wastes from patients that are known to be infected with blood-borne diseases be treated as infectious waste.

TABLE 4-4A
Designation of Infectious Waste

Waste Category	Examples
Isolation wastes	! refer to Centers for Disease Control (CDC), Guidelines for Isolation Precautions in Hospitals, July 1983
Cultures and stocks of infectious agents and associated biologicals	! specimens from medical and pathology laboratories ! cultures and stocks of infectious agents from clinical, research, and industrial laboratories; disposable culture dishes, and devices used to transfer, inoculate, and mix cultures ! wastes from production of biologicals ! discarded live and attenuated vaccines
Human blood and blood products	! waste blood, serum, plasma, and blood products
Pathological waste	! tissues, organs, body parts, blood, and body fluids removed during surgery, autopsy, and biopsy
Contaminated sharps	! contaminated hypodermic needles, syringes, scalpel blades, Pasteur pipettes, and broken glass
Contaminated animal carcasses, body parts, and bedding	! contaminated animal carcasses, body parts, and bedding of animals that were intentionally exposed to pathogens
Miscellaneous Contaminated Wastes	Examples
Wastes from surgery and autopsy	! soiled dressings, sponges, drapes, lavage tubes, drainage sets, underpads, and surgical gloves
Miscellaneous laboratory wastes	! specimen containers, slides, and cover slips; disposable gloves, lab coats, and aprons
Dialysis unit wastes	! tubing, filters, disposable sheets, towels, gloves, aprons, and lab coats
Contaminated equipment	! equipment used in patient care, medical laboratories, research, and in the production and testing of certain pharmaceuticals

4.4.6.4 *Packing and Storage.* Regulations require units and installations that generate infectious waste to segregate and store the waste in the area of generation until collected. Distinctive, clearly marked containers with tight-fitting lids and lined with an appropriate bag (normally red) shall be used for most solid or semi-solid infectious waste. Container liners are to be tightly sealed with twist ties, rubber bands, and/or taped before leaving the area of generation. Puncture-resistant containers shall be used for needles, syringes, and sharps. Liquid wastes shall be placed in capped or tightly closed bottles or flasks until treatment and disposal. When storage of pathological waste is necessary, the enclosed waste will be refrigerated until transferred for treatment. Infectious wastes shall be collected at regular intervals by properly trained personnel to minimize storage time.

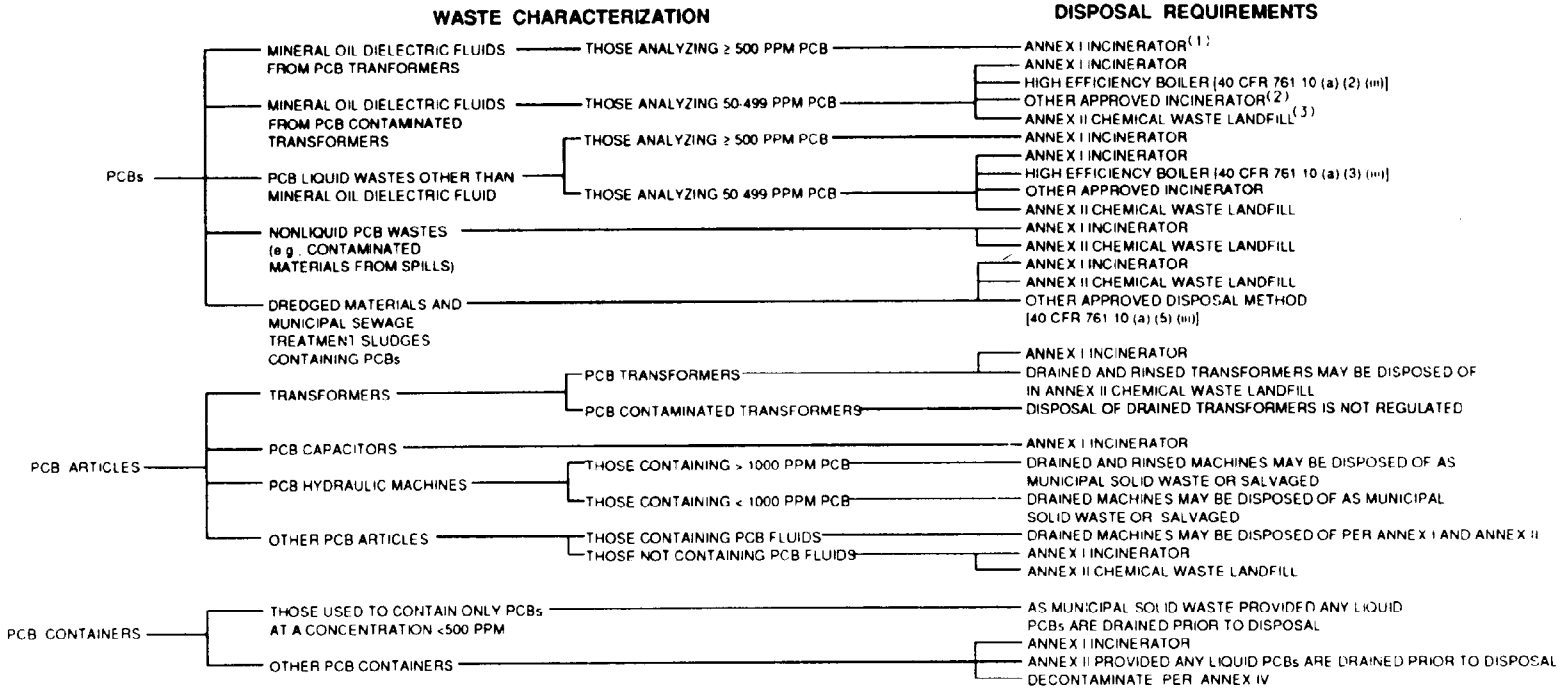
4.4.6.5 *Transporting.* Infectious wastes are to be transported in the original containers, or the sealed bags can be transported in larger carts. Infectious wastes shall be manually transported to avoid rupture of the package. Containers and carts used to transport infectious waste are to be cleaned after each use.

4.4.6.6 *Treatment.* Incineration or steam sterilization are the methods to be used for treating infectious wastes. The ash from incineration or the solid waste after steam sterilization can be disposed of at a sanitary landfill. pathological waste that has been steam sterilized shall be subjected to destruction (grinder) and flushed into the sanitary sewer. Treated liquid wastes shall also be discharged to the sewer system. Care must be taken when flushing waste down the sewer system to ensure that contamination of personnel or the public does not occur.

4.4.6.7 Correct identification and segregation procedures for infectious wastes management are important because the cost of disposal by incineration or sterilization has been estimated at $0.32/lb compared with $0.02/lb for normal landfill disposal. The high cost for permitting, purchasing, installation, and operation of infectious waste incinerators has caused most hospitals to use steam sterilization or private contractors for infectious waste treatment and disposal. Hospital wastes differ from normal municipal refuse in that they can contain as much as 50% disposable plastics. Upon incineration of PVC-containing plastics, HCl gas is produced. Increasing regulatory requirements on HCl and particulate emissions require that most incinerators be equipped with an acid gas scrubber and particulate abatement system. The ash residue from infectious waste incinerators may also require special disposal depending upon the content of leach able heavy metals.

4.4.7 PCB Wastes. Polychlorinated biphenyl wastes are regulated under the Toxic Substance Control Act. Wastes containing or contaminated with PCBs must be disposed of in accordance with 40 CFR 761, Polychlorinated Biphenyls (PCBs) Manufacturing, processing, Distribution in Commerce, and Use prohibition, and any state or local regulations. The PCB disposal requirements specified in Section 761.10 are shown in Figure 4-4A.

4.5 HAZARDOUS WASTES. The Solid Wastes Act was replaced by the Resource Conservation and Recovery Act of 1976. This means that solid wastes and hazardous wastes are both regulated under RCRA. However, hazardous wastes regulations are more stringent and require stricter compliance. Generally



(1) ANNEX I INCINERATOR IS DEFINED AT 40 CFR 761 40.
(2) REQUIREMENTS FOR OTHER APPROVED INCINERATORS ARE DEFINED AT 40 CFR 761 10 (e).
(3) ANNEX II CHEMICAL WASTE LANDFILLS ARE DESCRIBED AT 40 CFR 176 41 ANNEX II DISPOSAL IS PERMITTED IF THE PCB WASTE ANALYZES LESS THAN 500 PPM PCB AND IS NOT IGNITABLE AS PER 40 CFR PART 761 41 (b) (8) (iii)

Figure 4-4A
Disposal Requirements for PCBs and PCB Items

speaking, any solid waste mixed in with hazardous wastes is considered a hazardous waste. Therefore, solid wastes must be kept segregated from hazardous wastes. The following information is based on regulations that are still changing. The expectation is that more stringent requirements will be enforced in the future. The discussion in this section is intended only to make readers aware of the complexities of handling hazardous materials. This document is not meant to be official military guidance in handling such wastes.

4.5.1 Definition of Hazardous Wastes. In accordance with Section 1004(5) of RCRA (PL 94-580), the term "hazardous waste" means a solid waste or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may: (1) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

4.5.2 Hazardous Wastes Identification

4.5.2.1 The criteria for identifying hazardous wastes are as follows:

1. Waste can be analyzed to determine its characteristics using standard test methods, which can be done either in-house or contracted out to certified laboratories.

2. Wastes can be reasonably identified as hazardous by the generator through familiarity with the waste streams.

4.5.2.2 Hazardous Wastes Characteristics. The four common characteristics of hazardous wastes are listed below:

1. Ignitability - wastes that could catch fire during normal handling. Dangers from such fires not only include heat and smoke but also the spread of particles detrimental to health over wide areas.

2. Corrosivity - wastes that attack standard materials, thereby requiring special type of containers. These wastes must be segregated because they could dissolve toxic contaminants from other wastes.

3. Reactivity (explosiveness) - wastes that may react spontaneously and vigorously with water and air during normal handling. These wastes are unstable to shock or heat, and may explode and generate toxic gases.

4. Toxicity - wastes containing toxicants which, if released in sufficient quantities, pose substantial hazard to human health or the environment.

Test procedures to determine the above characteristics are described in 40 CFR 261, Subpart C.

4.5.2.3 *Criteria For Listing Hazardous Wastes.* Per 40 CFR 261.11, Subpart B, the basis for listing solid wastes as hazardous are as follows:

1. wastes exhibiting any of the characteristics identified in 40 CFR 261, Subpart C, shown above

2. wastes found to be fatal to humans in low doses, or capable of causing serious illness

3. wastes containing any of the toxic constituents listed in 40 CFR 261, Appendix VIII, unless the waste is not capable of posing a hazard to human health when. improperly treated, stored, transported or disposed of.

4.5.2.4 An EPA hazardous waste number is assigned for each hazardous waste. Lists of hazardous wastes from specific and nonspecific sources are found in 40 CFR 261.31 and 40 CFR 261.32. Exclusions from these lists are shown in 40 CFR 261, Appendix IX.

4.5.2.5 Discarded commercial products, off-specification species, and container and spill residues containing the generic substances listed in 40 CFR 261.33 are considered hazardous wastes. Any solid waste containing identified hazardous generic substances as an active ingredient of the mixture is a hazardous waste. Additional information regarding the identification of hazardous waste can be obtained from the installation environmental specialist.

4.5.3 Responsibilities

4.5.3.1 In addition to the standards imposed by the initial enactment of RCRA in 1976, the Congress enacted the Hazardous and Solid Waste Amendments of 1984, Public Law 98-616 (November 8, 1984), which substantially strengthened EPA's ability to protect health and the environment.

4.5.3.2 Regulations imposing requirements upon those who generate and transport hazardous waste, as well as those who own or operate a hazardous waste storage, treatment, or disposal facility are found in 40 CFR 260-267. Permit requirements and standards concerning state plan approval are found in 40 CFR 270-271. Each part regulates a different facet of hazardous waste management. Copies of the regulations are available from the U.S. Government Printing Office in Washington, D.C.

4.5.3.3 State hazardous wastes regulations vary nationwide. Some are more stringent than the federal regulations. For example, used oil is classified as hazardous waste in California and other states but not by EPA. Therefore, if an installation located in California plans to burn used oil as fuel in their boilers, a Part B permit may be required. This makes burning of used oil as fuel not economically feasible in California.

4.5.3.4 *DLA Responsibilities.* The Defense Logistics Agency (DLA) is responsible for disposition of all excess and surplus properties (including scrap and hazardous wastes) generated by DoD. The DLA has been charged with the management of hazardous wastes and other waste materials [except those defined in Defense Environmental Quality Program Policy (DEQPP)

Memorandum 80-5 as the responsibility of each branch] including the wastes listed below:

1. Toxicological, biological, radiological, and lethal chemical warfare materials which, by U.S. law, must be destroyed

2. material that cannot be disposed of in its present form because of military regulations, e.g., consecrated religious items and cryptographic equipment

3. municipal-type garbage, trash, and refuse resulting from residential, institutional, commercial, agricultural, and community activities, which the facilities engineer routinely collects

4. contractor-generated materials that are the contractor's responsibility for disposal under terms of the contract

5. sludges resulting from municipal-type wastewater treatment facilities

6. sludges and residues generated as a result of industrial plant process or operations

7. refuse and other discarded materials which result from mining, dredging, construction, and demolition operations

8. unique wastes and residues of a nonrecurring nature which research and development experimental programs generate.

DLA delegated the operational responsibilities to DRMS, DRMR, and DRMO in assisting DoD installations in the disposal of hazardous wastes and other excess or surplus properties.

Once DRMO takes custody of the hazardous wastes, one of their hazardous waste contractors is notified for pickup within 90 days. DRMO's responsibilities are given below:

1. Ensure that all containers are properly packaged, labeled, and manifested.

2. Place appropriate shipping labels and vehicle placards in compliance with DOT regulations.

3. Transport hazardous wastes to an approved Class I landfill for possible treatment and/or disposal.

4.5.3.5 *Installation Responsibilities.* At the installation level, the environmental office is responsible for managing the hazardous waste program. This task involves handling and disposal of hazardous wastes. Basically, the procedures for handling hazardous wastes are as follows:

1. Properly segregate and containerize all hazardous wastes.

2. Label each container and indicate EPA identification number.

3. Prepare disposal turn-in document DD Form 1348-1.

4. Prepare hazardous waste manifest.

4.5.4 Hazardous Waste Management Plan. The Hazardous Waste Management Plan (HWMP) provides guidance to installation personnel in handling and storage of hazardous wastes consistent with regulatory requirements. Guidelines for preparing an HWMP are contained in 40 CFR 260-270. In addition, state and local regulations must also be complied with, if more stringent than the federal requirements.

4.5.4.1 *Scope.* The scope of the HWMP depends on the installation's hazardous waste generation rates. This section is provided only for guidance and is not meant to be a complete discussion of HWMPs. Typically. the HWMP shall contain the following items:

1. Installation Instruction - implements the HWMP within the installation; is signed by the base commander.

2. Regulations - a summary of the applicable federal, state, and local regulatory requirements.

3. Responsibility - duties and responsibilities of all personnel involved with the management of the HWMP are listed.

4. Organizational Chart - an organizational structure showing the HWMP chain-of-command.

5. Hazardous Waste Inventory - a compilation of the quantities of hazardous waste being generated and their sources, type of accumulation, and storage time.

6. Location Map - a base map indicating the boundaries and all areas where hazardous wastes are generated and accumulated.

7. Standard Operating Procedures - detailed explanation of the correct procedures concerning the generation, containerization, collection, labeling, marking, recordkeeping, packaging, handling. storage, treatment, transportation, and disposal of hazardous waste. This is the most critical section in the HWMP.

8. Inspection Plan - a well-organized plan is required to ensure that the hazardous waste management program is implemented correctly and the installation is complying with all pertinent regulations.

9. Training Plan - personnel directly involved in hazardous waste management are required to be trained so they can successfully perform their duties.

10. Spill Contingency Plan - a description of actions installation personnel must take to respond to a spill of hazardous wastes. This

is a requirement for all military installations and will most likely be a separate document. The HWMP shall reference it in this section.

If an installation wants to operate a treatment, storage, and disposal (TSD) facility, the installation must prepare a hazardous waste analysis plan, facility inspection plan, facility contingency plan, facility closure plan, and facility post-closure plan, depending on the facility, pursuant to 40 CFR 264 requirements. These plans must be approved by EPA prior to issuance of TSD permit.

4.5.4.2 *Directives.* DoD directives supporting RCRA regulations are issued to the services for compliance. These directives, such as the Solid and Hazardous Waste Management Collection, Disposal, Resource Recovery, and Recycling Program; DoD Directive 4165.60; Hazardous Waste Minimization Program; Used Solvent Elimination Program; and other related hazardous waste issues are incorporated into the HWMP for compliance by the installations.

4.5.5 Hazardous Waste Handling, Storage, and Disposal

4.5.5.1 Segregation is one of the most important factors required to ensure a successful hazardous waste management program. To minimize contamination, use the original empty product can or container (provided it is in good condition) to collect the hazardous wastes. Containers shall be small enough to easily be handled and filled-up in less than 90 days. This is important if the installation does not have a permitted storage facility.

4.5.5.2 Store flammable hazardous wastes in Department of Transportation (DOT)-approved containers. Ensure these safety cans are properly grounded when used for storage of flammable solvents. In addition, check that containers are fully grounded when transferring flammable hazardous wastes.

4.5.5.3 Hazardous wastes must be packaged correctly so that they can be transported and stored safely pending disposal. Wastes must be packaged in tightly closed containers, either in the original container or in a DOT-approved container. Most wastes should be collected in the original container. The containers must show no signs of deterioration or damage. The container material of construction must be chemically compatible with the contents.

4.5.5.4 *Labeling and Color Coding.* A good segregation program requires proper identification of hazardous waste for both collection and subsequent handling. This is done in the following manner:

- Label containers on the side with the name, MILSPEC and FSN (Federal Stock Number), if available, of the used material to be collected.
- Place a sign (wood or metal) on the designated collection area or hang it over the collected containers.
- Use color coding of drums/containers to identify different types of hazardous wastes for treatment and/or disposal.

4.5.5.5 Manifesting. A generator who transports, or offers for transportation, hazardous waste for offsite treatment must prepare a manifest 0MB control number 2000-0404 on EPA Form 8700-22, and if necessary an EPA Form 8700-22A according to instructions in the Appendix of 40 CFR 62.

The manifest will contain:

1. Generator’s U.S. EPA identification number
2. generator's name, mailing address, and phone number
3. name and U.S. EPA identification number for each transporter
4. designated disposal facility name, site address, and U.S. EPA identification number
5. U.S. DOT description
6. number and type of containers for each waste
7. total quantity of each waste
8. special handling instructions
9. generator's dated signature.

4.5.5.6 *Storage.* Waste generators may accumulate hazardous waste onsite without a permit for 90 days or less after the date of generation. The accumulation date normally starts when a waste is first placed into a container or unused material is declared as waste. An exception to the regulation is allowed if wastes are collected at or near the point of generation. A satellite storage area is the waste collection area at or near the point of generation. The accumulation start date for wastes collected in this manner is the date the container is full or the quantity of hazardous waste exceeds 55 gal or the quantity of acutely toxic waste exceeds 1 qt. Hazardous wastes generated at the shops are collected in appropriately labeled cans or drums adjacent to the work areas. When they become full, they are moved to a central storage area for accumulation of less than 90 days. DRMO takes custody of the hazardous materials and hazardous waste in accordance with DoD 4160.21-M. If the DRMO does not have a permitted facility, the installation retains physical custody of waste while DRMO takes “paper” custody and begins to arrange for disposal.

4.5.5.7 *Disposal.* Hazardous waste and hazardous materials that cannot be treated or recycled onsite are sent to DRMO in accordance with DoD 4160.21-M. Hazardous materials and hazardous waste that cannot be reused or sold by DRMS are disposed of by service contract. DRMS employs contractors to provide a disposal service, which includes transportation and ultimate disposal. It may also include packaging and testing if required. DRMO services through the DRMO contract provide timely removals, discounted prices based on volume, and balanced interest for small generators in remote locations equal to large generators located on main transportation routes. DRMS surveillance of contractor performance reduces the liability for DoD.

4.5.6 Treatment Alternatives. Hazardous wastes generated at the installation's industrial facilities are treated either onsite or offsite. Typical hazardous wastes subjected to treatment are solvents, plating wastes, aircraft paint stripping wastes, and acids. Used petroleum products may or may not be considered hazardous depending on the nature of their contaminants. DoD established the Used Solvent Elimination Program and the Hazardous Waste Minimization Program to provide direction and guidance in reducing hazardous wastes generation.

4.5.7 Petroleum Products

4.5.7.1 Used petroleum products represent another source of revenue for recycling installations provided they are not contaminated. When contaminated, they are somewhat special wastes because in many cases they can be re-used. For example, lube oil which does not quite meet specifications far fighter aircraft might be suitable for maintenance equipment. Re-use is a higher priority than recycling and must be considered before submitting a product for recycling.

4.5.7.2 DoD Directive 4165.60 also addresses the recycling of used petroleum products. AFR 19-14 addresses Air Force policies, duties, accounting guidelines, and documentation instructions for recycling of and/or recovering liquid petroleum products.

1. Installations that generate used lubricating oil and other waste petroleum shall take the following steps:

   a. Maximize the sale through DRMO of recovered used lubricating oil and other waste petroleum for the purpose of re-refining, the most environmentally acceptable recycling option. When allowed by military specifications for lubricating oil products, large installations shall consider negotiating for "closed cycle" re-refining arrangements as a method to further enhance the net value of the used lubricating oil and thereby reduce the cost of replacing the used oil with more expensive virgin lubricating oil products. This does not prohibit justifiable, existing, or proposed "closed cycle" used oil recycling arrangements between a military installation and industry.

   b. Because re-refining may not be economically feasible in some areas of the U.S., used lubricating oil and other waste petroleum may be burned as a fuel or fuel supplement in boilers if no reasonable arrangements can be made for recovery by re-refining. Burning used oil is consistent with the general national conservation principle to conserve our petroleum resources and to preserve the quality of our natural environment. In this regard, the economics of energy recovery alone are not to be considered as sufficient justification for burning waste petroleum products. Environmental effects and conservation also need to be considered as high priority factors in making the final decision.

   c. Report waste inventories as generated and anticipated annual generations, where applicable, to the servicing DRMO for ultimate disposition.

   d. Conduct laboratory analysis, as necessary, to identify abnormal contaminants. If contaminants exceed the used oil specifications, the used oil becomes a hazardous waste and can only be burned in a permitted facility.

e. Segregate, fully identify, label, store, and maintain the integrity of waste petroleum assets pending DRMO disposition.

f. Ensure that waste petroleum suspected of containing 50 ppm or more PCB contamination is identified, segregated, and reported to the servicing DRMO for disposal.

g. Encourage voluntary participation of military and civilian employees who change the crankcase oil in their own personal vehicles to deliver the recovered oil to the DoD collection location as a means of easy disposal, pollution abatement, and effective resource recovery. Cooperative programs with regional and local business, civic, and governmental organizations also might be considered to increase public awareness and improve the economics of recycling.

h. Include military exchanges and other tenant organizations in the installation program for efficiency and economy of centralized recovery efforts.

2. All used oil disposal practices that are not acceptable environmentally shall be discontinued, including use of oil for weed control, insect control, and road dust control; open-pit burning (excluding firefighting training); and dumping into landfills/ sewers/water.

4.5.8 Used Solvent Elimination Program (USE)

4.5.8.1 The USE Program was developed primarily to reduce the costs and future liabilities associated with the disposal of used solvents. The alternatives for reducing solvent generation are

1. onsite recycling
2. offsite recycling
3. burning as fuel.

4.5.8.2 Recycling of solvents is widely practiced within the services installations. Solvent stills are used for recycling organic solvents such as freons, trichloroethane (vapor degreasing solvent), mineral spirits, and paint solvents.

4.5.8.3 Onsite recycling involves the use of a solvent recovery equipment (stills), located at the point of generation. These stills recycle the contaminated solvents through distillation.

4.5.8.4 Offsite recycling means hiring commercial contractors to transport and recycle the solvents outside the military installations.

4.5.8.5 Solvents can be blended with oil as fuel for the boilers. However, precautions must be followed to ensure that halogenated solvents are not mixed with the oil. In addition, the blended fuel oil must be tested for heavy metals contamination (40 CFR 266).

4.5.9 Hazardous Waste Minimization Program. This program was established to provide guidance in reducing hazardous waste generation at all military installations. Each of the services' research laboratories is pursuing research and development work to find a less toxic or biodegradable material as an environmentally acceptable substitute. Likewise, process modification involving the incorporation of any additional equipment or changes in the process itself has been investigated. Examples of process modifications that have been implemented are

1. plastic media blasting
2. zero rinse discharge hard chrome plating
3. can crushing
4. sludge dewatering
5. neutralization.

4.5.9.1 Plastic media blasting is a process for stripping paints from aircraft using plastic media instead of methylene chloride. The plastic media is a less toxic material, and hazardous waste generation has been reduced up to 90% in paint stripping applications.

4.5.9.2 Zero rinse discharge hard chrome plating is a process for recirculating plating rinse water to the plating bath instead of discharging it to the industrial treatment plant. This process modification has reduced plating wastes up to 80%.

4.5.9.3 Can crushing is a mechanical process for compacting empty paint cans and contaminated empty drums. This reduction in volume reduces disposal costs.

4.5.9.4 Dewatering industrial sludges with the use of filter presses squeezes the water out of the sludge, forming a much thicker sludge cake with much less volume.

4.5.9.5 Neutralization is a process for mixing acids with bases in order to decrease the corrosivity of the solution. This treatment is used for battery acids prior to disposal to the industrial wastewater treatment plant.

4.5.10 Household Hazardous Waste

4.5.10.1 Household wastes, including household waste that has been collected, transported, stored, treated, disposed of, recovered (e.g., refuse-derived fuel), or reused is not regulated as hazardous waste. "Household waste" means any material (including garbage, trash, and sanitary wastes in septic tanks) derived from households, residences, hotels, motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas. Many household wastes are, however, hazardous in nature and may be ignitable, corrosive, toxic, or reactive. A chemical is also considered hazardous if it may cause a substantial injury, serious illness, or harm to humans, domestic livestock, or wildlife. Tables 4-5A and B list common household and garage chemicals now considered hazardous.

4.5.10.2 Other sources of information about household hazardous wastes include the following.

4.5.10.3 *Labels.* Package warning labels do not always furnish complete and accurate information regarding whether or not a substance is hazardous. However if a package is labeled "CAUTION," "WARNING," "DANGER," or "POISON," assume that the product would be a hazardous waste if regulated.

4.5.10.4 *Hotline.* Even though most installations do not have a specific environmental hotline, information concerning hazardous material can be found at some local activity. The fire department, base security, or the environmental office may offer information regarding a household hazardous waste. Tables 4-SA and B have many practical suggestions. DRMS has a Hazardous Property Hotline to answer hazardous property disposal questions: A/V 932-4133/FTS 522-4133/Commercial (616) 961-4133.

4.5.10.5 *Community Household Hazardous Wastes Program.* Many civilian communities have become aware of the problems of introducing these hazardous wastes to their landfills. As a result, these communities have developed their own household hazardous waste disposal programs. One example is an annual waste collection day. Homeowners bring their chemical wastes to a central location in the city. Then the city/county groups the wastes and disposes of them free of charge to residents. By joining forces with the civilian community, the DoD may be able to save time and money dealing with household hazardous waste.

4.5.10.6 Household Hazardous Waste Handlers' Responsibilities

4.5.10.7 If you have such a program, household hazardous wastes are separated for primarily three reasons. Most importantly, materials that are not compatible must not be stored together to avoid explosions or the emission of toxic fumes. The second reason for segregation is to keep materials to be disposed of at the same location together to avoid resorting the hazardous wastes. Finally, substances that may be recycled, such as oils and paints, shall be combined. It is important not to rely on the warning label to obtain classification information. For example several corrosives are labeled "POISON."

4.5.10.8 *Segregation.* The first rule in segregation is to separate the acidic chemicals from the basic chemicals. Also, the flammable materials shall be separated from the oxidizers. Generally, the poisons containing heavy metals shall be contained separately from the other poisons. The heavy metals contained in poisons include mercury, lead, and arsenic. Before segregating the hazardous wastes, the disposal site management shall be contacted to determine if any segregation requirements are unique to the site.

4.5.10.9 *Limitation.* The quantity of waste that can be transported from any one vehicle per day is limited by the DOT to 5 gal or 50 lb. However, if an individual attempts to turn in more than this amount, it should be accepted to avoid either an accident on the individual's return trip or illegal disposal.

4.5.10.10 *Collection.* Several different schemes for the collection of household hazardous waste have been implemented. These include building-to-building pickup, occasional collection days, and permanent stations. The building-to-building pickup consists of breaking up a

Table 4-5A
Chemical Hazards in the Home

Product	Possible Hazards	Disposal Suggestions	Precautions and Substitutes
Aerosols	When sprayed, contents are broken into particles small enough to be inhaled. Cans may explode or burn.	Put only empty cans in trash. Do not burn. Do not place in trash compactor.	Store in cool place. Propellant may be flammable. Instead: use non-aerosol products.
Batteries: mercury button type	Swallowing one may be fatal if it leaks. Toxicity 5*	Throw in trash.	No substitutes.
Bleach: chlorine	Fumes irritate eyes. Corrosive to eyes & skin. Poisonous if swallowed. Toxicity 3*	Use up according to label instructions.	NEVER MIX WITH AMMONIA! Instead: use non-chlorine bleach or other laundry additive, sunlight, lemon juice.
Detergent cleaners	All are corrosive to some degree. Eye irritant. Toxicity varies. Toxicity 2-4*	Use up according to label instructions or give away. May be diluted & washed down sink.	Instead: use the mildest product suitable for your needs. Liquid dishwashing detergent is mildest, laundry detergent is moderate, automatic dishwasher detergent is harshest.
Disinfectants	Eye & skin irritant. Fumes irritating. Poisonous if swallowed. Toxicity 3-4*	Use up according to label instructions or dilute & pour down sink.	Some may contain bleach, others ammonia -- DO NOT MIX! Instead: use detergent cleaners whenever possible.
Drain cleaners	Very corrosive. May be fatal if swallowed. Contact with eyes can cause blindness.	Use up according to label instructions.	Prevention best; keep sink strainers in good condition. Instead: use plunger, plumber's snake, vinegar & baking soda followed by boiling water.
Flea powders, sprays & shampoos	Moderately to very poisonous. Toxicity 2-4*	Use up or save for hazardous waste collection day.	DO NOT USE DOG PRODUCTS ON CATS. Vacuum house regularly & thoroughly. Launder pet bedding frequently.
Insect and pest sprays	All are poisonous, some extremely so. May cause damage to kidneys, liver, or central nervous system. Toxicity varies from product to product.	Use very carefully & according to label instructions. Save for hazardous waste collection day.	Instead: do not attract insects; keep all food securely covered, practice good sanitation in kitchen & bathrooms, remove trash every night.
Medicines: unneeded or expired	Frequently cause child poisonings.	Flush down sink or toilet.	Check contents of medicine chest regularly. Old medications may lose their effectiveness, but not necessarily their toxicity.
Metal polishes	May be flammable. Mildly to very poisonous. Toxicity 2-4*	Use up according to label instructions or give away.	Use only in well-ventilated area. Instead: substitute vinegar & salt or or use baking soda on damp sponge.
Mothballs	Some are flammable. Eye & skin irritant, poisonous, may cause anemia in some individuals.	Use up according to label instructions or give away.	Do not use in living areas. Air out clothing and other items before use. Clean items before storage. Instead: use cedar shavings or aromatic herbs.
Oven cleaner	Corrosive. Very harmful if swallowed. Irritating vapors. Can cause eye damage. Toxicity 2-4*	Use up according to label instructions or give away. Save for hazardous waste collection day.	Do not use aerosols, which can explode and are difficult to control. Instead: use paste. Or heat oven to 200 degrees, turn off, leave small dish of ammonia in oven overnight, then wipe oven with damp cloth and baking soda. Do not put baking soda on heating elements.
Toilet bowl cleaner	Corrosive. May be fatal if swallowed. Toxicity 3-4*	Use up according to label instructions or wash down sink or toilet.	Ventilate room. Instead: use ordinary cleanser or detergent and baking soda.
Window cleaner	Vapor may be irritating. Slightly poisonous. Toxicity 2*	Use up according to label instruction or give away.	Ventilate room. Instead: spray on vinegar, then wipe dry with newsprint.
Wood cleaners, polishes, and waxes	Fumes irritating to eyes. Product harmful if swallowed. Eye & skin irritant. Petroleum types are flammable.	Use up according to label instruction or save for hazardous waste collection day.	Do not use aerosols. Use only in well-ventilated areas. Instead: use lemon oil or beeswax.

* General Toxicity Ratings

Number Rating	1	2	3	4	5	6
Toxicity Rating	Almost Non-Toxic	Slightly Toxic	Moderately Toxic	Very Toxic	Extremely Toxic	Super Toxic
Lethal Dose for 150 lb. Adult	More than 1 Quart	1 Pint to 1 Quart	1 Ounce to 1 Pint	1 Teaspoon to 1 Ounce	7 Drops to 1 Teaspoon	Less than 7 Drops

Table 4-5B
Chemical Hazards in the Garage and Workshop

Product	Possible Hazards	Disposal Suggestions	Precautions and Substitutes
Aerosols	When sprayed, contents are broken into particles small enough to be inhaled. Cans may explode or burn.	Put only empty cans in trash. Do not burn. Do not place in trash compactor.	Store in cool place. Propellant may be flammable. Instead: use non-aerosol products.
Asphalt roofing compound	Eye irritant. Fumes moderately toxic. Toxicity 3*	Use up according to label instructions or give away.	No substitutes. Do not use indoors.
Auto: antifreeze	Very poisonous. Has sweet taste - attractive to small children & pets. Toxicity 3-4*	Amounts of less than 1 gallon pour down sink with plenty of water. Do not do this if you have a septic tank. Put in a secure container & take to a garage or service station.	No substitutes. Clean up any leaks or spills carefully.
Auto: batteries	Contain strong acid. Very corrosive. Danger to eyes & skin.	Recycle	No substitutes. Trade in old batteries.
Auto: degreasers	Corrosive. Poisonous. Eye & skin irritant. Toxicity 2-4*	Use up according to label instructions.	Choose strong detergent type over solvent type.
Auto: motor oil & transmission fluid	Poisonous. May be contaminated with lead. Skin & eye irritant.	Recycle.	No substitutes.
Auto: waxes & polishes	Fumes irritating to eyes. Harmful if swallowed. Eye & skin irritant.	Use up according to label instructions or give away.	Use outside.
Lacquer & lacquer thinner	Extremely flammable. Very poisonous. Toxicity 4*	Use up according to label instructions or save for hazardous waste collection day.	Ventilate area very well. Do not use in room with pilot light, open flame, electric motors, spark-generating equipment, etc. DO NOT SMOKE WHILE USING.
Paint strippers, thinners, & other solvents	Many are flammable. Eye & skin irritant. Moderately to very poisonous. Toxicity 3-4*	Let settle, pour off cleaner for re-use. Pour sludge into container & seal, or wrap well in newspaper & throw in trash. Use up according to label instructions or save for hazardous waste collection day.	Avoid aerosols. Buy only as much as you need. Ventilate area well. Do not use near open flame. Instead of paint stripper; sand or use heat gun. Use water cleanup products as much as possible.
Paints, oil-based, & varnishes	Flammable. Eye & skin irritant. Use in small, closed area may cause unconsciousness.	Use up according to label instructions or save for hazardous waste collection day.	Ventilate area well. Do not use near open flame. May take weeks for fumes to go away. Instead: use water-based paints if possible.
Pesticides**, herbicides, fungicides, slugbait, rodent poison, wood preservatives	All are dangerous to some degree. Can cause central nervous system damage, kidney & liver damage, birth defects, internal bleeding, eye injury. Some are readily absorbed through the skin. Toxicity 3-6*	Use up carefully, following label instructions. Save for hazardous waste collection day.	Do not buy more than you need. Instead: try hand-picking, mechanical cultivation, natural predators. Practice good sanitation. Choose hardy varieties. Use insect lures & traps. As a last resort, use least toxic suitable pesticides.

**Some pesticides have been banned or restricted. These pesticides shall be carefully stored and saved for a hazardous waste collection day. A partial list of these products follows:
Aldrin, Amitraz, Arsenic Trioxide, Benomyl, BHC, Bithionol, Chloranil, Chlordane, Chlorobenzilate, Copper Arsenate, DBCP, DDD(TDE), DDT, Diallate, Dieldrin, Dimethoate, EDB, Endrin, EPN, Fluorocetamide, Heptachlor, Kepone, Lindane, Mercury, Mirex, OMPA, Parathion, Polychlorinated Biphenyls, Phenarzine Chloride, Pronamide, Safrole, Silvex, Sodium Arsenite, Sodium Cyanide, Sodium Fluoracetate, Strobane, Strychnine, Thallium Sulfate, TOK, Toxaphene, Trifluralin, Vinyl Chloride.

* General Toxicity Ratings

Number Rating	1	2	3	4	5	6
Toxicity Rating	Almost Non-Toxic	Slightly Toxic	Moderately Toxic	Very Toxic	Extremely Toxic	Super Toxic
Lethal Dose for 150 lb. Adult	More than 1 Quart	1 Pint to 1 Quart	1 Ounce to 1 Pint	1 Teaspoon to 1 Ounce	7 Drops to 1 Teaspoon	Less than 7 Drops

collection area into several regions. each region having a different pickup day. The occasional collection day method calls for setting up a collection site only on an occasional basis. However, this method does not offer a permanent solution to the disposal problem. The preferred collection system for household hazardous waste is the implementation of a permanent receiving site, operated on a regular daily basis. This method has been the most successful because it becomes well known by the generators of hazardous waste. A second advantage to the latter alternative is that transportation costs associated with collection are minimized.

4.5.10.11 *Procedures.* The procedure for collecting and handling the incoming hazardous waste consists of four major steps: (1) make sure the container is not leaking and has known contents; (2) identify the hazard category for the waste; (3) document the type, amount, and destination of the waste; and (4) properly pack the waste into a drum of similar materials. The EPA guidelines for packing drums, found in 40 CFR 265.316, are summarized below:

1. The waste must be contained in sealed, sound, and leakproof containers, which will not react with the waste contained.

2. The drum must meet DOT specifications, not have a volume of greater than 110 gal, and must be filled completely with enough absorbent to absorb all the liquid contained in the inner containers.

3. The absorbent material must not react dangerously with, be decomposed by, or be ignited by the waste in the inner containers.

4. All of the wastes contained in the drum must be compatible. Reactive wastes, other than cyanide or sulfide-bearing wastes, must be rendered nonreactive before being packaged in the drum.

4.5.10.12 *Transportation.* Before drums containing the household hazardous waste can be transported, they must be labeled in accordance with the DOT regulations and be recorded on a Uniform Hazardous Waste manifest. All shipments must be made by a licensed hazardous waste hauler, generally obtained through the bidding process, and disposed of in a Class 1 disposal facility.

4.5.11 Education and Training. Handling of hazardous waste requires specialized knowledge and training. This requirement is essential for maintaining both a safe working environment and a work force capable of dealing with emergencies related to hazardous substances. Often the lack of knowledge will lead to a fire, explosion, or spill, and the situation may be worsened by the absence of correct and timely response to the situation. Therefore, proper training can help prevent emergencies and the corresponding losses of property damage and personnel injury.

4.5.12 Regulatory Requirement. Both RCRA and the Superfund Amendments and Reauthorization Act (SARA) call for training in the areas of hazardous waste and materials. RCRA requires installation personnel to be trained in safe techniques of performing their duties and how to respond to emergencies relating to hazardous waste and hazardous materials. Specifically, personnel are to be trained in their installation's hazardous waste management program,

spill prevention control and countermeasure program, and the spill contingency program. The spill contingency program includes instruction on emergency equipment, systems, and procedures.

4.5.13 Training Programs

4.5.13.1 Table 4-5C lists federal regulations and their associated training requirements.

TABLE 4-5C
Federal Regulations Requiring Training

40 CFR 264	Permitted TSDF Standards
40 CFR 265	Interim Status TSDF Standards
40 CFR 151	SPCC Regulations
40 CFR 125	BMP Plan Regulations
29 CFR 1910	OSHA Standards
29 CFR 1915	OSHA Standards
29 CFR 1916	OSHA Standards
29 CFR 1917	OSHA Standards
29 CFR 1918	OSHA Standards
29 CFR 1926	OSHA Standards
29 CFR 1928	OSHA Standards
49 CFR 177	DOT Carrier Regulations

4.5.13.2 Five major regulator programs have specific training requirements. For hazardous waste treatment, storage and disposal facilities (TSDFs) a training program is required under 40 CFR 264.16 and 40 CFR 265.16. For employees of contractors involved in Superfund cleanups, RCRA TSDF operations, spill response teams and first responders, etc., the SARA requires that OSHA develop a set of regulations that includes employee training. These training regulations can be found in 29 CFR 1910.120.

4.5.13.3 OSHA’s Hazard Communication Standard (HCS) requires that a training program be developed for employees exposed to hazardous chemicals. The training requirements can be found in 29 CFR 1910.1200(h).

4.5.13.4 Additional training is required under the Clean Water Act. The Best Management Plan (BMP) requirements under 40 CFR 125 and the Spill Prevention Control and Countermeasure requirements under 40 CFR 151 both have training provisions.

4.5.13.5 Three training programs are specified through SARA. These courses are designed to provide workers with the ability to complete their tasks safely, while minimizing health risks to themselves and to others. The first training program is intended to provide personnel exposed to hazardous substances while working on RCRA and CERCLA initiated projects. This program provides all personnel with 40 h of initial classroom training as well as 3 days of on-the-job training, and 8 h of annual refresher training. All of the trainers must have a higher degree of training than that of what they are to teach. This first training program also requires that supervisors and managers have 8 h of specialized training on managing operations.

4.5.13.6 Workers involved in regular operations at permitted treatment, disposal, storage, and hazardous waste sites are required to participate in the second type of training program. This program consists of 24 h of initial training and 8 h of annual refresher training.

4.5.13.7 Emergency response and HAZMAT teams are to receive training under the third program, which requires regular monthly training totaling 24 h per year. Emergency response teams are made up of police and fire departments. It is the responsibility of the HAZMAT teams to control or stop leaks in containers that contain hazardous substances.

4.5.13.8 Health/safety courses shall also discuss the identification and treatment of Severe allergic reactions and any potential hazards from animals and insects in addition to the risks posed by hazardous materials.

4.5.13.9 Both the Navy and the Marine Corps have their own training requirements. The Marine Corps requires that personnel involved in the handling of hazardous substances and operators of hazardous substance facilities have training according to MCO P11000.8 at Section 4608.9. The Navy requires training be provided for employees involved in hazardous waste operations as stated in OPNAVINST 5090.1, SECTION 11104d.(9). Navy safety and health training requirements are specified by OPNAVINST 5100.23B.

4.5.13.10 *Course Options.* There are five types of training available. These are courses taught by contractors off-base, taught by contractors on-base, taught on-base by installation personnel, prerecorded training courses (video tapes, films, Cassette tape , and self-study courses consisting of booklets and other written materials. For specific information such as availability and nomination procedures of training courses, contact the respective training office.

APPENDIX A

STATE OF VIRGINIA
BUREAU OF SOLID WASTE MANAGEMENT

DOCUMENTATION REQUIREMENTS FOR A LANDFILL PERMIT APPLICATION

APPENDIX A

This appendix uses State of Virginia requirements for a landfill permit application as one example of the information required to get a permit. The appendix discusses site information, operating plans and financial documentation required to get a landfill permit. Although other state requirements may differ slightly in an item by item comparison, the Virginia example provides guidelines on the level of detail needed in most states.

STATE OF VIRGINIA
BUREAU OF SOLID WASTE MANAGEMENT

DOCUMENTATION REQUIREMENTS FOR A LANDFILL PERMIT APPLICATION

The Bureau of Solid Waste Management will consider applications for permits for three types of sanitary landfills; general sanitary landfills, construction and demolition debris landfills and industrial waste landfills. In order for an application to be considered by the bureau, the following shall accompany and document the application. These documents will be incorporated in the permit and deviation from the permit shall not be allowed except by amendment of the permit. A permit application not fully documented may be rejected, and the bureau reserves the opportunity to require further clarification or detail for any item during the application review process. Four copies of all documents are required to be provided to the bureau.

1. Essential site documentation includes:

   a. Copies of the latest United States Geological Survey topographic and geologic maps encompassing the area of the site and adjacent land within 2500 feet of the property boundary of the site in all directions. The site shall be clearly outlined and labeled. Maps shall be of the 7-1/2 minute quadrangle series.

   b. Fifteen mile radius map. This vicinity map shall show the site outline and outstanding features within that radius to include, at least, the following:

      (1) Boundaries of any city, county or town and the location of any significant incorporated areas or communities;

      (2) All surface water streams, rivers, or significant water bodies;

      (3) All federal, state, city, county or town roads;

      (4) All public water supply surface intakes, treatment facilities, reservoirs or wells;

      (5) All railroads, wastewater treatment facilities, and existing solid waste management facilities.

c. A near vicinity map, having a scale of 250 feet or less to 1 inch and containing the information described in the preceding item for a radius of 2500 feet in all directions from the site boundaries and the following:

(1) All homes, building or structures;

(2) The 100-year and 500-year flood plain, where they pass through the map area, or otherwise, a note indicating the expected flood occurrence period for the area;

(3) Existing land uses and zoning classification;

(4) All water supply wells, springs or intakes, both public and private;

(5) All utility lines, pipelines or land based facilities (including mines and wells); and

(6) All parks, recreation areas, dams, historic areas, wetlands areas, monument areas, refuges, unique natural areas or similar features.

d. Copy of lease, deed (showing page and book location) or certification or ownership of the site. The department will not consider as an applicant for a permit any person who does not demonstrate legal control over the site. A documentation of an option to purchase will be considered as a substitute for a deed; however, the true deed must be provided to the department before construction at the site begins.

e. Site hydrogeologic and soils report shall include, as a minimum, the following:

(1) Boring records and analyses from properly spaced borings in the facility portion of the site, with no less than five borings on any site and no less than one boring per five acres of facility. Boring shall extend for twenty feet below the elevation of the contemplated bottom of the facility or to the bedrock. In carbonant bedrock, karst areas, covered karst areas, areas of possible collapse or other problem areas, appropriate corings into the rock may be necessary.

(2) Complete description of the soil units on the site, including tests of permeability (the results of at least three in site tests for important units). All corroborating and supporting data for permeability tests shall also be submitted. In site permeability tests data includes test method, calculations, natural moisture, attenberg limits, natural unit weight, method of sampling, etc.; remolded permeability tests require a proctor comparison test (ASTM-D-698). Those results, plotted, along with percent comparison of the test sample and the data listed for the site permeability tests are needed for accurate interpretation of the results.

(3) Water table elevations, direction and estimated rate of ground-water flow and similar information on the hydrogeology of the site. All data shall be submitted with calculations.

(4) A cataloging and description of aquifers, geological features or any similar characteristic of the site that might affect the operation of the facility or be affected by that operation.

(5) If a geological map or report from either the Virginia Division of Mineral Resource or the U.S. Geological Survey is published, it shall be included.

f. A signed statement by the applicant that he has sent written notice to all adjacent property owners that he intends to develop SWMF on the site, a copy of the notice and the names and addresses of those to whom the notices were sent.

g. For wastes, other than residential solid waste, a complete description of the waste amount and character including complete chemical analysis when appropriate.

2. Essential elements of the plans include the following:

a. Design plans. Design plans shall be prepared by a person registered to practice professional engineering in the Commonwealth and hydrogeologic studies shall be prepared by a professional geologist registered for practice in the Commonwealth.

(1) Design plans for landfill consists of, at least, the following:

(a) A title sheet indicating the project title, who prepared the plans, the person for whom the plans were prepared, a table of contents, and a location map showing the location of the site and the area to be served.

(b) An existing site conditions plan sheet indicating site conditions prior to development.

(c) A base grade plan sheet indicating site base grades or the appearance of the site if it were excavated in its entirety to the base elevation, before installation of any engineering modifications or the beginning of any filling.

(d) An engineering modification plan sheet indicating the appearance of the site after installation of engineering modifications. More than one plan sheet may be required for complicated sites. This plan is required only for those sites with engineering modifications.

(e) A final site topograph plan sheet indicating the appearance of the site at closing including the details necessary to prepare the site for long-term care.

(f) A series of phasing plan sheets showing the progression of site development through time. At a minimum a separate plan shall be approved for initial site preparations and each subsequent major phase of filling on site for operation through closure.

It shall indicate all items and quantities necessary to prepare each phase indicated.

(g) A site monitoring plan sheet showing the location of all devices for the monitoring of leachate production, groundwater quality and gas production and venting. This plan shall include a table indicating the parameters to be monitored for and frequency of monitoring before and during site development. This separate plan sheet is required only for sites with a design capacity of more than 3 acres. Smaller projects may display this information on other plan sheets for submittal.

(h) A long-term care plan sheet showing the site at the completion of closing and indicating those items anticipated to be performed during the period of long-term care for the site. The plan shall include a table listing the items and the anticipated schedule for monitoring and maintenance. In many instances this information can be presented on the final site topography sheet.

(i) When applicable, the following information shall be presented on the plans sheet(s).

1. All information required for the existing site conditions map as described in Section 4.1.A.C., unless including this information leads to confusion with the data intended for display.

2. A survey grid with base lines and monuments to be used for field control.

3. Limits of filling each major waste type of fill area.

4. All drainage patterns and surface water drainage control structures both within the actual fill area and at the site parameter. Such structures may include berms, ditches, sedimentation basins, pumps, sumps, culverts, pipes, inlets, velocity breaks, sodding, erosion matting, or other methods of erosion control.

5. The direction and sequence of filling within each phase.

6. Bound surface contours at the time represented by the drawing. Spot elevations shall be indicated for key features.

7. Areas to be cleared and grubbed and stripped of topsoil.

8. Borrow areas for liner materials, gas venting materials, berms, roadway construction, daily cover and final cover.

9. All soil stockpiles including daily and final cover, topsoil, liner materials, gas venting materials and other excavation.

10. Access roads and traffic flow patterns to and within the active fill area.

11. All temporary and permanent fencing.

12. The methods of screening such as berms, vegetation or special fencing.

13. Leachate collection, control and treatment systems which may include pipes, manholes, trenches, berms, collection sumps or basins, risers, liners, and liner splices.

14. Base, leachate and groundwater monitoring devices and systems.

15. Severe weather disposal areas.

16. Maintenance building, weight scales, etc.

17. Special waste handling areas.

18. Construction notes and references to details.

19. Other appropriate site features.

(j) A series of site cross-sections shall be drawn perpendicular and parallel to the site base line at a maximum distance of 500 feet between cross-sections and at points of grade break and important construction features. The location of the cross-sections shall be shown on the appropriate plan sheet(s) and the section labeled using the site grid system. Where applicable, each cross-section shall show existing, proposed based and final grades; soil borings and monitoring wells which the section passes through or is adjacent to; soil types, bedrock and water table; leachate control, collection and monitoring systems; limits of filling for each major waste type; drainage control structures; access roads and ramps on the site parameter and within the active fill area; the filling sequence or phases; and other appropriate site features.

(k) Detailed drawings and typical section for, as appropriate, drainage control structures, success roads, fencing leachate and gas control systems and monitoring devices, buildings, signs, and other construction details.

2. An operations manual and design report for a landfill consisting of, at least, the following information:

(a) The report shall identify the project title; engineering consultants(s); site owner, licensee and operator; proposed licensed acreage; site life and capacity; municipalities, industries and collection and transportation agencies served; waste types and quantities to be disposed; and any exemption waste types and quantities to be disposed; and any exemptions applied for.

(b) Specifications for site construction and operation shall be presented, including detailed instructions to the site operator for all aspects of site construction and operation. Reference to specifications on the plan sheet shall be pointed out as well as additional instructions included, where appropriate. The specifications shall include, at a minimum, the following information:

(1) Initial site preparations including specifications for clearing and grubbing, topsoil stripping, other excavations, berm construction, drainage control structures, leachate collection system, access roads and entrance, screening, fencing, groundwater monitoring and other special design features.

(2) A plan for initial site preparation including a discussion of the field measurements, photographs to be taken, sampling and testing procedures to be utilized to verify that the in-field conditions encountered were the same as those defined in the feasibility report, and to document that the site was constructed according to the engineering plans and specification submitted for department approval.

(3) Daily operations including a discussion of the timetable for development, waste types accepted or excluded, typical waste handling techniques, hours of operation, traffic routing, drainage and erosion control, windy, wet and cold weather operations, fire protection equipment, manpower, methods for handling of unusual waste types, methods for vector, dust and odor control, daily cleanup, direction of filling, salvaging, record keeping, parking for visitors and employees, monitoring, abandonment of filled areas, gas and leachate control methods, backup equipment with names and telephone numbers where

equipment may be obtained, and other special design features. This may be developed as a removable section to improve accessibility for the site operator.

(4) Development subsequent phases

(5) Site closing information consisting of a discussion of the anticipated sequence of events for site closing and discussion of those actions necessary to prepare the site for long-term care and any future use.

(6) Long-term care information including a discussion of the procedures to be utilized for the inspection and maintenance of run-off control structures, settlement, erosion damage, gas and leachate control feasibilities, monitoring for gas leachate and groundwater, and other long-term care needs.

(c) A design report shall be submitted which includes supplemental discussions and design calculations to facilitate department review and provide supplemental information including the following information:

(1) A discussion of the reasoning and logic behind the design of the major features of the site, such as traffic routing, base grade and relationships to subsurface conditions, anticipated waste types and characteristics, phases of development, liner design, facility monitoring, and similar design features shall be provided. A list of the conditions of site development as stated in the department determination of site feasibility and the measures taken to meet the conditions shall be included. A discussion of all calculations, such as refuse-cover balance computations, stockpile sizing estimates, estimate of site life and runoff and leachate volume estimates shall be included. The calculations shall be summarized with the detailed equations presented in the appendix.

(2) A detailed analysis in accordance with section 3.15 shall be made of the financial responsibility for the time of site closing.

(d) An appendix shall be submitted which shall include any additional data not previously presented, calculations, material specifications, operating agreements, leachate treatment agreements, documents related to long-term care funding and other appropriate information.

(3) Closure Plan. The applicant shall prepare and submit a detailed plan for closing any SWMF. Such a plan shall be prepared in two parts, one reflecting those measures to be accomplished at the midpoint of the permit period, and the other when the useful life of the landfill is reached.

(4) Noise Survey. When required by the Executive Director, the applicant shall survey, record and submit background sound level data in the vicinity of the proposed facility at the time of application for a permit.

4. Financial Assurance Regulations specify documents and presentations required of operators of landfills which are not cities, counties, towns or other governmental entities. These must be submitted before a permit can be issued.

APPENDIX A-I

PROPOSED REVISIONS TO CRITERIA FOR MUNICIPAL SOLID WASTE DISPOSAL LANDFILLS

The following pages were received as a letter from the Headquarters office of the U.S. Environmental Protection Agency. They were dated 22 August 1988 and are reproduced here in their entirety.

SOLID WASTE DISPOSAL FACILITIES CRITERIA: A SUMMARY

I. INTRODUCTION

Through Subtitle D of the Resource Conservation and Recovery Act (RCRA) of 1976, EPA is establishing a framework for Federal, State, and local government cooperation for the management of solid waste. The Federal role is to establish the overall regulatory direction, provide minimum standards for the protection of human health and the environment, and provide technical assistance to States for planning and developing sound solid waste management. The actual planning, enforcement, and direct implementation of solid waste management programs under Subtitle D of RCRA remain State and local functions.

This Federal framework currently is contained in the Criteria for the Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257), which were developed in 1979. These Criteria establish general environmental performance standards addressing eight major topics: floodplains, endangered species, surface water, ground water, land application, disease, air, and safety. Under the Hazardous and Solid Waste Amendments of 1984 (HSWA), Congress directed EPA to assess, and revise as necessary, the Criteria for facilities that may receive household hazardous waste (HHW) and small quantity generator (SQG) hazardous waste, particularly with respect to ground-water contamination.

To fulfill its responsibilities under HSWA, EPA conducted a series of studies and analyses of solid waste characteristics, waste disposal practices, and environmental and public health impacts resulting from solid waste disposal. Final results, which form the basis for the Agency decision-making on this rule, are incorporated in EPA’s Subtitle D report to Congress, scheduled to be issued shortly.

EPA’s studies reveal that there were more than 11 billion tons of solid waste generated in 1986 and managed in some 227,000 solid waste disposal facilities. This included 160 million tons of municipal solid waste, 126 million tons of which were disposed of in 6,034 municipal solid waste landfills (MSWLFs). The remaining waste was recycled, incinerated, or managed by some other method.

Because of the limited data available concerning solid waste facilities and practices other than MSWLFs, EPA has decided to revise the Part 257 Criteria in phases. The first phase revises the Criteria for MSWLFs. In August 1988, EPA proposed the revised Criteria for MSWLFs in the Federal Register. In addition to general environmental performance standards, this proposal calls for a notification requirement for industrial solid waste facilities and construction/demolition waste landfills. The data obtained through these notifications and from other ongoing and planned data collection efforts may lead to a second phase of Criteria revisions, which would address other types of solid waste management facilities and practices.

II. SUMMARY OF THE RULE

This proposed action would amend Part 257 by: 1) including information requirements for owners and operators of industrial solid waste disposal facilities and construction/demolition waste landfills and 2) excluding MSWLFs from Part 257. This action also would add a new Part 258 to propose specific requirements for MSWLFs, including those that co-dispose sewage sludge with household waste. In addition, landfills that receive ash residue from municipal waste combustion (MWC) facilities, including ash monofills (i.e., landfills that receive only ash), would be subject to these Criteria.

The new Part 258 sets forth revised minimum criteria for MSWLFs, primarily in the form of performance standards, including location restrictions, facility design and operating criteria, closure and post-closure care, financial assurance, ground-water monitoring, and corrective action requirements. The primary goals of this rule are to establish standards that protect human health and the environment, provide flexibility to the States, and minimize disruption of current solid waste management practices by taking into account the practicable capability of the regulated community.

Part 258 will be co-promulgated under the authorities of the Clean Water Act (CWA) and RCRA and, in part, will fulfill EPA's mandate to promulgate regulations governing the use and disposal of sewage sludge. A separate regulation for sludge monofills is being prepared for future proposal under the CWA.

III. AMENDMENTS TO PART 257

EPA is proposing to add to Part 257 a notification requirement applicable to owners and operators or industrial solid waste disposal facilities (landfills, surface impoundments, waste piles, and land application units) and construction/demolition waste landfills. The owner or operator of these facilities would be required to complete and submit a form to the State and EPA that would include basic information on facility type and location, waste type and volume, and management practices, as well as limited exposure data.

The proposal would exempt MSWLFs from the Part 257 Criteria; these facilities would be covered by the proposed Part 258. In addition the proposal updates and Maximum Contaminant Levels (MCLs) for the ground-water to include MCLs established since the current criteria were promulgated.

IV. SUMMARY OF THE NEW PART 258

A. Subpart A -- General

Part 258 sets forth minimum national criteria for the location, design operation, cleanup, and closure of new and existing MSWLFs, including those receiving sewage sludge from publicly owned treatment works (POTWs) and ash from MWC facilities. The revised Criteria would apply to all new and existing MSWLFs except those that close prior to the effective date of the rule. Under the proposal, the revised Criteria would be effective 18 months from when the Criteria revisions are finalized.

B. Subpart B -- Location Restrictions

In this Subpart, EPA has identified six types of locations for NSWLFs that require special siting restrictions and/or performance standards. These are:

- Proximity to Airports: New and existing MSWLF units located within 10,000 feet of airports handling piston-type aircraft would be required to be operated in a manner that does not pose a bird hazard to aircraft. (This requirement has not changed from Part 257.)

- 100-year Floodplains: New and existing MSWLF units located in the 100-year floodplain would be prohibited from restricting the flow of the 100-year flood, reducing the temporary water storage capacity of the floodplain, or resulting in the washout of solid waste so as

to pose a threat to human health and the environment. (This requirement has not changed from Part 257.)

- Wetlands: New MSWLF units would not be allowed to be located in wetlands unless the owner of operator demonstrates to the State that the new unit: 1) meets the discharge restrictions developed pursuant to Section 404(b)(1) of the CWA, 2) there is no practicable alternative, and 3) siting will not result in significant adverse environmental impacts. This proposal does not apply to existing units.

- Fault Areas: New MSWLF units would be prohibited from siting within 200 feet (61 meters) of faults that have had displacement in Holocene time (i.e., within 11,000 years). This provision applies only to new units.

- Seismic Impact Zones: New MSWLF units in a seismic impact area would be required to be designed to resist the maximum horizontal acceleration of hard rock at the site (i.e., ground motion from earthquakes). This provision only applies to new units.

- Unstable Areas: The owner or operator would be required to incorporate engineering components into the unit design to ensure the stability of a MSWLF unit located in an unstable area (e.g., Karst terrain, landslide-susceptible areas). Existing units would be required to close within five years unless: 1) the owner or operator demonstrates the structural integrity of the MSWLF, or 2) the State extends the deadline.

The owner or operator of a MSWLF unit would be required to demonstrate to the State that the design at the proposed location is in compliance with the location restrictions.

C. Subpart C -- Operating Criteria

The requirements of this Subpart would apply to all new and existing MSWLFs. Operating criteria comprise four major components: Day-to-day operating criteria, closure, post-closure care, and financial assurance.

a. Day-to-Day Operating Criteria

Specific operating requirements would include the following, and apply to both new and existing MSWLFs:

- Procedures for Excluding the Receipt of Hazardous Waste: The owner or operator would be required to implement a program to detect and prevent attempts to dispose of regulated quantities of hazardous waste. This program would include random inspections of incoming loads, inspections of suspicious loads, recordkeeping of inspections, training of personnel to recognize hazardous waste, and procedures to notify the State if regulated hazardous waste is found.

- Daily Cover: This requirement would strengthen current Part 257 criteria by requiring the application of cover material at the end of each operating day, or more frequently, to control disease vectors (disease-carrying rodents or flies), fires, odors, blowing litter, and scavenging.

- Disease Vector Control: The owner or operator of the MSWLF would be required to prevent or control disease-carrying populations (e.g., rodents or flies) using appropriate techniques. (This requirement has not changed from Part 257.)

- Explosive Gases Control: This provision would strengthen the current Part 257 Criteria for methane concentration limits (i.e., 25 percent of the lower explosive limit (LEL) in facility structures and the LEL at the facility boundary) by adding a landfill gas monitoring provision. If the standard has been exceeded, the owner or operator would be required to take steps to ensure protection of human health and the environment, submit a remediation plan to the State and work with the State in implementing the appropriate protective measures.

- Air Criteria: These proposed requirements prohibit open burning of solid waste, except infrequent burning of agricultural and silvicultural waste, land clearing debris, diseased trees, debris from emergency cleanup operations, and ordnance. The owner or operator would be required to comply with State Implementation Plans under the Clean Air Act. These requirements are not substantively different from the current Part 257.

- Access Restrictions: The MSWLF owner or operator would be required to control public

access, illegal dumping, and unauthorized vehicular traffic through use of natural and/or artificial barriers.

- Run-on/Run-off Control: The owner or operator would be required to design, construct, and maintain: 1) a run-on control system to prevent flow into active portions of the MSWLF during a 25-year storm, and 2) a run-off control system to collect and control at least the volume of water from a 24-hour, 25-year storm. Run-off would be handled in accordance with the surface water requirements described below.

- Surface Water Requirements: No MSWLF would be allowed to: 1) cause a discharge into waters of the U.S that violates CWA standards, or 2) cause a nonpoint source discharge that violates a water quality management plan under sections 209 or 319 of the CWA. This requirement has not changed from Part 257.

- Liquids Restrictions: The intent of this provision is to prohibit the disposal in MSWLFs of 55 gallon drums filled with liquids and the disposal of tank trucks filled with liquids. Household waste, except tank trucks filled with septic waste, are exempt. Leachate and gas condensate from the unit would be allowed to be recirculated only if the unit has a composite liner and a leachate collection system.

- Recordkeeping: The owner or operator would be required to retain historical records, including ground-water and landfill gas monitoring, data; inspection records; State notification procedures; and closure and post-closure care plans.

b. Closure Criteria

The closure criteria are designed to minimize the need for maintenance after closure and minimize the formation and release of leachate and explosive gases to air, ground water, or surface water during the postclosure care period. The owner or operator would be required to submit a closure plan to the State for approval.

Closure activity would be required to begin shortly after the final receipt of waste at that landfill. Upon closure, the owner or operator would be required to certify to the

State that closure of the MSWLF unit has been completed in accordance with the approved closure plan.

c. Post-Closure Criteria

Following closure of the MSWLF unit, the owner or operator would be required to conduct two phases of post-closure care. In the first phase of the post-closure care period (a minimum of 30 years) the Agency proposes that the owner or operator conduct routine maintenance of any final cover, continue any leachate collection, and maintain and operate ground-water and landfill gas monitoring, as necessary, to control environmental hazards.

Following completion of the first phase of post-closure care, the Agency proposes to require a second less intensive phase of care. The Agency proposes that the owner or operator be required to continue, at a minimum, ground-water and landfill gas monitoring in order to detect any contamination that might occur beyond the first 30 years of post-closure care. The State would establish the length of this period and the exact notation stating that the land formerly was a MSWLF and specifying approved post-closure uses would be required.

d. Financial Assurance

Under the proposed rule, the owner or operator of a MSWLF would be required to demonstrate the financial and technical ability to conduct closure and post-closure care, and, if applicable corrective action for known releases. This requirement would ensure that the owner or operator adequately plans for all the costs involved. While State and Federal Government entities would be excluded from financial assurance requirements, local governments would not be excluded. (The Agency is requesting comment on a financial test that could lead to local government exemption and whether to exempt Indian Tribes from financial assurance requirements.)

The amount of financial assurance required would be based upon written site-specific cost estimates. EPA proposes that the cost estimate account for the costs of closure, post-closure care, and corrective action for known releases. The cost estimate would be adjusted annually for inflation until the entire landfill has been closed. The State may release the owner or operator from post-closure financial requirements after the State has received certification that post-closure care has been completed.

D. Subpart D -- Design Criteria

The proposed design criteria establishes a performance standard that allows State flexibility in determining the allowable risk level and the point of compliance. New and existing units would be required to meet the performance standard but different options for control mechanisms are given for each.

New units would be required to be designed with liners, leachate collection systems, and final cover systems as necessary to meet a State-established alternative boundary. The alternative boundary would be no more than 150 meters from the waste management unit boundary and would be required to be on facility-owned land.

Existing units would be required to install a final cover that prevents infiltration of liquid into the waste, but would not be required to install liners or leachate collection systems.

E. Subpart F -- Ground-Water Monitoring and Corrective Action

This Subpart proposes a two-phased ground-water monitoring system and corrective action requirement to ensure that ground-water contamination as new and existing MSWLFs will be detected and cleaned up as necessary to protect human health and the environment. These requirements would be applicable to all new and existing MSWLF units. In Phase I monitoring, the owner or operator would monitor for specified constituents. If contamination is detected, the owner or operator would be required to comply with Phase II monitoring requirements and monitor for additional constituents.

Existing landfill units would be exempt from groundwater monitoring only if the owner or operator could demonstrate to the State that there is no potential for migration of hazardous constituents from the unit to the uppermost aquifer during the active life of the unit and the post-closure care period.

States would be required to specify a schedule for all units in the State to be in compliance with the ground-water monitoring requirements. Ground-water monitoring would be conducted throughout the active life, as well as, during closure and the post-closure care periods for that unit. The State would have final approval for the ground-water monitoring well system at each unit.

The owner or operator would be required to conduct a corrective action assessment if the Phase II

constituent levels are exceeded. The State would be required to evaluate corrective action measures, select the remedy, establish corrective action standards (considering sitespecific factors), and set the corrective action schedule. The owner or operator would be required to carry out corrective action until the State determines that ground-water protection standard would be selected by the State within a protection risk range of 1×10^{-4} to 1×10^{-7}.

APPENDIX B

TECHNICAL REQUIREMENTS AND GUIDELINES FOR SOLID WASTE MANAGEMENT CONTRACTS

1. Introduction

This appendix outlines the steps necessary for developing contracts for solid waste management services. Note that Air Force has their own service contract guidance (AFR 400-28, Vol. 1). The Navy's guidance on writing and inspecting service contracts is NAVFAC Manual MO-327 "Facility Support Contract Quality Management Manual."

a. Advantages of such contract service include the following:

(1) The acquisition of land, buildings and equipment is not required.

(2) Many of the overhead and administrative costs are eliminated.

(3) The day-to-day operating problems of solid waste management are diminished.

b. Disadvantages of contract service include the following:

(1) High bid prices may result from limited contractor competition, especially in thinly populated areas.

(2) The contractor may cut corners and skimp on the quality of service to increase his profit margin. Therefore, contracts shall provide for protection penalties. However, NAVFACENGCOM contracts do not contain protection penalties since they are difficult to enforce.

(3) To be attractive to private enterprise, the term of the contract must cover a sufficient period for the contractor to amortize his capital expenditures. However, long term contracts often result in contractor complacency and poor performance.

2. Types of Contract Services

Contract services may be used in parallel operations and/or in functional area operations. In a parallel operation the contractor provides a duplicate solid waste management service for specific wastes or certain locations within an installation. This service may be necessary for those problem wastes which cannot be managed safely in-house. However, the parallel method is not normally cost effective. In functional area services -— the most common type -- a contractor provides one or more of the services of storage, collection, transfer, or disposal. The installation provides the remaining services. In general, the more functions provided by the contractor, the greater the economic advantages realized.

3. Cost Analysis

The decision to use contract services shall be based on economic considerations of contract versus in-house operations. From applicable methods, select the disposal method which is lowest in cost. (Air Force personnel should refer to AFM 91-11. Navy activities must refer to OPNAVINST 4860.7B for additional guidance when determining whether to perform solid waste services in-house or by contract.) Consider a choice conclusive if its indicated cost is ten percent or more below the next lowest estimate. Complete records shall be kept on the overall operation to facilitate planning and cost control. Where cost differences are not conclusive, favor the proposal which includes recycling or resource recovery as the preferred method of disposal as opposed to incineration or landfill.

Municipal Contracts. Contracts with municipalities shall be favored where the cost is less than that of building and operating government facilities. If cooperation allows enlarging the scale of the operation, municipal disposal facilities can be made more efficient and environmentally more acceptable.

Consolidated Military Operations. Where a number of Department of Defense installations are concentrated in a geographic area and the use of municipal operations is not feasible, serious consideration shall be given to establishing a consolidated Department of Defense facility. Consolidation allows for design and operation of a more sophisticated, economical, and safe facility. A centralized control authority shall be established to develop management and operational guidelines for the facility.

Contract Development Guidelines. The following shall be considered in solid waste management contracts:

a. Economics. Near urban areas, economics often favor contractor collection and disposal of wastes. Preparation of the contract must be in accordance with the procedures given in appropriate procurement regulations for each service, and the Federal Acquisition Regulations (FAR).

b. Equipment and Work Force. On all but the smallest installations, a contractor would require additional equipment and work force to meet contractual requirements. These represent a high initial cost which must be recovered by the contractor. Even considering resale of equipment, a one-year contract at a medium-sized base represents a high initial investment and low equipment utilization which will result in increased costs that the contractor must be permitted to recover. Two methods which have been successfully used to overcome this problem are

1) regional contract for all government installations in a particular area

2) use of a multi-year rather than a single-year service contract, which will allow recovery of investment costs over a longer period of time

At some locations a combination of both methods has been used. The multiyear method requires prior approval from the General Services Administration via the chain of command.

c. Contract Contents. The following general considerations shall apply to contract contents:

(1) Guide Specifications. Guide specifications provided herein have been written in broad terms to cover the variety of situations found at Department of Defense installations. Therefore, they require modification to meet local needs.

(2) Drawings. Drawings provided as part of the contract documents shall be complete and sufficiently detailed for planning routes and schedules.

(3) Contract Requirements. The contract shall provide for only the level of work required to maintain predetermined sanitary conditions. The collection frequencies discussed in Chapter 3 shall be used, unless justified otherwise. Unnecessary pickups and long routes result in extra costs or charges and shall be avoided. Any items not specified entirely or left to the option of the Department of Defense and contractor personnel can result in delays and added costs.

(4) Economic Considerations. When work is performed under contract, the economic desirability of the Department of Defense installation supplying the containers, equipment, or disposal facilities shall be addressed. Such equipment or items shall be furnished to the contractor when it is cost effective. Heavy equipment, such as bulldozers, cranes, or collection vehicles, would only be furnished for the contractor if exceptionally large savings are expected and realized.

(5) Collection and Disposal Costs. The cost of waste collection and disposal is a direct reflection of collection frequency, length of haul, number of stops, and availability of disposal facilities.

4. General Contract Specifications

NAVFACENGCOM issues specific guidance on developing solid waste contract specifications in the "NAVFACENGCOM Guide Performance Work Statement (GPWS) for Solid Waste Collection and Disposal" Navy activities should use this GPWS rather than the "General Contract Specifications" and "Example Contract" shown below.

a. Scope. These specifications and accompanying drawings *(supply drawings)* provide for the collection and disposal al of refuse in a complete and workmanlike manner for a period of **** years after the contract. The contractor will furnish all plant supervision, labor, material and equipment, except government-furnished items.

b. Description of Work. The work covered by these specifications consists of furnishing all necessary equipment. labor, supervision, and materials for performing all operations necessary for the collection, transportation, and disposal of all refuse specified in this contract, complete and in accordance with these specifications and subject to the terms and conditions of the contract. Drawings (or plans) number **** through **** show the work areas and details, where applicable, of the work to be accomplished.

c. Location. This contract is to be performed at *(Installation)* in areas shown on the plot plan included in the above drawings.

d. Performance of Work. These specifications and the accompanying plans herein state and show the work to be performed under this contract. Refuse collection and disposal will be conducted in conformity with applicable regulations to contribute maximum satisfaction protection of property.

e. Supervision. The contractor will provide competent supervision at all times when work is in progress. The contractor is responsible for scheduling and coordinating various trade activities. He is also responsible for assuring that all work accomplished and materials used are in accordance with the plans and specifications.

f. Government-Furnished Equipment. *(Use where applicable.)*

(1) Items to be Furnished. The following items of government-furnished equipment will be made available for the contractor's use during the period of this contract. *(List items to be furnished.)*

(2) Inspection and Receipt Required. The contractor will sign a receipt for each item of equipment. He must inspect each item at the time of acceptance and make notation of discrepancies on the receipt; otherwise, the contractor's signature on the receipt will indicate that the equipment is in a fully acceptable condition. Within five days after completing the work under this contract, the contractor will return the equipment to the installation in a condition equivalent to that at the time of acceptance, except for normal wear and usage.

(3) The contractor will supply all fuel, lubricants, and spare parts, and provide repair and maintenance necessary to keep equipment in condition acceptable to the contracting officer. Repair and maintenance will be performed only by qualified mechanics of journeyman level, except for day-to-day operator-type maintenance, which may be performed by the operators. Fuel, lubricants, and spare parts used on equipment will meet the standards established by the manufacturer of the equipment. No modification, changes, or substitution of parts will be permitted without written approval of the contracting officer.

(4) Qualified Operators Required. Only qualified operators, as determined by the installation contracting officer, will be permitted to operate government-furnished equipment. When

necessary, operator demonstrations of proficiency and training will be performed under the supervision of the contracting officer's representative. The contractor will provide a qualified instructor when deemed necessary by the contracting officer.

(5) Substitute Equipment. The contractor will provide substitute equipment, if necessary, to maintain schedules in the event government-furnished equipment is out of service due to breakdown or other causes.

g. Contractor-Furnished Equipment

(1) Furnish All Necessary Equipment. The contractor will provide all necessary equipment (except government-furnished equipment) required for performing the contract.

(2) Safety and Noise Prevention. All of the contractor's equipment will be equipped with proper safety and noise-limiting devices and will be in safe operating condition.

(3) Qualified Operators Required. Only qualified operators will be permitted to operate equipment. When necessary, operator training will be performed in an area approved by the contracting officer.

h. Government-Furnished Materials and Supplies. (Use as applicable.)

(1) Items to be Furnished. The following materials and supplies to accomplish this contract will be furnished to the contractor at no cost. (List materials and supplies.)

(2) Requests for Materials and Supplies. The contractor will notify the contracting officer 48 hours in advance of his requirement for materials and supplies. Items will be picked up by the contractor at (give location, building number, or area).

(3) Lost or Damaged Items. Any items (as mentioned in the preceding paragraph) that are lost or damaged in service will be replaced by the contractor at contractor expense.

i. Applicable Publications, Laws, and Regulations. Unless specifically exempted by these specifications and drawings, all work accomplished under this contract will conform to the requirements of all applicable Federal, state, and local regulations pertaining to environmental protection and occupational safety and health, and to the procedures and safety requirements at each installation.

j. Inspection. All work performed, the methods and manner of performance, all areas assigned for use by the contractor, and all equipment, materials, and supplies used for the work will be subject to inspection at any and all times by the contracting officer's authorized representatives.

All notices of unsatisfactory conditions or services will be issued in writing to the contractor by the installation contracting officer. The contracting officer will have access at any and all times to the contractor's equipment, materials, supplies, assigned areas, and sites of operations for inspection purposes.

k. Collection of Waste.

(1) Points of Collection. The points of collection (collection stations and units) for pickup of waste by the contractor will be as shown on the accompanying plans. Any increase or decrease in the number of points that exceed (number) will be cause for adjusting contract cost. The government will designate collection stations, provide numbered markers as required for identification with the plans and, where necessary, provide pads, stands, or other suitable structures for assembling and storing wastes for pickup by the contractor.

(2) Frequency of Collections. The frequency of collections will be as follows:

Locations	Collections per Week
(list locations)	*(indicate number)*

(3) Schedule of Operation. After the contract has been awarded and before work begins, the contractor will establish a schedule of proposed operations. This schedule will govern the days, and time of day, collections will be made. The schedule will be subject to change, provided the proposed modification contributes toward a more satisfactory service. In addition, the schedule and modification thereof will meet the contracting officer's approval.

(4) Additional Equipment or Work Time Required. The contractor will execute the collection and disposal operations in order to provide minimum delay or divergence from the schedule.

(5) Abnormal Quantities of Waste. Excess waste or wastes beyond the normal daily quantity resulting from holidays or recognized customs shall be disposed of by the contractor at no additional cost to the government. The contractor will employ additional equipment or make additional trips, if necessary, to adequately dispose of extra waste. This shall be accomplished with minimum interference of regular collection schedules.

(6) Hours of Operation. The contractor will confine his operations to daylight hours commencing not earlier than (time) and continuing not later than (time), unless otherwise approved by the contracting officer. When unusual conditions require deviations the contractor will, upon approval of the contracting officer, perform his services at no additional cost to the government.

l. Transportation

(1) All waste will be transported from the collection point to the disposal area in closed packer-type bodies mounted on suitable trucks approved for hauling waste. Transportation equipment will be clean, attractively painted, and in acceptable sanitary condition. Transportation equipment will not be overloaded, and all doors or other openings in the body of the vehicle will be closed during transit.

m. Disposal. (Use government-operated disposal areas or revise as necessary for contract operation.) This disposal area is located as shown on the plans and is operated by the government on the sanitary fill system. Insofar as practicable, and on approval of the area supervisor, a trench into which waste may be unloaded will be provided for the sole use of the contractor at his request. The government will supervise the disposal areas and the contractor will exercise such cooperation as may be necessary to obtain the maximum benefit the facilities might provide for all parties using them.

n. Containers

(1) Containers may be standard galvanized garbage cans with tight fitting lids; approved paper bag collection systems incorporating stands/hangers and lids; or larger approved metal containers having a capacity of 3.06 to 6.12 cubic meters (4 to 8 cubic yards). They will be handled, cleaned, and maintained as provided herein.

(2) Emptying Containers. Do not strike containers against the collection vehicle to loosen and remove contents. Return them to their proper station in an upright position with lids securely in place after emptying. Collection of a group of containers from collection points and then returning them later in the day will not be permitted.

(3) Unconfined Excess Waste. Each collection station and adjacent area will be left free of loose waste at the end of each regularly scheduled collection. Waste placed at the collection station in sacks, cartons, cans, or boxes, or uncontained waste will be removed by the contractor in the same manner and at the same time as if it were placed in the regularly provided containers.

(4) Spilled Waste. Each vehicle will carry a broom, yard rake, and scoop to facilitate immediate pickup of spilled wastes.

(5) Unserviceable Containers. Containers which, in the opinion of the contracting office become unserviceable, will be replaced with new or serviceable units and returned to the can cleaning and storage area. Unserviceable cans will be segregated from serviceable cans by the contractor. (Use government-furnished containers.) The segregated cans will be inspected daily by

the contracting officer's representative who shall designate the cans as condemned, irreparable, reparable, or serviceable.

(6) Disposition. (Use government-furnished containers.) Containers which have been inspected and classified as "condemned irreparable" will be cleaned thoroughly and disposed of as directed. Cans designated as "serviceable" shall be put back into service. The contractor will deliver "reparable" cans to an appropriate location for repair by the government. After cans have been repaired they will be picked up by the contractor and returned to service.

(7) Cleaning. The contractor will thoroughly clean and wash all containers and lids as specified in the following, or as often as necessary to maintain sanitary conditions. All containers used in housing and barrack areas for storing small quantities of putrescible wastes will be washed and sprayed at least once per month. Containers used to store dry wastes exclusively shall be washed as often as necessary to maintain good sanitary conditions as required by the inspector.

(8) Spraying. Immediately after cleaning and washing each vehicle or container and its lid, each will be sprayed inside and out with an approved disinfectant solution. The contractor will be responsible for all activities incident to storage, exchange, segregation, and washing and spraying of containers, lids, and cans used in collecting wastes.

o. Vehicles. Only trucks specially designed for collecting waste and of a type approved by the contracting officer will be used. Collection vehicles will be kept closed when moving or when not actually engaged in collecting wastes. Vehicles must be operated in accordance with base rules and regulations while in the base area. The cost of maintenance and repair of contractor-owned and government-owned vehicles assigned or loaned to the contractor will be borne by the contractor. Vehicles to be furnished by the contractor are as follows:

(1) Vehicles Required. As a minimum requirement, the contractor will have the following vehicles, or their equivalent as approved by the contracting officer, available for service at all times during this contract.

Type of Vehicle	Number	Capacity
(indicate vehicle types)	*(list numbers)*	*(list capacities)*

(2) Maintenance, Operation, and Repair of Vehicles. The contractor will maintain all vehicular equipment used under this contract in good repair and in safe, clean, and well-painted condition. The contractor's name will be painted or otherwise displayed prominently on each contractor-owned vehicle.

p. Sanitation Requirements. All phases of waste collection and disposal service will be conducted to comply with current applicable sanitary

regulations, and will meet the approval of the base surgeon or his designated representative.

(1) Contractor's Responsibility. The contractor's responsibility will include the following minimum requirements:

(a) Trucks, including the bodies, used for hauling waste will be washed and sprayed not less than once each week, or more often if necessary, to maintain a clean condition and neat appearance, as directed.

(b) All metal containers will be cleaned not less than as required and so directed.

(c) All contractor's equipment will be sprayed with approved insecticides and/or disinfectants as required for insect and/or sanitary control.

(d) Spillage at collection sites will be recovered before the collecting vehicle moves from the site.

(e) Spillage en route will be recovered immediately.

(f) Disposal area assigned to or used by the contractor will be maintained in a sanitary condition.

(g) The contractor shall police all collection sites within the immediate areas of the containers at the time pickups of wastes are made. All paper, boxes, cans, bottles, rags, garbage, or other waste within the immediate area will be recovered and hauled away for disposal.

(2) Cleaning Methods. Steam cleaning, spraying, and sanitation methods will be used at the discretion of the contractor so long as results are approved.

(a) If the contractor elects to steam clean containers at the collection site, he will provide equipment such as a tight truck, trailer bed, or approved metal-lined box on which the cleaning can be accomplished. This equipment will retain all washings, residues, and detergents and will be dumped and/or cleaned only at a disposal site. No washing or cleaning of containers or equipment will be permitted in housing areas or when washings, residues, or detergent solution may be deposited on natural ground, grassed, or paved surfaces.

(b) Washing and cleaning containers at the disposal area will require providing additional containers to replace those being cleaned so that no unit or collection station will be without a waste container for more than one hour.

(c) All waste containers will be clean, dry, and free of any quantity of detergent solution when replaced for use at a collection site.

(d) Steam Rack. At the end of each day's operation, the contractor will leave the steam rack drains and can storage area clean and free of debris.

(3) Equipment. The contractor will provide, operate, and maintain equipment in a sanitary condition and in a satisfactory and efficient manner. Mobile and steam cleaning equipment will be kept in safe operating condition and in neat appearance at all times. A heavy duty, high-pressure, multiple-hose, detergent-type steam cleaning unit of adequate size and capacity to perform the required work will be provided for use in the work covered by the contract. (Optional -- revise according to local conditions.) The government will provide water by pipe connection or delivery to the contractor's tank at the site of the steam cleaner in the disposal area.

(4) Sanitation Supplies. The contractor will provide movable bumper blocks required for operations at the sanitary landfill, and will be responsible for their use and maintenance.

(5) Covering Refuse. Covering will be as directed by the inspector, and will be accomplished by the contractor's personnel and equipment at no additional cost to the government.

(6) Conditions in Disposal Area. The contractor will be responsible for exercising judgement necessary for safety in the contractor's operations at the disposal area. No liability will be accepted by the government for conditions of ground surface, unstable ground, location of trenches, or any other condition which the contractor may encounter in performing his work.

(7) Wind Fence. A portable wind fence approved by the contracting officer will be installed and maintained by the contractor at the contractor's expense. The fence will be of sufficient height to prevent the escape of wind-blown litter and of sufficient length to extend the full length of the open fill. The fence will be installed on the side of the fill in the direction toward which prevailing winds blow. The fence will be relocated as necessary to afford full protection for the open fill. Upon erection and installation, title to the wind fence will pass to the government.

r. Salvage Operations. The contractor will not salvage any material unless designated salvageable materials by the contracting officer's representative. If the contractor or his employees discover materials which they believe to have a salvage value, the contracting officer will be notified immediately by the contractor and requested to determine the disposition of the item(s).

s. Assigned Area. An area of convenient size and location will be designated for the contractor's use. All contractor's equipment, when not in use, will be kept within the assigned area. The area will be kept clean, with equipment neatly parked or stacked, and the facility and the installations and operation will conform to current applicable fire, safety, and sanitary regulations. The contractor is responsible for the security of the assigned area and the equipment kept therein.

t. Personnel.

(1) The contractor will personally supervise the work or have a competent foreman or superintendent, satisfactory to the contracting officer, supervise the work at all times. The superintendent or foreman will have sufficient training and experience in sanitation to recognize unsanitary conditions and take necessary corrective action. He or she will be available at all times during regular working hours to accompany representatives of the contracting officer on inspection tours.

(2) Operations and Laborers. In addition to a superintendent or foreman, a sufficient number of personnel will be employed to properly accomplish all work in accordance with these specifications.

(3) Identification of Employees. The contractor will be responsible for furnishing to each employee, and requiring each employee engaged on the work to display, identification which is approved by the contracting officer. All prescribed identification will be returned to the contracting officer for cancellation immediately upon release of an employee. When required by the contracting officer, the contractor will obtain and submit fingerprints of all persons employed or to be employed on the project.

(4) Releasing an Employee. The contracting officer may, in writing, require the contractor to release any employee deemed incompetent, careless, insubordinate, or otherwise objectionable, or whose continuous employment is deemed, by the contracting officer, to be contrary to the public interest.

u. Reports. Reports shall be made in accordance with local requirements.

APPENDIX B-1

EXAMPLE CONTRACT

**TECHNICAL PROVISIONS FOR
REFUSE COLLECTION FROM FAMILY QUARTERS
AT MILITARY INSTALLATIONS**

GENERAL

Scope of Work. The contractor shall furnish all labor, tools, materials, vehicles, equipment, transportation, and supervision, except as specified herein as Government-furnished, to manage and perform all operations for the collections, transportation, and disposal of all refuse generated at the installations or areas defined in the schedules. This shall include, but is not limited to, repair parts, tools, shelter, and maintenance mechanics to perform maintenance repairs on equipment. The contractor shall perform in accordance with all terms, conditions, specifications, and standards contained in this contract and all current local, State of Washington, and Federal regulations, and shall obtain such permits, bonds, licenses, or other authorizations as may be required.

Type of Refuse. The refuse consists of general household and yard wastes including lawn and flower bed trimmings, grass, grass clippings and grass roots, cardboard boxes, cartons, plastic bags, bundled and tied newspapers, magazines, tree branches, etc. Frequently large and unusual types of waste, (examples include discarded furniture, toys, packing cartons, lumber, appliances, very large branches, Christmas trees) are placed out for collection by quarters' occupants. On an average, the volume of refuse is equivalent to three and one half (3-1/2) 32-gallon refuse containers per week from all of the quarters.

Personnel

Contractor's Project Manager. The contractor shall designate in writing to the Contracting Officer a project manager who shall be in charge of contract administration and supervision and shall be available at all times during normal working hours. This project manager shall direct the contractor's work force and operations in accordance with the requirements of this contract. The contractor's project manager shall be empowered with authority to make normal field decisions which may arise in the day-to-day operations without undue delay. The contractor's project manager shall report to the Refuse Section Foreman or his assistant in the morning and noon period of each working day in person or by phone to receive any complaints that have been reported.

The project manager shall be responsible for insuring that deficiencies have been corrected and the work properly reported to the Contracting Officer's Representative (COR). If there is a problem beyond the control of the contractor that does not permit the contractor to perform the requirements of this contract, the contractor shall report such instances the following workday. Failure to correct reasonable deficiencies will result in reduced monthly payments as shown in the Performance Requirements Summary or may be cause for the termination of the contract as determined by the "Default"

clause. The provisions specified shall not relieve the contractor of responsibility for competent supervision and compliance with contract requirements. Furthermore, continued noncompliance with contract provisions may also be cause for the termination of this contract.

Contractor Personnel and Identification. The contractor shall furnish an adequate number of personnel to carry out the intent of this contract. Each of the contractor's employees shall wear uniforms of the same design and color while on duty. Each employee shall be properly identified by displaying the name of the contractor and the employee's name or other identification as approved by the Contracting Officer. Contractor's personnel shall obey all the rules and regulations of the base while on the premises of the installation. Contractor's employees appearance shall be as neat and clean as practicable, and employees shall conduct themselves in a proper and efficient manner that shall cause the least inconvenience and disturbance to family housing occupants. The Contracting Officer may direct the contractor to immediately remove any employee from the job site found to be a security risk, abusive, under the influence of alcohol or drugs or in violation of installation regulations. The removal from the job site of such an employee shall not relieve the contractor of the requirement to provide sufficient personnel to perform adequate and timely service.

Each contractor vehicle shall have the contractor's name, home city, and local telephone number printed on the sides. The contractor's name shall be in 2-inch high (minimum) letters. Each contractor highway and employee vehicle shall be registered with base Law Enforcement Command. The owner shall maintain current post registration decals.

Strike Contingency Plan. The contractor shall develop and submit to the Contracting Officer for review a Strike Contingency Plan explaining how the contractor shall provide for no interruption of contract services due to labor disruption. The plan shall describe how and where qualified personnel will be acquired as well as a description of recruiting procedures to be used and time frames that may be needed to secure additional personnel.

Quality Control/Quality Assurance

Quality Control. The contractor shall establish a complete quality control program to ensure that the requirements of the contract are provided as specified. Appropriate sanitation measures shall be established and enforced to ensure that the ultimate disposal methods will not create a public nuisance. All rules of safety and sanitation which are imposed upon the contractor by any State or Federal code or law governing garbage or refuse collection and disposal shall be recognized and effectively carried out in performance of this contract.

An inspection system covering all the services as stated in the Performance Requirements Summary shall be adhered to. It must specify areas to be inspected on either a scheduled or unscheduled basis and the individuals who will do the inspection.

A method shall be developed for identifying deficiencies in the quality of services performed before the level of performance is unacceptable.

A file of all inspections conducted by the contractor and the corrected action taken shall be maintained. This documentation shall be made available to the Government during the term of the contract.

Quality Assurance. The Government will monitor the contractor's performance under this contract using the quality assurance procedures as specified in the Quality Assurance Surveillance Plan.

Hours of Operation. All collections shall be made between the hours of 0730 and 1600. Collections shall normally not be made on Sunday (or Saturday at Base B). At the option of the contractor, collections may be made on Federal holidays or schedules may be varied to provide pickup as required. At least ten (10) days prior to any Federal holiday on which pickup is scheduled, the contractor shall notify the Contracting Officer that collections will be made on that day or shall arrange for varying the collection schedule.

Management Plan. Within five (5) working days after award of contract, the contractor shall submit to the Contracting Officer for approval a schedule of proposed routes and the day(s) of the week of collection for each quarters area.

Access to Facilities. The Base A Sanitary Fill is available to the Contractor without charge. The contractor shall comply with rules and directions of the Fill Dumpmaster. Only refuse collected pursuant to this contract may be disposed of at the Base A Sanitary Fill.

Safety Requirements. In order to provide safety control for the protection of life and health of employees and other persons; for the prevention of damage to property, supplies, materials, and equipment; and for avoidance of work interruptions in the performance of this contract, the contractor shall comply with OSHA and all pertinent provisions of military safety documents published by the U.S. Army and published by the U.S. Government Printing Office.

Vehicles shall be operated at all times in a safe manner with all posted speed limits strictly observed. Vehicles shall not be "leapfrogged" or driven side by side when making collections.

Conservation of Utilities

Utilities provided to the contractor such as heat, electricity, and water shall be conserved and used only as needed.

The contractor shall conserve electrical power that is Government provided to any contractor office or storage area on post.

Physical Security/Key Control

The contractor shall safeguard all Government property provided for contractor use. At the close of each work period, Government facilities, equipment, and materials shall be secured.

The contractor shall establish and implement methods of insuring that all keys issued to the contractor by the Government are not lost or misplaced and are not used by unauthorized persons. No keys issued to the contractor by the Government shall be duplicated.

Definitions

As used throughout this contract, the following terms shall have the meanings set forth below:

Refuse. All garbage, ashes, debris, rubbish, and other similar waste material. Not included are explosive and incendiary waste and contaminated waste from medical and radiological processes.

Garbage. Animal and vegetable waste (and containers thereof) resulting from the handling, preparation, cooking, and consumption of foods. Edible or hogfood garbage is the portion of waste food which has been segregated for salvage.

Ashes. The residue from burned wood, coal, coke, and other combustible material.

Debris. Grass cuttings, tree trimmings, stumps, street sweeping, roofing and construction wastes, and similar waste material.

Rubbish. A variety of unsalvageable waste material such as metal, glass, crockery, floor sweepings, paper, wrapping, containers, cartons, and similar articles not used in preparing or dispensing food. Rubbish is further subdivided into:

Combustible Rubbish. Material which can be burned readily in an incinerator or burning pit.

Noncombustible Rubbish. Material which cannot be burned readily in an incinerator or burning pit.

Receptacles or Containers. Cans, drums, bins, or similar receptacles which can be handled easily, and multiple containers which are handled by mechanical truck-mounted hoists.

"Refuse collection" means a system of transporting refuse, including nonaccountable salvage, from pickup stations to points of disposal. It includes the dumping, disposal, or unloading of refuse at the point of disposal.

"Collection" means the accumulated refuse from any one unit at any one time, regardless of the number of containers, cartons, bundles, or weight.

"Pickup stations" means the nearest adjacent alley, street or parking lot edge or curbside, as the case may be, where refuse may be conveniently and efficiently assembled and stored in containers for collection.

"Curbside" means the area within ten (10) feet from the alley, street, or parking-lot edge or curbing, except in unusual circumstances.

Collection Frequency. The number of times collection is provided in a given period of time.

Open Burning. The combustion of solid waste without (a) control of combustion air to maintain adequate temperatures for efficient combustion, (b) containment of the combustion reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, or © control of the emission of the combustion products. THIS IS A PROHIBITED ACTION and not an authorized means of ultimate disposal.

Refuse Disposal. For the purpose of this contract, the delivery of the collected refuse to the Base A Sanitary Landfill and the emptying of the refuse as directed by the landfill manager.

Sanitary Landfill. A site where refuse is disposed using an engineering method in a manner that protects the environment by spreading the waste in thin layers, compacting it to the smallest practical volume, and covering it with soil by the end of each working day; it meets the criteria of PL 94-580, 90 Stat 2800, 42 USC 6903. The sanitary landfill will be operated by others.

Solid Waste. Garbage, refuse, sludges, and other discarded solid materials resulting from industrial and commercial operations and from community activities. It does not include solids or dissolved materials in domestic sewage or other significant pollutants in water resources such as silt, dissolved or suspended solids in industrial waste water effluents, dissolved materials in irrigation return flow or other common water pollutants.

Government-Furnished Property and Services

Maintenance. An area for vehicle maintenance repair and vehicle storage at the landfill will be made available at no cost to the contractor upon request. The area shall be maintained in a neat and orderly manner by the contractor. If a shop or covered work area is required, it shall be provided by the contractor. The liability for and the safeguarding of all contractor equipment shall be the responsibility of the contractor.

Utilities. The Government will provide the contractor with all utilities such as electricity, water, and sewage. Any additional services other than those existing in the facilities assigned shall be provided by the contractor. It shall be the contractor's responsibility to make any required utility connections at no cost to the Government.

Property and Services

Vehicles and Equipment. Contractors shall use trucks specially designed for refuse collection that have watertight bodies and which do not permit loss of said refuse. Open-box trucks, with or without canvas cover, will not be acceptable, except for collection of large and abnormal items. Contractor's trucks shall meet all applicable standards established by the Federal Government. These standards include, but are not limited to, Motor Carriers

Safety Standards (49 CFR 390-396) and Noise Emission Standards for Motor Carriers Engaged in Interstate Commerce (40 CFR 202) and Federal Motor Vehicle Standards (40 CFR 500-580) and shall comply with all federal, state, and local air pollution standards and regulations.

The contractor shall provide sufficient equipment to maintain a standby vehicle in case of breakdown or emergency. The contractor shall also provide adequate maintenance and repair service for this equipment to ensure that sufficient vehicles are maintained in good operation. All trucks must be kept clean and in good mechanical condition and shall be painted so as to present a good appearance, preferably white. Also, each vehicle shall be identified with a number which will be clearly painted on each side of the vehicle. Vehicles shall be washed at least weekly to maintain a sanitary condition.

The refuse collection trucks, except for those used for collection of large and abnormal items, shall be equipped with a closed circuit television camera that views the area immediately behind the vehicle up to the distance that cannot be seen in the vehicle's rear view mirrors. As an alternate, a ground guide shall be used during all backing operations.

Within five (5) days after award of the contract, the contractor shall have his collection equipment inspected by an authorized representative from Base Facilities Engineering for conformance with contract requirements. Approval of equipment shall be made by the Contracting Officer prior to commencement of refuse collection. Any additional or replacement equipment to be used in the performance of this contract shall be similarly inspected and approved prior to use.

Custodial Service. The contractor shall be responsible for custodial services for the areas assigned to him for his use, to include care and maintenance for the grounds around the facilities.

SPECIFIC TASKS

Schedule and Points of Collection

The contractor shall provide the services of refuse collection and disposal as described below:

Route and Collection Schedules. The contractor shall establish a plan for vehicle routes and collection schedule and submit this plan to the Contracting Officer for approval five (5) days after contract award.

The refuse collection schedule shall be accomplished between the hours of 0730 and 1600, Monday through Friday. No work shall be done on weekends without the prior approval of the Contracting Officer.

In the event of change in routes or schedules that alter the day of pickup, the contractor shall submit a plan and description of the change two (2) weeks prior to the commencement of the proposed change to the Contracting Officer for approval. If the change is approved, the Contractor shall notify in writing the family housing occupants affected, one (1) week prior to making the change.

Points of Collection. (Pickup Stations)

Collections of refuse by the contractor shall be made from areas noted on the vicinity maps shown in Technical Exhibit _____.

Larger-scale map(s) showing quarter numbers will be supplied to the contractor by the Contracting Officer.

Frequency of Collection. Collection of refuse shall be made in a systematic manner at the frequency specified in the bid schedule. These collections shall be scheduled so that collection in each area will be made the same day/days every week and approximately the same time of day. If twice weekly collection option is selected, the contractor's schedule shall be arranged so that the collections are at least three days apart each week from each quarters. All refuse, whether in reusable or in disposable containers, placed at designated pickup stations, shall be collected. The quantity of refuse to be collected may be slightly larger due to the frequency of personnel reassignments which are not normal to a civilian community but are normal in military housing. The number and size of the reusable containers will vary at each set of quarters.

Prior to collection on scheduled collection days, quarters occupants will place all refuse at the pickup station which is the nearest adjacent alley, street, or parking-lot curbside, as the case may be. All large and abnormal items of waste to be collected will be placed in the vicinity of the pickup station by the quarters occupant.

All items generated from family housing units too large to fit into the packer-type refuse trucks or items more efficiently and economically collected by the use of other types of equipment such as a open-top container truck shall be collected on the scheduled pickup day. No large items, leaves, and/or limbs shall be left on the street or curbside over the weekend. The weekend is defined as a period of time between 1600 on Friday and 0700 on Monday. See Section ___, Specific Collection, for items to be picked up. All items collected shall be disposed of at a Sanitary Landfill. Large items shall be collected no later than 1600 on the normal refuse collection day scheduled for the housing area in which items are located. All refuse shall be picked up without regard to size, weight, or container contents.

Position of Containers. The contractor shall return containers to their original position in an upright position with lids securely in place. The contractor shall not place the emptied containers on sidewalks, in streets, in front of mail boxes, or in any manner which shall interfere with motor vehicle traffic, pedestrian traffic, or mail delivery.

Special Collections. In addition to the collections specified above, the contractor shall make collections of all large and abnormal items of waste, including but not limited to discarded furniture, toys, packing cartons, lumber, appliances, very large branches, Christmas trees, and other material placed out for collection by quarters occupants. These items may not be tied or bundled. The contractor shall not collect large rocks (greater than two inches in diameter), earth (but not including the earth that is attached to lawns and flower bed edge trimmings), or any other type of fill material. The Refuse Section foreman will report any calls for collections of

such large and abnormal items of waste to the contractor for collection. However, a minimum of one collection trip shall be made each week through all quarters areas for the collection of all large and abnormal items of waste. Extra trips during the holiday season may be required to collect all discarded Christmas trees. A general purpose or dump truck may be used for this purpose.

Spillage. The contractor shall exercise due care to prevent spillage from collection trucks and shall promptly clean up all material as a result of such spillage. The pickup stations shall be left in a neat and orderly manner. (Contractor shall be responsible for repair of damage he causes, regardless if it was accidental or willful destruction.)

Abnormal Quantities of Refuse and Missed Pickups. If it is found that all scheduled pickup stations cannot be emptied before the end of the normal workday, the contractor shall take necessary action whether it be to work additional hours or provide additional equipment to route to ensure that all containers are emptied. The contractor shall be required to collect refuse at missed pickup points within eight (8) working hours after notification by the Contracting Officer or the COR. It shall be mandatory that all full or partially filled containers found on the route be emptied that day. If, because of contractor equipment breakdown or lack of manpower, the contractor is unable to complete collection of a route as scheduled, it shall be the contractor's responsibility to notify the DEH Refuse Collection Section of the delay and provide emergency service within twenty-four (24) hours of the time of the equipment breakdown preventing refuse collection. Failure to provide emergency services within twenty-four (24) hours may constitute grounds for finding the contractor in default in accordance with the DEFAULT clause of the CONTRACT CLAUSES since the contractor is required to maintain a standby vehicle in case of equipment breakdown or emergency.

Refuse not collected on scheduled collection trips, due to the quarters' occupant's failure to place said materials at the pickup station, shall not be picked up until the next regularly scheduled collection by the contractor. Quarters' number of all failures shall be recorded by the contractor.

Inclement Weather Schedule. The contractor shall collect refuse during periods of inclement weather. Exceptions to this may be authorized by the Contracting Officer in cases of severe weather. When exceptions are granted, the contractor shall accomplish all collections for each day missed in order to make up all missed collections within 24 hours. The contractor shall submit a revised schedule to the Contracting Officer for approval. Rescheduling to provide makeup collections shall not be a basis for a claim by the contractor for additional compensation.

Cleaning Requirements

The contractor shall be responsible for keeping all mobile equipment clean and free of obnoxious odors. The contractor shall thoroughly wash all refuse collection equipment with steam, soap, or detergents, and water as specified below. (Other methods of cleaning shall be approved by the Contracting Officer prior to use.)

Trucks, including the bodies, used for hauling refuse shall be cleaned at least once per week, or more frequently, to maintain a clean condition and to prevent the propagation or attraction of vectors.

Cleaning operations shall be performed to prevent the contamination of the surrounding area or result in environmental pollution.

The contractor shall leave the washrack area clean, free of debris, and clear of any blockage at the end of the day's operation.

Apparent Serviceable Material

The contractor shall not dispose of any material which has an obvious value and appears to have been inadvertently placed near the collection point unless such material is designated as refuse by the COR.

Disposal

The contractor shall dispose of all refuse at the Sanitary Landfill. The contractor shall place the refuse at locations directed by the Government. The contractor shall cooperate with the Government to obtain maximum benefit for the facility.

Reports and Records

The contractor shall maintain daily records of the routes covered by each truck, locations on scheduled routes which were skipped, reason for failure to make collection, number of trips by each truck, and weight of refuse delivered to the Sanitary Fill. The daily records shall be submitted weekly to the authorized representative from the Directorate of Engineering and Housing. Each load delivered to the Sanitary Fill by the contractor shall be verified by reporting to the Dumpmaster Office at the time of delivery. Forms shall be furnished by the Contracting Officer.

The contractor shall deliver to the Inspection Branch, two (2) copies of a properly filled out Daily Contract Inspection Report for each day worked. Daily reports shall be delivered to the Contract Inspection Branch once a week at no later than 0815 hours on the first working day of the week for the previous week. Blank forms will be provided to the contractor by the Contracting Officer.

Invoices. In addition to all other requirements for invoices, two (2) copies of every invoice shall be forwarded to the Contract Inspection Branch. Failure to do so may result in delays in acceptance and payments.

Restrictions

The contractor shall not drive on the grass, sidewalk, and/or dirt walking trails for any reason in the family housing areas.

The contractor or his employees shall not contact the occupants regarding refuse collection problems. The contractor shall report problems of any kind to the Contracting Officer or his designated representative.

TECHNICAL EXHIBIT 1

PERFORMANCE REQUIREMENTS SUMMARY FOR EXAMPLE CONTRACT

The purpose of this exhibit is to:

- List the contract requirements considered most critical to acceptable contract performance. (NOTE: NAVFACENGCOM contracts are based on procedures based in Mo-327. MIL-STD-105D is not used in NAVFACENGCOM contracts.)
- Show the maximum allowable degree of deviation (Acceptable Quality Level or AQL) from performance for each requirement that shall be allowed by the Government before contract performance is considered unsatisfactory.
- Show the percentage of the major elements of the contract price that each listed contract requirement represents.
- Explain the Quality Assurance methods the Government will use to evaluate the contractor's performance in meeting the contract requirements.
- Define the procedure the Government shall use in reducing the contractor's monthly payment if satisfactory performance is not rendered by the contractor.

The Government's primary Quality Assurance procedures are based on random sampling of the recurring critical output products of the contract using the concepts of random number sampling. Some contract requirements will be reviewed periodically (i.e., monthly, quarterly, semiannually).

The criteria for acceptable and unacceptable performance are as follows:

For Areas Surveilled by Sampling. Criteria are derived from MIL-STD105D based on the lot size, sample size, and AQL for each contract requirement. When the number of defects in the contractor's performance discovered by the COR exceeds the unacceptable criterion level, the contractor shall be required to complete a Contract Discrepancy Report (CDR). The CDR will require the contractor to explain in writing why performance was unacceptable, how performance will be returned to acceptable levels, and how recurrence of the problems will be prevented in the future. In accordance with the Inspection of Services clause, the Contractor will not be paid for services not rendered in accordance with the Inspection of Services clause, or the standards set forth in this contract.

Other Requirements. The criterion for nonsampled requirements is the level of performance deemed acceptable to the Government. The use of the Contract Discrepancy Report as described above applies to these requirements as well.

Monthly payments to the contractor will be reduced for unsatisfactory performance using the following methods:

Each month, contractor performance will be compared to contract standards and acceptable quality levels using the quality assurance surveillance plan.

If performance in any required service is unsatisfactory and the poor performance is clearly the fault of the contractor, an amount of money up to the percentage cost of the services as stated in Column 5 of the Performance Requirements Summary will be withheld.

Performance Requirements

Example for data in Table B-2.

Frequency of pickups.

Base A

3508 pickup stations
* 2 pickups/week
* 4 weeks/month = 28,064 pickups/mo
Sample size = 315 samples
(See Tables B-3 and B-4; Level II inspection)
(Reference MIL-STD-105D for more details)

Base B

860 pickup stations
* 1 pickup/week
* 4 weeks/month = 3,440 pickups/mo
Sample size = 200 samples
(See Tables B-3 and B-4; Level II inspection)
(Reference MIL-STD-105D for more details)

In assigning numbers to pickup stations, a pickup station will receive one number for each scheduled pickup.

The sample required/month will be taken from 28,064 pickups at Base A and the 3,440 pickups at Base B separately.

Examples of Payment Computation

1. For services surveyed by sampling, the maximum contract payment per month is multiplied by the maximum percentage for the service to determine the maximum payment for acceptable service. This payment is multiplied by the percentage found acceptable to determine what the contractor will be paid for the listed service. The total number of defectives found, not just those in excess of the reject level, are used to determine the percentage of the sample found unacceptable. The percentage of the sample found unacceptable subtracted from 100 percent determines the percentage of the lot found acceptable. The payment computation would be as follows:

Assume:

- AQL = 2.5% for timely collection at Base A
- lot size 28,064 units
- sample size = 315 units
- defectives found = 30
- defectives corrected = 0

Maximum contract payment per month	$20,000
Maximum payment percentage for the service (column 5 Table 8-2)	* 30%
Maximum payment for acceptable services	$ 6,000
Acceptable reject level (i.e., number of defectives) See Tables 8-3 and B-4; Level II inspection) (Reference MIL-STD-1O5D for more details)	= 15

30 defectives exceeds reject level of 15 defectives

Percentage of sample found unacceptable (defectives divided by sample size times 100%) 30/315 * 100%	9.5%
Percentage of sample found acceptable (100% minus percentage found unacceptable)	90.5%
Payment for percentage of acceptable services (Maximum payment for acceptable services times fraction of sample found acceptable) $6,000 * 90.5/100	$ 5,430

2. For services surveyed by sampling with all samples defectives corrected by reperformance.

Assume:

- AQL = 2.5% for timely collection at Base B
- lot size = 3,440 units
- sample size = 200 units
- defectives found = 15
- defectives corrected = 15

Maximum contract payment per month is	$20,000
Maximum payment percentage for the service (column 5, Table B-2)	* 30%
Maximum payment for acceptable services	$ 6,000
Acceptable reject level (i.e. number of defectives) (See Tables B-3 and 8-4; Level II inspection) (Reference MIL-STD--105D for more details)	= 11

15 defectives exceeds reject level of 11

Percentage of sample found unacceptable (defective divided by sample size times 100) 15/200 * 100	7.5%
Percentage of sample found acceptable (100% minus percentage found unacceptable)	92.5%
Credit for sample defectives corrected (samples corrected divided by lot size * 100%) 15/3,440 * 100%	0.4%
Acceptable percentage (% of sample found acceptable + credit for corrected defectives) 92.5 + 0.4	92.9%
Payment for percentage of acceptable services (Maximum payment for acceptable services times [acceptable percentage]/100) $6,000 * 92.9/100	$ 5,574

The rights and remedies of the Government described in this section are in addition to all other rights and remedies set forth in this solicitation. Specifically, the Government reserves its rights under the Inspection of Services clause and the Termination for Default clause. Any deductions pursuant to the Performance Requirements Summary shall reflect the reduced value of services performed hereunder.

TABLE B-1
Performance Requirements Summary

Required Service	Standard	Maximum Allowable Degree of Deviation from Requirement (AQL)	Method of Surveillance	Deduction from Contract Price for Exceeding the AWL
Timely collection of refuse on established routes and collection schedule.	Refuse must be collected in accordance with approved routes and collection schedule unless deviation is approved by the Contracting Officer.	2.5% AOL Lot is number of pickup stations X frequency of collections per month.	Random sampling	30%
Timely collection of large and abnormal items of waste.	Collect all large and abnormal items of waste when notified and make one special collection through all areas each week.	2.5% AOL Lot is number of special collections per month.	Random sampling	15%
Removal of spillage enroute and at collection stations	Immediate pickup of all spillage at time of pickup.	2.5% AOL Lot is number of pickup stations X frequency of collections per month.	Random sampling	5%

TABLE B-2

Location and Number of Housing Units

BASE A

Housing Area	Number of Housing
Avenue A	458
Avenue B	168
Avenue C	518
Avenue D	433
Avenue E	257
Avenue F	129
Avenue G	524
Avenue H	700
Avenue I	206
Avenue J	115
Subtotal	3,508

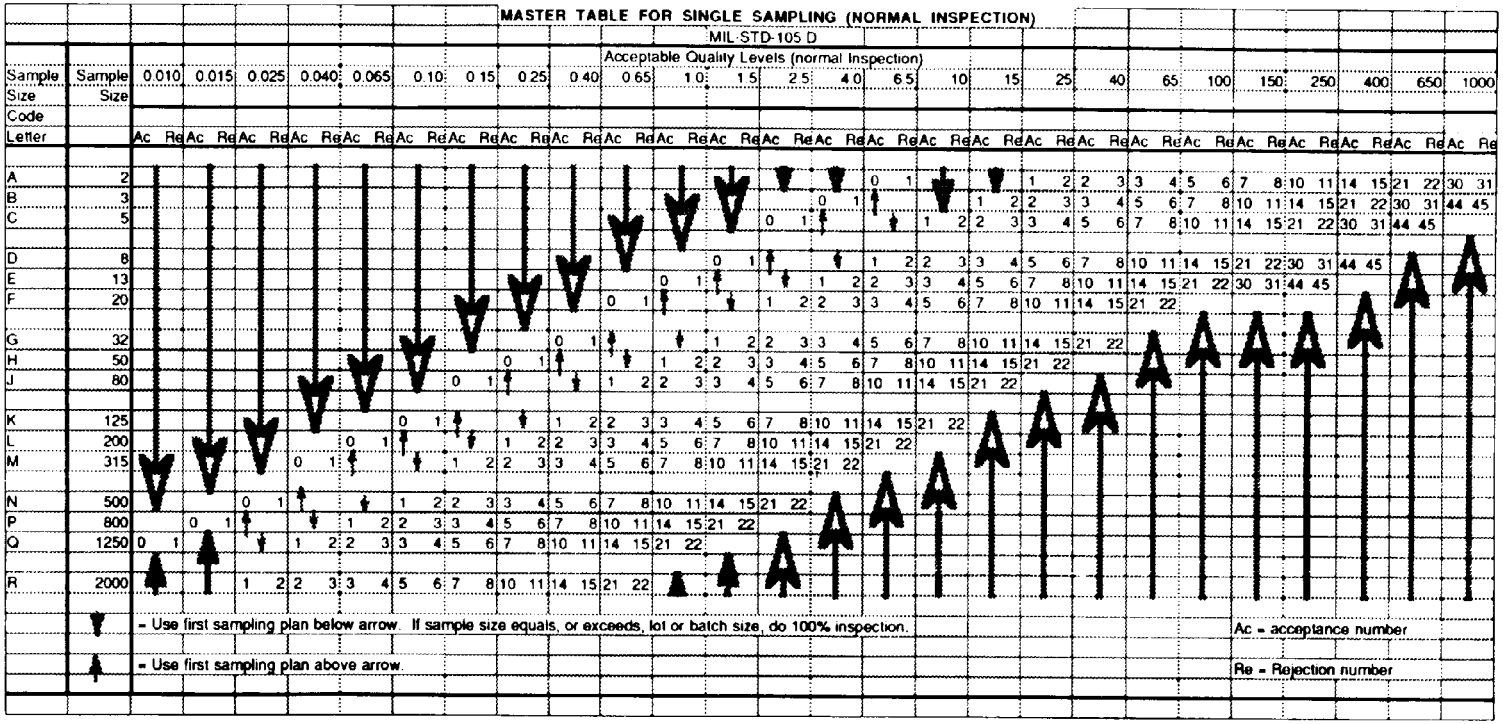
BASE B

General Officers Quarters	5
100 Area	110
200 Area	595
300 Area	150
Subtotal	860
Total Pickup Stations	4,368

TABLE 8-3
Sample Size Code Letters from MIL-STD-105D

Lot or Batch Size			General Inspection Levels		
			I	II	III
2	to	8	A	A	B
9	to	15	A	B	C
16	to	25	B	C	D
26	to	50	C	D	E
51	to	90	C	E	F
91	to	150	D	F	G
151	to	280	E	G	H
281	to	500	F	H	J
501	to	1,200	G	J	K
1,201	to	3,200	H	K	L
3,201	to	10,000	J	L	M
10,001	to	35,000	K	N	N
35,001	to	150,000	L	N	P
150,001	to	500,000	N	P	Q
500,001	and	over	N	Q	R

TABLE B-4
Single Sampling, Normal Inspection



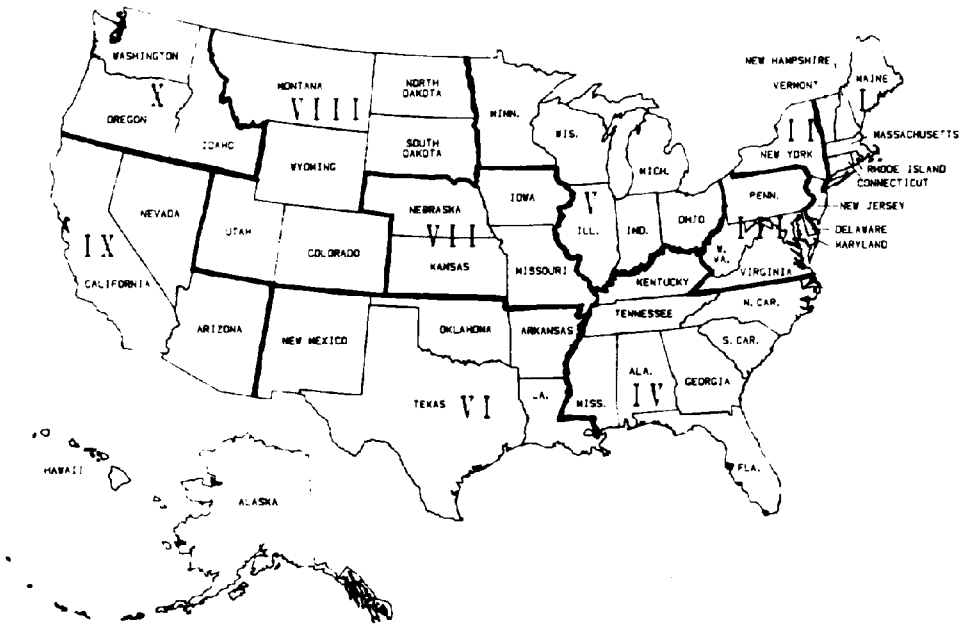
APPENDIX C

REGIONAL EPA OFFICES

Region	Regional Administrator	Division Director	(RCRA) Branch Chief
I	Michael R. Deland John F. Kennedy Bldg. Boston, MA 02203 FTS 8-223-7210 (617) 223-7210	Merril S. Hohman Waste Management Div. (HHA) FTS 8-835-3698 (617) 565-3698	Linda Murphy MA Waste Management Branch (HRL-1 300) FTS 8-223-5655 (617) 223-5655
II	Christopher J. Daggett (2RA RM 900) 26 Federal Plaza New York, NY 10278 FTS 8-264-2525 (212) 264-2525	Conrad Simon (2AWM-SW RM 1000) Air & Waste Management Division FTS 8-264-2302 (212) 264-2302	Rich Walka (2AWM-SW 9th Floor) Solid Waste Branch FTS 8-264-0504/5 (212) 264-0504/5
III	James M. Seif (3RA00) 841 Chestnut Street	Stephen R. Wassersug Hazardous Waste Management Division	Robert L Allen Waste Management Branch
(3HW30)	Philadelphia, PA 19107 FTS 8-597-9814 (215) 597-9814	(3HWOO) FTS 8-597-8131 (215) 597-8131	FIS 8-597-0980 (215) 597-0980
IV	Jack E. Ravan 345 Courtland St. N.E. Atlanta, GA 30365 FTS 8-257-4727	Pat Tobin Waste Management Division FTS 8-257-3454 (404) 347-3454	James H. Scarbrough Residuals Management Branch FTS 8-257-3016 (404) 347-3016
V	Valdas V. Adamkus 230 So. Dearborn St. Chicago, IL 60604 (5RA1 4) FTS 8-353-2000 (312) 353-2000	Bill Constantelos Waste Management Division (5H12) FIS 8-886-7579 (312) 886-7579	Karl Bremer Solid Waste Branch (5HS1 3) FTS 8-886-7435 (312) 886-7435

APPENDIX C (cont'd)

Region	Regional Administrator	Division Director	(RCRA) Branch Chief
VI	Robert E. Layton, Jr. Allied Bank Tower 1445 Ross Avenue Dallas, TX 75202-2733 FTS 8-255-2100 (214)655-2100	Allyn M. Davis Hazardous Waste Management Division (6H) FTS 8-255-6700 (214) 655-6700	Randy Brown, Chief Hazardous Waste Program Branch (6H-H) FTS 8-255-6745 (214) 655-6745
VII	Morris Kay 726 Minnesota Avenue Kansas City, KS 66101 FTS 8-757-2800 (913) 236-2800	David Wagoner Waste Management Division FTS 8-757-2850 (913) 236-2850	Mike Sanderson RORA Branch FTS 8-757-2852 (913) 236-2852
VIII	John Welles One Denver Place Suite l300 999 18th Street Denver, CO 80202 FTS 8-564-1603 (303)293-1603	Robert L Duprey Air and Haz. Matls. Division FTS8-564-1719 (303) 293-1719	Louis W. Johnson Waste Management Branch FTS 8-564-1662 (303) 293-1662
IX	Judith E. Ayres 215 Fremont Street San Francisco, CA 94105 FTS 8-454-8153 (415)974-6153	Jeff Zelikson (acting) Toxics & Waste Management Division (T-1) FTS 8-454-7460 (415)974-7460	Philip Bobel Waste Programs Branch (T-2) FTS8-454-8119 (415)974-8119
X	Robie Russell 1200 6th Avenue Seattle, WA 98101 (Mail Stop 601) FTS 8-399-5810 (206) 442-5810	Charles Findley Hazardous Waste Division (HW-1 12) FTS 8-399-1352 (206) 442-1352	Kenneth D. Feigner Waste Management Branch (HW-112) FTS 8-399-2782 (206) 442-2782



REGIONS	LOCATIONS
IV	Alabama
X	Alaska
IX	Arizona
VI	Arkansas
IX	California (San Francisco)
VIII	Colorado (Denver)
I	Connecticut
III	Delaware
III	District of Columbia
IV	Florida
IV	Georgia (Atlanta)
IX	Hawaii
X	Idaho
V	Illinois (Chicago)
V	Indiana
VII	Iowa
VII	Kansas (Kansas City)
IV	Kentucky
VI	Louisiana
	Maine
III	Maryland
	Massachusetts (Boston)
V	Michigan
V	Minnesota
IV	Mississippi

REGIONS	LOCATIONS
VII	Missouri
VIII	Montana
VII	Nebraska
IX	Nevada
I	New Hampshire
II	New Jersey
II	New York (New York)
IV	North Carolina
VIII	North Dakota
V	Ohio
VI	Oklahoma
X	Oregon
III	Pennsylvania (Philadelphia)
I	Rhode Island
IV	South Carolina
VIII	South Dakota
IV	Tennessee
VI	Texas (Dallas)
VIII	Utah
I	Vermont
III	Virginia
X	Washington (Seattle)
III	West Virginia
V	Wisconsin
VIII	Wyoming

IX American Samoa
IX Guam
II Puerto Rico
II Virgin Islands

APPENDIX D

STATE SOLID WASTE AGENCIES

ALABAMA

Alabama Department of
Environmental Management
Land Division
State Office Building
Montgomery, Alabama 36104
(205) 834-1303

ALASKA

Department of Environmental Conservation
Land Management
Mail Pouch 0
Juneau, Alaska 99811
(907) 465-2600

ARIZONA

Department of Health Services
Solid Waste Section
411 North 24th Street
Phoenix, Arizona 85008
(602)255-1162

CALIFORNIA

California Waste Management Board
1020 Ninth Street
Suite 300
Sacramento, California 95814
(916) 322-3330

COLORADO

Department of Health
4210 East Eleventh Street
Denver, Colorado 80220
(303) 320-8333

CONNECTICUT

Department of Environmental Protection
Solid Waste Management Program
122 Washington Street
Hartford, Connecticut 06106
(203) 566-3672

DELAWARE

Department of Resources and
Environmental Control
Solid Waste Section
P.O. Box 1401
Edward Tatmall Building
Dover, Delaware 19901
(302) 736-4781

DISTRICT OF COLUMBIA

Department of Environmental Services
RCRA Inventories
415 Twelfth Street, N.W.
Washington, D.C. 20004
(202) 767-8192

FLORIDA

Department of Environmental Regulation
Solid Waste Management Program
Twin Towers Office Building
2600 Blairstone Road
Tallahassee, Florida 32301
(904) 488-0300

GEORGIA

Environmental Protection Division
Land Protection Branch
270 Washington Street, S.W.
Room 822
Atlanta, Georgia 30334
(404) 656-2836

HAWAII

State Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801
(808) 548-6410

IDAHO

Department of Health and Welfare
Solid Waste Management Section
State House
Boise, Idaho 83720
(208) 334-4107

ILLINOIS

Environmental Protection Agency
Division of Land Pollution Control
2200 Churchill Drive
Springfield, Illinois 62706
(217) 782-6760

INDIANA

State Board of Health
Land Pollution Control Division
Solid Waste Management Branch
1330 West Michigan Street
Indianapolis, Indiana 46206
(317) 633-0176

IOWA

Department of Water, Air, and
Waste Management
Air and Land Quality Division
Henry A. Wallace Building
900 East Grand
Des Moines, Iowa 50319
(515) 281-8853

KANSAS

Department of Health and Environment
Solid Waste Management Section
Topeka, Kansas 66620
(913) 862-9360

KENTUCKY

State Department for Natural Resources
and Environmental Protection
Waste Management
Capital Plaza Tower
Frankfort, Kentucky 40601
(502) 564-6716

LOUISIANA

Department of Natural Resources
Solid Waste Division
P.O. BOX 44066
Baton Rouge, Louisiana 70804
(504) 342-1216

MAINE

Department of Environmental Protection
Bureau of Land Quality
Division of Solid Waste Management Control
State House
Augusta, Maine 04333
(207) 289-2111

MARYLAND

Department of the Environment
Hazardous and Solid Waste Management
2500 Broening Highway
Baltimore, Maryland 21224
(301) 631-3368

MASSACHUSETTS

Department of Environmental Quality and
Engineering
Division of Hazardous Wastes
Leverett Saltonstall Building
100 Cambridge Street
Boston, Massachusetts 02202
(617) 727-0774

MICHIGAN

Environmental Protection Bureau
Ground Water Quality Division
P.O. Box 30028
Lansing, Michigan 48909
(517) 373-2794

MINNESOTA

Pollution Control Agency
Solid Waste Division
Enforcement Section
1935 West County, Road B-2
Roseville, Minnesota 55113
(612) 297-2706

MISSISSIPPI

State Board of Health/Bureau of Pollution Control
Division of Solid Waste Management
P.O. Box 10385
Jackson, Mississippi 39206
(601)961-5171

MISSOURI

Department of Natural Resources/
Division of Environmental Quality
Management Program
State Office Building
P.O. Box 1368
Jefferson City, Missouri 65102
(314) 751-3241

MONTANA

State Department of Health
Solid Waste Management Bureau
1424 Ninth Avenue
Helena, Montana 59601
(406) 449-2821

NEBRASKA

State Environmental Control Board
Division of Water Waste Management
Permitting and Ucensing
Box 94877
Lincoln, Nebraska 68509
(402) 471-2186

NEVADA

Department of Conservation and Natural Resources
Division of Environmental Protection
Capital Complex
Carson City, Nevada 89710
(702) 885-4670

NEW HAMPSHIRE

Department of Health and Welfare
Bureau of Solid Waste Management
State Laboratory Building
Hazen Drive
Concord, New Hampshire 03301
(603) 271-4623

NEW JERSEY

Department of Environmental Protection
Solid Waste Administration
32 East Hanover Street
Trenton, New Jersey 08625
(609) 292-8242

NEW MEXICO

Department of Health and Environment
Bureau of Solid Waste
P.O. Box 968
Crown Building
Santa Fe, New Mexico 87503
(505) 827-5271

NEW YORK

Department of Environmental Conservation
Waste Disposal Bureau
50 Wolf Road
Albany, New York 12233
(518) 457-6605

NORTH CAROUNA

Department of Human Resources
Division of Health Services
Solid Waste and Vector Control
P.O. Box 2091
Raleigh, North Carolina 27602
(919) 733-2178

NORTH DAKOTA

State Department of Health
Division of Water Supply and Pollution Control
1200 Missouri Avenue
Bismark, North Dakota 58505
(701) 224-2375

OHIO

Ohio Environmental Protection Agency
Division of Solid and Hazardous Wastes
361 East Broad Street
Columbus, Ohio 43126
(614) 466-8934

OKLAHOMA

State Department of Health
Industrial and Solid Waste Service
Solid Waste Division
P.O. Box 53551
Northeast Tenth and Stonewall Streets
Oklahoma City, Oklahoma 73105
(405) 271-5338

OREGON

Department of Environmental Quality
Division of Solid Waste
P.O. Box 1760
Portland, Oregon 97207
(503) 229-5913

PENNSYLVANIA

Department of Environmental Resources
Bureau of Solid Waste Management
Fulton Building, P.O. Box 2063
Harrisburg, Pennsylvania 17120
(717) 787-7383

RHODE ISLAND

Department of Environmental Management
Division of Air and Hazardous Waste Materials
204 Health Building, Davis Street
Providence, Rhode Island 02908

SOUTH CAROLINA

Department of Health and Environmental Control
Solid Waste Management Division
J. Marion Simms Building
2600 Bull Street
Columbia, South Carolina 29201
(803) 758-5681

SOUTH DAKOTA

Department of Environmental Protection
Joe Foss Building
Pierre, South Dakota 75761
(605) 773-3329

TENNESSEE

Department of Health and Environment
Bureau of Environmental Management
Division of Solid Waste Management
160 Ninth Avenue, North Terra Building
Nashville, Tennessee 37203
(615) 741-3424

TEXAS

Department of Health
Bureau of Solid Waste Management
1100 West 49th Street
Austin, Texas 78756
(512) 458-7271

UTAH

State Department of Health
Division of Environmental Health
Bureau of Solid Waste Management
150 West North Temple
P.O. Box 2500
Salt Lake City, Utah 84110
(801) 533-4145

VERMONT

Agency of Environmental Conservation
Air and Solid Waste Section
P.O. Box 489
Montpelier, Vermont 05602
(802) 828-3395

VIRGINIA

State Department of Health
Division of Solid Waste
109 Governor Street
Richmond, Virginia 23219
(804) 225-2667

WASHINGTON

State Department of Ecology
Solid Waste & Recycling
Mail Stop PV-11 1
Olympia, Washington 98504-8711
(206) 459-6322

WEST VIRGINIA

State Health Department
Division of Solid Waste
1800 Washington Street, East
Charleston, West Virginia 25305
(304) 348-2987

WISCONSIN

Department of Natural Resources
Bureau of Solid Waste Management
P.O. Box 7921
Madison, Wisconsin 53709
(608) 266-1327

WYOMING

Department of Environmental Quality
Solid Waste Program
State Office Building, West
Cheyenne, Wyoming 82001
(307) 777-7752

APPENDIX E

ORGANIZATIONS PROVIDING ASSISTANCE FOR RECYCLING AND RESOURCE RECOVERY PROGRAMS

There are numerous government, industrial, and citizen organizations that can help in a recycling program. The U.S. Environmental Protection Agency (EPA) is the governmental contact point for all solid waste matters. EPA Regional Affairs Offices can assist in developing local programs. The following is a list of some of the organizations that can provide information for recycling programs:

Federal Agencies:

Bureau of Mines
Publications Distribution Branch
4800 Forbes Avenue
Pittsburgh, PA 15213

National Technical Information Service
Document Sales Department
5285 Port Royal Road
Springfield, VA 22161

U.S. Environmental Protection Agency
Office of Solid Waste Management Programs
1835 K Street, N.W.
Washington, DC 20460

Department of Defense:

Facilities Engineering
Office of the Chief of Engineers
Department of the Army
Washington, DC 20341

Headquarters, Air Force Engineering and Services Center
HQ AFESClDEMM
Technical Operations Division
Tyndall AFB, FL 32403

Naval Facilities Engineering Command
Code 18
200 Stovall Street
Alexandria, VA 22332

Commander, Atlantic Division
Naval Facilities Engineering Command
Norfolk, VA 23511

Commander, Pacific Division
Naval Facilities Engineering Command
FPO San Francisco 96610

Commander, Western Division
Naval Facilities Engineering Command
P.O. Box 727
San Bruno, CA 94066-0720

Commanding Officer, Northern Division
Naval Facilities Engineering Command
Philadelphia, PA 19112

Commanding Officer, Chesapeake Division
Naval Facilities Engineering Command
Building 57, Washington Navy Yard
Washington, DC 20374

Commanding Officer, Southern Division
Naval Facilities Engineering Command
P.O. Box 10068
Charleston, SC 29411

Commanding Officer
Naval Civil Engineering Laboratory
Port Hueneme, CA 93043

Commanding Officer
Naval Energy and Environment Support Activity
Code 112
Port Hueneme, CA 93043

Trade Associations and Industrial Sources

Aluminum Association
750 Third Avenue
New York, NY 10017

American Can Company
Americology Program
1660 L Street, N.W.
Suite 1007
Washington, DC 20036

American Iron and Steel Institute
1000 16th Street, N.W.
Washington, DC 20036

American Paper Institute
260 Madison Avenue
New York, NY 10016

American Petroleum Institute
Environmental Affairs
1801 K Street, N.W.
Washington, DC 20006

American Public Works Association
1313 East 60th Street
Chicago, IL 60637

Can Manufacturers Institute
1625 Massachusetts Avenue, N.W.
Washington, DC 20036

Continental Can Company
633 Third Avenue
New York, NY 10017

Glass Container Manufacturers Institute, Inc.
330 Madison Avenue
New York, NY 10017

International Paper Company
220 East 42nd Street
New York, NY 10017

Institute of Scrap Recycling Industries
1729 H Street, N.W.
Washington, DC 20006

Keep America Beautiful
99 Park Avenue
New York, NY 10017

National Can Corporation
Midway Center
5959 South Cicero Avenue
Chicago, IL 60638

National Canners Association
1130 20th Street, N.W.
Washington, DC 20036

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, N.W.
Suite 800
Washington, DC 20336

National Soft Drink Association
1100 16th Street, N.W.
Washington, DC 20336

National Solid Waste Management Association
Technical Director
1730 Rhode Island Avenue, N.W.
Washington, DC 20036

National Tire Dealers and Retreaders Association, Inc.
1343 L Street, N.W.
Washington, DC 20005

Society of the Plastics Industry, Inc.
250 Park Avenue
New York, NY 10017

U.S. Brewers Association, Inc.
1750 K Street, N.W.
Washington, DC 20006

APPENDIX F

ESTIMATION TECHNIQUES

An accurate estimation of the quantities of solid waste materials is fundamental to all aspects of solid waste management. Planning in collection, landfill, incineration, or resource recovery demands accurate estimates of the materials available. The techniques outlined here provide varying degrees of accuracy. The more precise the estimate must be, the more it will cost to obtain.

APPENDIX F

ESTIMATION TECHNIQUES

SOLID WASTE SURVEY PLANS

1. **Introduction**

The following plans are excerpts from the Logistics Management Institute Report, Measurement and Description of the DoD Solid Waste Problem, Project 8 (Interim Report) of March 1976, selected to familiarize the users of this document with four methods of accomplishing a solid waste survey: Plan A, Low Cost/Low Precision - No Measurement Study; Plan B, Low Cost/Low Precision Survey; Plan C, Medium Cost/Medium Precision Survey; and Plan D, High Cost/High Precision Survey.

Plan A uses information readily available on the installation or from published sources. It requires no field measurements and a minimum of expense. Plan B encompasses Plan A as a reference base, but requires measurements of solid waste weights on each of 15 collection days and visual estimates of the composition and container load-volume percentages. It is a low-cost plan because it utilizes collection personnel to record the data. Plan C also encompasses Plan A. A sampling schedule, which identifies individual or groups of similar waste-generating facilities, is constructed and implemented by a survey team for 20 collection-day measurements. Composition is determined by hand segregation and weight measurements. Plan C provides a higher level of waste measurement and is more expensive to conduct than Plan B. Plan D is similar to Plan C but the survey is conducted over four 20-day measurement periods with each 20-day measurement period taking place in a different quarter of the year.

2. **Low Cost/Low Precision - No Measurement Study (Plan A)**

a. Time Series Analysis, Step 1. Collect recorded monthly weight, container trips, or container load volumes of the solid waste disposed in the landfill or incinerator, plus the weight of scrap materials turned into the Defense Reutilization and Marketing Officer (DRMO), for the three most recent fiscal years. Determine if the data constitute a time series; if so, determine the secular trend and develop the seasonal index. Convert all container trip data to tons using a density factor of 82 pounds per cubic yard. If the loose-cubic-yard volume has already been adjusted for percent load (i.e., container 100, 75, 50, or 25 percent filled), convert to tons using a density factor of 180 pounds per cubic yard. Use the calculated trend and seasonal index of the time series analysis to forecast the monthly and yearly total of the solid waste tonnage for the current year. Use the trend to forecast the yearly totals for the next four fiscal years. Record, by month, the total weight and type of solid waste recovered through sales by the DRMO or volunteer efforts.

b. **Emission Variable Analysis**

(1) Step 2. Itemize the major solid waste generating facilities (or groups of facilities) and collect population, square footage, and

other pertinent emission variable data. Construct similar tables for each year of interest. For future years the estimates of the variables are restricted to the major categories of Family Housing, Troop Support, Industrial Activities, and Total Installation.

(2) Step 3. Using the average emission factor values of Table F-I and the models of Table F-2, calculate estimates of the solid waste generated.

(3) Step 4. Compare the total solid waste weights calculated in Steps 1 and 3. If there is wide variation between the estimated weights for the most recent year of recorded data, adjust the emission factor estimates of Step 3 to close agreement with the weights determined by Step 1. The Step 1 weight is based upon volume measurements of the particular installation, while the emission factor estimates were derived from composite measurements of other installations. Once adjusted, the Step 3 estimates, which reflect the installation's activity levels, shall be used to forecast the solid waste of future years.

(4) Step 5. The weights derived through Step 4 can be converted to component values by multiplying the estimated installation weights by the pertinent composition percentages of Table F-3.

3. **Low Cost/Low Precision Survey (Plan B)**

Plan B consists of the no measurement" study of Plan A combined with a limited (15-day) waste source survey. Approximately 90 percent of the staffing will be composed of supervisory personnel (GS-11 or equivalent). The 15 days of weight measurements will provide a quarterly estimate of the mean weight with a precision close to plus or minus 10 percent of the mean, with a confidence level of 0.8. It will not be possible to provide a confidence level of the composition estimates as they rely on visual approximations.

a. No-Measurement Analysis, Step 1. Complete the five-step analysis of Plan A. The estimates of the aggregate solid waste weight and component weights will be used as a reference base to afford comparisons with the measurement (weighed) values.

b. Limited Solid Waste Survey

(1) Step 2. The survey supervisor develops a system for identifying the collection vehicles and the solid waste generating sources (by building or groups of similar buildings). The survey supervisor, after consulation with collection personnel, constructs a collection and weighing schedule for each day of the two-week survey. Since the collection personnel will do all of the data recording, only minor modifications shall be made to the existing collection schedule. A protocol, covering the various steps of the solid waste survey, is constructed by the survey supervisor and explained to the collection personnel, along with instructions on filling out a collection card and weigh card.

TABLE F-1. Military Solid Waste Quantity Emission Factors by Facility Type

Code	Waste Source	Pounds/1000 sq ft/day		Pounds/employee-(resident)/day		Other		
		USN	USAF	USN	USAF	USN	USAF	
	Type 0 Waste							
610	Office	7.3	10	1.5	1.5			
	Office	17.8	7.4		1.8			
	Business	39.4	8	11.1	4.3	(600	20	Pounds/$1000 sales/day)
740	Service Station		63					
171	Classroom	3.3	8	0.8	3.7			
	Classroom	3.3	3.3					
440	Storehouse	23.7	5	8.8	12.0			
	Storehouse	10						
440	Warehouse-Transfer		3.3					
	Transfer & Pack		31					
210	Maintenance	13.2	2	5.4	1.6			
	Maintenance	15.6						
	Jet Engine Shop		4.8					
	Electronic Shop		8.2		1.7			
	Machine Shop		7.4		2.4			
	Aircraft		17.5					
220	Production	22						
	Munitions - General		21		4.4			
740	Community Facilities		9		12.5			
	Community Facilities		4.7					
	Field House		20					
141	Operational	15						
150	Piers & Wharves	150		5.1				
310	R&D	3.3						
	Type 1 Waste							
740	Commissary	63	121	28.4	10.1	(90	80	Pounds/$1000 sales/day)
	Commissary		74					
	Exchange		200					
510	Hospital	9	12	1.9	2.5		(2.6	Pounds/meal/day)
	Hospital	9	12					
540	Dental Clinic	9						
550	Dispensary		9.1		1.9			
720	Barracks (No Mess)		4	0.31	0.8			
	Barracks (No Mess)	1.7	4		0.3			
	Type 2 Waste							
710	Family Housing	10	10	3.5			(3.3	Pounds/capita/day EPA)
723	Bachelor Housing	7						
730	Stockade		5.3					
	Type 3 Waste							
722	Mess Hall	74.7	60	22.8	30	(0.6	0.92	Pounds/meal/day)
	Mess Hall		60					
740	Clubs	20.3	60	5.85	30	(1.2		Pounds/meal/day)
	Officer	14						
	CPO	42.7						
	Aggregate Installations					(4.6 - 9.3		Pounds/capita/day)

TABLE F-2. Models of Solid Waste Generation Rates Based on Military Facility Emission Variables

Code	Waste Source Generation Rate in Pounds/Day	Emission Variables	R*	F‡	No. Observ.	Comments
	Type 0 Waste					
610	Administrative Building	66 + 0.01 (No. Employees)	0.55	16.0	15	Category may be too broad; "Square Footage" variable N.S.; low R
440	Storage-Covered	434 + 0.0 (No. Employees) - 3.1 (1000's square feet)	0.75	33.4	25	"Sq. Ft." variable sign negative; data includes a commissary
210	Maintenance	200 + 2.1 (No. Employees)	0.62	15.1	16	"Sq. Ft." variable N.S.; dummy variable for Navy vs. Air Force facility N.S.
	Type 1 Waste					
740	Commissary	-1292 + 53 (1000's Square Feet) + 74 (1000's $ Sales/Day)	0.97	56.4	6	Three degrees of freedom; negative constant term; "No. Employees" variable N.S.
740	Main Exchange	-784 + 15 (No. Employees)	0.997	302	3	One degree of freedom; negative constant term
610	Hospital	-1065 + 25 (1000's Square Feet)	0.93	64.7	7	"Meals Served/Day" and No. Beds" variables N.S.; negative constant term
720	Bachelor Housing	12 + 0.52 (No. Residents)	0.64	15.0	11	"Sq. Ft." variable N.S.; grade structure not measured
	Type 3 Waste					
720	Mess Halls	-60 + 1.2 (Meals Served/Day)	0.95	60.1	7	"Sq. Ft." variable N.S.; negative constant term
	Type 1-3 Waste (Non-Military)					
	Clothing, Hardware and Restaurants (Pounds/Week)	-197.29 + 5.20 (No. Hours Open/Week) + 19.36 (No. Employees)	0.70	--	81	81 observations of 32 stores summer of 1967; dummy variables for Clothing, Hardware, and Restaurants N.S.; emission variables "No. Business Days Open/Week," "Average Annual Gross Receipts," "Square Footage," "Average Inventory $," "Equipment Value in $," and "No. Delivery Days/Week," N.S.
	Drug Stores (Pounds/Week)	-349.25 + 5.20 (No. Hours Open/Week) + 19.36 (No. Employees)				
	Grocery Stores (Pounds/Week)	31.46 + 5.20 (No. Hours Open/Week) + 19.36 (No. Employees)				

* A correlation coefficient which is a measure of the fit of the mathematical expression to the observed data. R is a number between 0 and 1. If R=1 the fit is "perfect."

test statistic which is a frequency distribution of a ratio of the ... es of two populations. Its computed value when compared ... standard statistical tables, gives another measure of how appropria ... mathematical model is for describing the real observations.

TABLE F-3
Composition of Solid Waste by Weight Percentage

MIL. SER.		PAPER	CARDBOARD	SUBTOTAL PAPER	WOOD	VEGETATION	PLASTIC	RUBBER/LEATHER	TEXTILES	FOOD WASTE	FERROUS METALS	NON-FERROUS METALS	SUBTOTAL METALS	GLASS/CERAMICS	INERTS AND MISC.
							TYPE O WASTE								
N	OFFICE			87	3	11	2	4	1	4			6	1	3
N	BUSINESS			83	6		3			5			2		1
A	ADMINISTRATIVE	70	2	72			3		1	10			8	3	3
A	ADMINISTRATIVE	43	16	59		10	8		1	6	6	2	8	8	
N	CLASSROOM			68	6	4	3	1	1	3			6		7
N	STOREHOUSE			57	22		2	1	1	2			2	2	11
N	MAINTENANCE			55	11	2	2	9	4				6	1	10
A	WAREHOUSE	23	52	75			12		2	3	4	1	5	1	2
A	INDUSTRIAL	14	22	36	31		6		4		19		19	4	
A	INDUSTRIAL	15	16	31			10	1	9	2			13	8	28
A	RECREATIONAL	27	31	58		1	7		4	9	19	4	13	8	
A	OFFICES, SCHOOLS			58		15	2	3	2	5	8	1	9	5	
							TYPE 1 WASTE								
N	COMMISSARY			85	6		2			5			2		1
A	COMMISSARY	11	61	72	14		2			8				1	3
A	COMMISSARY			58		23	4			8	7		7	1	
A	EXCHANGE	8	62	70			4			12	4		4	6	3
N	HOSPITAL			78	1	5	6		2				1	2	5
N	LAUNDRY			81			3	3					5		8
N	BARRACKS (NO MESS)			54	4	11	2	2	1	17			7	1	2
A	QUARTERS (NO MESS)	29	22	51	1		5		1	5	13	2	15	16	6
AF	E.M. HOUSING			47		7	3		8	7			12	14	
							TYPE 2 WASTE								
A	FAMILY HOUSING	29	7	36		20	4		1	15	5	2	7	9	9
A	FAMILY HOUSING	42	2	44			4		3	19			11	13	6
A	FAMILY HOUSING			57		10	1	3	5	5	9	2	11	9	
AF	FAMILY HOUSING	63	6	69		6	7		6	2	6	1	7	2	
AF	NCO & OFCR. QUARTERS			56		4	4		6	11			9	8	3
							TYPE 3 WASTE								
N	MESS HALL			62		9	4			18			6		2
A	MESS HALL			49		21	1	1		7	13	1	14	6	
A	DINING	11	18	29			6		1	43	10		10	8	1
A	DINING (EXCLUDING SOLD GARBAGE)	17	26	43			9		3	17	14		14	12	1
N	CLUB			46	9	2	3		4	21			5	12	3
A	CLUB			27		29	1		1	5	8	1	9	29	
							TYPE 0-3 WASTE								
A	INSTALLATION	28	19	47	1	9	6		1	11	7	1	8	9	7
A	INSTALLATION			56		14	2	2	3	5	9	1	10	7	
AF	INSTALLATION	34	14	48	3	6	4		3	12	8		8	2	17
AF	INSTALLATION			58	7	4	4		2	8			10	3	2
N	INSTALLATION			57	17		9		5				8		3
							MUNICIPAL SOLID WASTE NATIONAL AVERAGE, 1968								
	MUNICIPAL (MOIST BASIS)			43	3	12	2	1	3	13			9	9	7
	MOISTURE CONTENT			20	15	49	12	7	20	49			5	2	5
	ADJ. MUNICIPAL (DRY BASIS)			44	3	8	2	1	3	3			11	12	8
							MUNICIPAL SOLID WASTE GENERATION BY MATERIAL AND SOURCE, 1971								
	MUNICIPAL (AS GENERATED)	19	12	31	4	19	3	3	1	18	9	1	10	10	1
	MUNICIPAL (AS DISPOSED)	23	15	38	4	15	4	3	2	14			10		2

(2) Step 3. A collection card is filled out by the truck driver for each refuse container collected during a collection run.

(a) Date -- month, day and year.

(b) Can Size -- circle volume units.

(c) Building Number -- according to method approved by survey supervisor.

(d) Truck Identification -- according to method approved by survey supervisor.

(e) Run Number -- circle number which corresponds to the load of the day.

(f) Load Type -- circle number which corresponds to the predominant refuse type in the container; if none can be determined, circle mixed refuse. Unusual waste materials included in an otherwise homogeneous waste load shall be noted under the "other" category (e.g., motor block in a container full of wood scraps would be reported as a load type 2, 8-motor block).

(g) Load Volume -- circle number which best approximates the volume of waste in a container. The "no load" category is used only when investigating the waste production of a particular building or group of buildings. All conditions must be reported.

(h) Weather -- circle number which best describes the predominating weather for the run. Intermittent drizzle or snow flurries shall be reported as "dry."

(3) Step 4. A weigh card is filled out by the truck driver at the end of each trip to the landfill or incinerator. The survey supervisor will arrange for the scale operator to fill out similar weigh cards on all non-scheduled truck loads arriving at the landfill. The survey supervisor will collect information on truck capacities and composition ratios. Each collection truck driver will supply the following information on the weigh cards:

(a) Date -- month, day and year.

(b) Truck Identification -- according to the method approved by the survey supervisor.

(c) Run Number -- circle number which corresponds to the number of loads for that day.

(d) Loaded Weight -- the weigh master or truck scale operator will supply the loaded weight values to be entered in this blank.

(e) Load Type -- circle the numbers of the major components of the load and visually estimate the volume percentage of all load

types composing over 20 percent of the load. The mixed refuse category shall be used when no predominating load types can be identified.

(f) Load Volume -- circle the number which best approximates the volume of the load in the truck. "No bad" is used to record the empty weight of the truck and driver.

(g) Weather -- circle the number which best describes the predominating weather for the run. Intermittent drizzle or snow flurries shall be reported as "dry."

(h) After the weigh card is completed, the driver initials the bottom line and bands together that run's weigh card with the appropriate collection cards. At the end of the day, the driver turns in that day's information card bundles to his route supervisor who forwards the material to the survey supervisor.

b. Single Waste Stream Analysis, Step 5. Sort the collection cards by building number(s) and place them in chronological order. The loose yardage volume generated between collections is determined by multiplying the can size by the percentage of load volume. An approximate value of the collected weight is determined by multiplying the loose yardage volume by the appropriate bulk density values. Composition of the single waste stream is determined from the "Load Type" section on the collection card, or by using composition percentages. If a collection run is confined to a particular facility grouping (as family housing), the appropriate weigh card can be isolated and used to provide weight, volume and composition information.

c. Installation Total Waste.

(1) Step 6. The volume and weight estimates, derived from the analysis of the collection cards in Step 5, are summed over all the "single waste streams" to provide total weight and volume estimates on the collection points. Sum the net weights (loaded weight minus no load) from the weigh cards to arrive at the total collected weight. The loose yardage volume of each compactor truck is determined by multiplying the compactor's capacity by the load volume (percent) and the compaction ratio. Multiply non-compactor truck capacities by the load volume (percent). Sum the calculated volumes of all collection runs to determine the total volume. The bulk density of each collection run, or total installation waste, can be determined by dividing the net weight by the loose-cubic-yard volume. "Composition" information can be obtained from weigh cards by converting load type volumes to load type weights, and dividing by the sum of the adjusted refuse weights for all collection trucks. Load type weight is determined by multiplying load type volume by the appropriate load type bulk densities. Component weights of the solid waste materials can also be derived by multiplying the total weight by the installation composition percentages.

(2) Step 7. As a check on the survey operation, make preliminary calculations of the weights and volumes (as per Steps 5 and 6), using

data from the first two days of the survey, and compare the estimates derived independently from the collection cards, the weigh cards, and the no-measurement analysis of Plan A.

(3) Step 8. Revise the estimates of Plan A using the estimates derived from the two-week, limited solid-waste survey and present the historical and forecasted results.

4. **Medium Cost/Medium Precision Survey (Plan C)**

Plan C combines the no-measurement study of Plan A with a survey which entails 20 contiguous days of weight measurements of the installation's waste streams, and the physical segregation and weighing (for composition analysis) of three 100- to 200-pound samples of solid waste generated by each of the various facilities on the installation. Effective implementation of the Plan C survey shall result in an estimate of the installation's mean daily waste generating rate for the encompassing quarter with a 0.9 level of confidence and an error plus or minus 10 percent of the mean. Estimates for the year, or other periods outside the sample quarter, can be accomplished through revision of the Plan A estimates based on the weight measurements. Three 100-to 200-pound randomly selected samples from each solid waste emission source (building or group of similar buildings) shall provide estimates of the component proportions with at least 0.9 confidence levels and errors of plus or minus 10 to 30 percent of the fraction means.

a. No-measurement Analysis, Step 1. Repeat the steps of the "no-measurement" Plan A analysis described in Plan A, paragraph F.2.

b. Medium Cost/Medium Precision Survey.

(1) Step 2. The survey supervisor designs the survey and prepares an implementation protocol. To ensure coordination and control, the survey supervisor shall be located on the installation for the duration of the survey. The major tasks to be accomplished in the preparation of the protocol are as follows:

(a) Identify collection containers, waste generating sources (buildings), collection routes and disposal points on a map of the installation.

(b) Group the buildings and their containers by the major waste source categories (Family Housing, Troop Support, Industrial Activities) and subcategories.

(c) With the assistance of the collection supervisor, restructure the collection routes so that each truckload contains a single-source category of waste. Arrange for the return of each dumpster to its initial collection location. Set up a special collection team to collect the waste from those buildings which do not fall into a collection-run category.

(d) Designate a weighing station location (preferably at the main sanitary landfill) and instruct all facility managers that loaded solid waste trucks must have their loads and tare weights weighed and recorded by the survey truck-scale reader.

(e) Arrange for the special collection team to make daily stops to weigh the garbage at dining facilities with wet garbage contracts.

(f) Arrange for an enclosed space in which the composition team can segregate and weigh the composition samples.

(g) Arrange for the provision of necessary equipment:

- A pickup truck to collect plastic bags from designated buildings and the landfill. Note: If the contractor will not cooperate in collecting containers, a small dump truck will be required instead of a pickup.
- Portable, calibrated, truck scales (two each with 20,000-pound capacities).
- Bathroom scales (two) for weighing garbage at dining facilities.
- Plastic bags and tags for distribution by the special collection team.
- Two broad-mouth shovels and two rakes for mixing and quartering the refuse selected for composition analysis.
- Weighing scale for incinerator operators.
- Plastic bags and tags for transporting refuse from the landfill to the composition analysis location.
- Large table (6 x 4 feet) for composition analysis
- Fifteen 32-gallon containers for composition analysis.
- Weighing scale to weigh components (200-pound capacity).
- Broom, brush, and pan for cleanup after composition analysis.
- Liquid disinfectant detergent for cleaning up after composition analysis.
- Approximately six to ten pairs of reinforced neoprene gloves for sanitation purposes during composition analysis.
- Protective clothing (shoes, glasses and coveralls; four pairs each).

c. Weight and Volume Measurements, Step 3. Construct a daily schedule for the special collection team indicating which containers (including solid wet garbage) to weigh. If the weighing is accomplished by the team at the collection point, the data (excluding Load Type information) can be recorded on the collection cards. If the loaded truck is weighed, a weight sheet shall be used to record the data. All truckloads of solid waste traveling from the

installation facilities to final destinations must be weighed and measured for percent fillage, preferably at a central truck-scales location. The data shall be recorded on a weight sheet. It is assumed that each truckload of solid waste, as a result of Step 2 (b) and (c) can be identified with a particular installation building or grouping of similar buildings.

d. Composition Sampling.

(1) Step 4. Construct a daily schedule indicating which truck-loads, scheduled for disposal, are to be sampled for composition analysis. Truckloads to be sampled shall be randomly selected to ensure that each waste source stream (building or grouping of similar buildings) will have three 100- to 200-pound samples taken over the 20-day sampling period. The collection supervisor shall arrange to have the preselected truckloads delivered to the landfill (or point of sample collection) as soon as the regular daily collection runs begin. After each selected truckload is weighed at the truck-scales location, the load is dumped. The composition team rakes the pile to obtain an even distribution of the components and then subdivides the pile into 100- to 200-pound portions. A portion is randomly selected (using numbered slips drawn from a hat), bagged and tagged with proper identification. After the scheduled number of loads is sampled, the bags are brought to the segregation site. Each composition sample is then segregated by hand into component parts which are weighed. The data are recorded on composition sheets.

(2) Step 5. After two days of collecting weight, volume, and composition data, make preliminary calculations of the weights, volumes, and compositions of the facility waste streams and check these values against the estimates derived by the no-measurement analysis of Plan A (Step 1, paragraph F.2). Revise the survey procedure where necessary.

(3) Step 6. On completion of the 20-day survey, compile the recorded data, make the necessary calculations, and present the results.

(4) Step 7. Revise the monthly and yearly forecasts of Plan A using the estimates derived in Step 6.

5. **High Cost/High Precision Survey (Plan D)**

Plan D consists of the "no-measurement" study of Plan A, combined with the repeated application of the Plan C survey (20 contiguous days of weight, volume, and composition measurements) in each quarter of the year. Over a twelve-month period the installation's total waste stream, and the waste streams from the major solid waste generating sources (buildings or groups of buildings), will undergo 80 days of weight and volume measurements. Twelve 100- to 200-pound composition samples will be analyzed for each generating source. A survey of this scope shall result in estimates with errors less than plus or minus 10 percent of the mean weight with a 0.9 confidence level, for each quarter and the year. A similar level of precision shall hold for estimates of the solid waste components. The derived estimates can be used to determine the secular trend of the installation's waste-growth and a seasonal determine the secular trend of the installation's waste-growth and a seasonal index of the solid waste pattern. Factors for converting collection volumes to weights, and emission factors that associate solid waste generation rates

with facility activities (personnel levels, floor space, etc.) can be accurately determined. The goal of the survey is to enable the installation to construct models of its solid waste streams. The models can be used to forecast the levels of composition of future waste streams. The installation will, of course, be interested in the historical data on the solid waste operation, but, in making decisions on waste reduction and resource recovery, its primary interest will concern the future nature of the solid waste streams.

a. No-Measurement Analysis, Step 1. Complete the five-step analysis of Plan A (paragraph F.2). The no-measurement estimates of the activity solid waste streams and component weights will be used as a reference base to afford comparisons with the measured (weighed) values.

b. High Cost/High Precision Survey.

(1) Step 2. Perform Steps 2 through 7 of Plan C for the first quarter's survey. The four 20-day survey periods shall start approximately 91 days apart, but two of the survey periods shall be scheduled within, or bridging, months of high- and low-generation rates. If the seasonal pattern is expected to be different for the year surveyed, randomly select a starting month, and then schedule the remaining three 20-day survey periods to start every 91 days.

(2) Step 3. Repeat Step 2 for each of the remaining quarterly surveys. The protocol of Step 2 can be reused, with the exception that new schedules for composition sampling (Step 4 of Plan C) shall be constructed to avoid inadvertent bias.

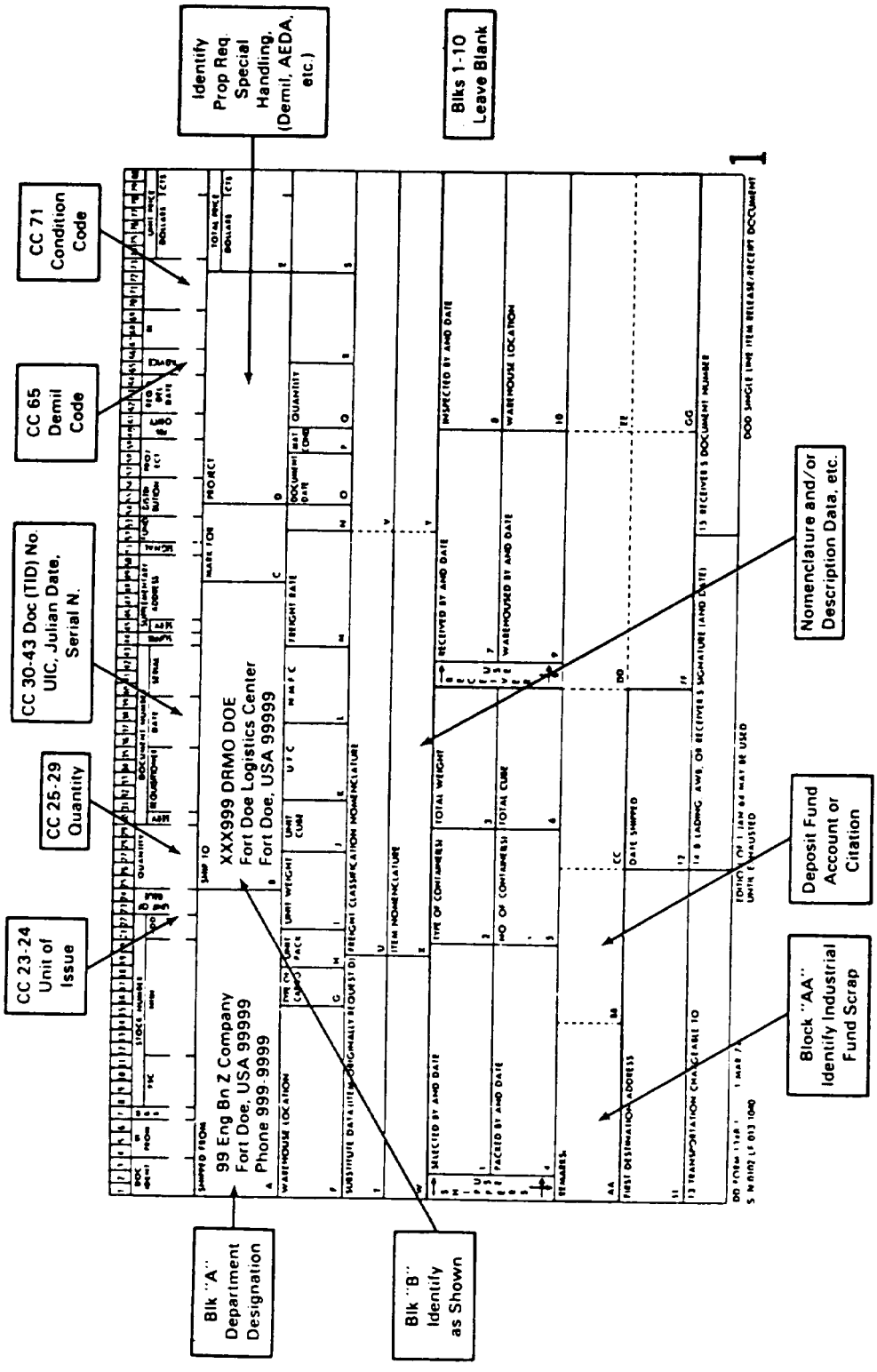
APPENDIX G

SAMPLE FORMS

The enclosed forms relate to Resource Recovery Operations. The first form shows information required on DD1348-1 for turning in scrap materials to DRMO. The second page gives explanations of what belongs in various columns of the form.

The second form shows a sample tracking sheet which allows installations to monitor their shipments to DRMO. The form is set up so computer tracking on a PC is reasonably straightforward if all the items are entered into a database.

The last form is a simple balance sheet for RRRP activities. It shows simply and quickly the financial status of an operation.



SCRAP AND WASTE TURN-IN

CC 1-22	Leave Blank.
CC 23-24	Unit of issue - pounds, tons, or troy ounces.
CC-25-29	Weight being turned in.
CC 30-43	Document number. Perpetuate from source document for locally determined excesses generated at base, post, camp, or station. Assign a document number as determined by service/agency procedures.
CC 44	Leave blank.
CC 45-50	Supplementary address. Enter DODAAC of predesignated consignee DRMO.
CC 51-61	Leave blank.
CC 62-64	Effective transfer date. Date dropped from accountable records or leave blank.
CC 65	Demilitarization code. Code assigned as required by DoD 4160.21-M-1. When demilitarization has been accomplished prior to transfer to a DRMO, the appropriate demil certification must be reflected in blocks W-Y.
CC 66	Leave blank.
CC 67-69	Routing Identifier Code. Perpetuate from Disposal Release Order.
CC 70	Ownership code. Enter applicable code or leave blank.
CC 71	Supply Condition Code.
CC 72	Management Code. Perpetuate from source document or leave blank.
CC 73-80	Leave blank.

Block A	The shipping point identified by name and/or DODAAC.
Block B	The predesignated consignee DRMO by DODAAC name and address.
Block C	Enter information if applicable.
Block D	Identify property requiring special handling by disposal. These categories are not readily identified by individual nomenclature and must be entered "in the clear" in this block. Examples: - Contractor Inventory - Foreign Equity Property - Industrial Fund Property - Radioactive Material - Red Cross Property - Redistributable MAP Property - Shelf-Life Property - Exchange/Sale Property - Nonappropriated Fund Property
Block E	Leave blank.
Block F	The location from which material is to be selected, if required by the shipper.
Block G	Coded cargo data, if required by the shipper.
Blocks H-J	Leave blank.
Block K	Uniform Freight Classification, if required by the shipper.
Block L	National Motor Freight Classification, if required by the shipper.
Block M	Freight weight, if required by the shipper.
Block N	Leave blank.
Block O	Date of document preparation, if required by the shipper.
Block P	Leave blank.

Block Q	Weight actually transferred to DRMO, if different from CC 25-29.
Blocks R-U	Leave blank.
Block V	Enter mode of shipment code.
Blocks W-Y	Basic materiel content and specified additive data or certification required from the generating source for specific types of property should be entered in these blocks or attached.
Blocks 1-10	Leave blank.
Block AA	Leave blank.
Blocks BB-EE	Enter appropriation citation to be credited with the proceeds from sale or transfer when reimbursement to a specific fund other than the DLA Deposit Fund Account is authorized. Leave blank if sale proceeds are to be deposited to the DLA Deposit Fund Account.
Blocks FF-GG	Leave blank.
Blocks 11-15	Leave blank.

DATE MONTH	MWR APF RESOURCE, RECOVERY, AND RECYCLING TURN-IN TRACKING CHART												
	ITEM DESCRIPTION	DD FORM 1348-1 DOCUMENT NO.	QTY.	UNIT OR ORG.	DATE TO DMRO	DRMO SALE PRICE	DRMO SALE DATE	DATE DIS. TO BASE	DIST. AMOUNT	% TO UNITS ORG.	TO UNIT ORG.	TURN-IN UNIT MONITOR SIGN.	INCOME VERIFIED BY UNIT MONITOR

SAMPLE

RESOURCE RECOVERY, AND RECYCLING PROGRAM (RRRP)
NAF ECONOMIC QUARTERLY REPORT

Reporting Period Dates: _____

Quarterly Total Income: _____

Year-to-Date Total Income: _____

Quarterly Operating Costs: _____

Quarterly Total MWR Projects Funded/Type/Cost

Funded: _____ Type: _____ Cost: _____

Type: _____ Cost: _____

Type: _____ Cost: _____

Total Cost: _____

Total Percentage Reimbursements: $_____

Problem Areas:

a.

b.

c.

OPR: _____ Date Prepared: _____
(Organization)

OPR Monitor: _____
(Print name/rank)

_____
(Signature)

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Laws, Regulations and Directives Pertaining to Solid Waste

Military installations are required to comply with all federal, state, and local waste disposal regulations for the area in which they operate. Additional branch regulations may also apply.

Applicable federal solid waste guidelines and regulations include:

EPA Guidelines for the Land Disposal of Solid Wastes	(40 CFR 241)(1)
EPA Guidelines for Thermal Processing of Solid Wastes	(40 CFR 240)
EPA Guidelines for Solid Waste Storage and Collection	(40 CFR 243)
EPA Guidelines for Resource Recovery Facilities	(40 CFR 245)
EPA Guidelines for Procurement of Products that Contain Recycled Material	(40 CFR 247)
EPA Guidelines for Identification of Regions and Agencies for Solid Waste Management	(40 CFR 255)
EPA Guidelines for State Solid Waste Management Plan	(40 CFR 256)
EPA Regulations on Criteria for Classification of Solid Waste Disposal Facilities and Practices	(40 CFR 257)
EPA General Regulations for Hazardous Waste Management	(40 CFR 260)
EPA Regulations Identifying Hazardous Waste	(40 CFR 261)
EPA Requirements upon Generators of Hazardous Waste	(40 CFR 262)
EPA Requirements upon Transporters of Hazardous Waste	(40 CFR 263)
EPA Requirements upon Owners and Operators of Permitted Hazardous Waste Facilities	(40 CFR 264)
EPA Interim Status Standards	(40 CFR 265)
EPA Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilties	(40 CFR 267)
EPA's Permitting Procedures	(40 CFR 270)
Interface of RCRA Regulations with State Programs	(40 CFR 271)
EPA Regulations on Polychlorinated Biphenyls Manufacturing Processing, Distribution in Commerce, and Use Prohibitions	(40 CFR 761)

Solid Waste Disposal Act of 1965	(42 USC 3251)
Resource Conservation and Recovery Act of 1976	(42 USC 6901, et seq.)(2)
Clean Water Act	(33 USC 1251, et seq.)
Toxic Substances Control Act	(15 USC 2601, et seq.)

(1) 40 CFR 241 = Title 40 Part 241 Code of Federal Regulations
(2) 42 USC 6901 = Title 42 United States Code, Section 6901

Department of Defense Publications

MI L-R-2395C, MIL-R-22827C	Refuse Containers, Hoisting Units
MIL-STD-105D	Sampling Procedures and Tables for Inspection by Attributes
DoD 81-4	Department of Defense Management of Polychlorinated Biphenyls (PCBs) and PCB Items Overseas (Defense Environmental Quality Program Policy Memorandum)
DoD 4100.33	Commercial Activities
DoD 4140.7-M	Military Standard Requisitioning and Issue Procedures
DoD 4160.17-M	Standard Procedures for Preparation of a DTID
DoD 4160.21	DoD Directive Personal Property Utilization and Disposal
DoD 4160.21-H	Defense Scrap Yard Handbook
DoD 4160.21-M	Defense Reutilization and Marketing Manual
DoD 4165.60	Solid Waste Management - Collection, Disposal, Resource Recovery and Recycling Program
DoD 5030.41	Oil and Hazardous Substances Pollution Prevention and Contingency Program
DoD 5100.50	Environmental Protection and Enhancement
DoD 7040.4	Military Construction Authorization and Appropriation
DoD 7220.9-M	DoD Accounting Manual
PL 97-214	Military Construction Codification Act

Army Publications

AR 40-5	Medical Services Preventive Medicine
AR 40-573	Disposal of Infectious Wastes
AR 40-580	Disposal of Toxic Wastes
AR 200-1	Environmental Quality Environment Protection and Enhancement
AR-200-2	Environmental Effects of Army Actions
AR 235-1	Contracting for Refuse Services
AR 420-17	Real Property and Resource Management
AR 420-47	Solid and Hazardous Waste Management
AR 420-76	Pest Control Services
AR 420-83	Maintenance and Services Equipment and Facilities Engineering
AR 755-380	TAMMAS 38-750, Army Maintenance Manual, the Maintenance Management System
TM 5-814-7	Hazardous Waste Land Disposal and Land Treatment Facilities
TM 5-634	Solid & Hazardous Waste Collection and Disposal
TM 5-814-5	Sanitary Landfill
TM 5-814-4	Incineration
TM 5-814-6	Industrial Wastes

Air Force Publications

AFM 67-1	Volume II Part Two, Section 20 Reclaimed Fuel
AFM 91-11	Solid Waste Management
AFP 19-5	Environmental Quality Control Handbook
AFP 85-11	Financial Management Guide
AFR 19-1	Pollution Abatement and Environmental Quality
AFR 19-2	Environmental Impact Analysis Process (EIAP)
AFR 19-11	Hazardous Waste Management and Minimization
AFR 19-14	Management of Recoverable and Waste Liquid Petroleum Products
AFR 88-15	Section G Solid Wastes
AFR 177-102	Commercial Transactions at Base Level
AFR 400-28	Base Level Service Contracts, Volume I

Navy Publications

NEESA 5-010	Guide for Developing a Recyclable Materials Sales Program
NEESA 20.2-001H	Directory of Federal Contacts on Environmental Protection
Design Manual 5.10	Solid Waste Disposal, NAVFACENGCOM, Port Hueneme, California
TN No. N-1712	Phase II of the Waste Assessment Method for Navy Shore Activities, NAVFACENGCOM, Port Hueneme, California
TN No. N-1711	Solid Waste Management Options for Naval Installations on Guam, NORTHNAVFAGENGCOM
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GLOSSARY

AQUIFER - A subterranean geological formation of porous, water-bearing rock.

ASHES - The residue from burned wood, coal, coke, arid other combustible material.

AUDIBLE REVERSE WARNING DEVICE - An apparatus, usually in the form of a bell, which is activated by the motion of a vehicle's wheels operating in the reverse gear. It produces a loud, rhythmic sound warning both driver and bystanders (or other motorists) that the vehicle is operating in reverse.

BALER - A machine used to compress and bind solid waste or other materials.

BASKET-GRATE INCINERATOR - An agitated bed incinerator where refuse is burned in a perforated grate shaped like a truncated cone and rotated about its axis of symmetry.

BEVERAGE CONTAINER - An airtight metal, glass, paper, or plastic bottle, jar, can, or carton containing a beverage under pressure of carbonation. Cups and other open receptacles are specifically excluded from this definition.

Btu (British thermal unit) - The quantity of heat required to increase the temperature of one pound of water one degree Fahrenheit.

BUBBLE TAILGATE - A hollow, roughly hemispherical frame that can be attached to a compactor vehicle, thereby increasing its total effective capacity.

BUCKET ELEVATOR - A conveyor belt that utilizes a system of bucket-like containers to transport materials.

BULKY WASTE - Large items of solid waste such as appliances, furniture, trees, large auto parts, branches, stumps, and other oversized wastes whose large size precludes or complicates their handling by normal collection, processing, or disposal methods.

CHARGING HOPPER - An enlarged opening at the top of the incinerator through which waste materials drop into the combustion chamber.

COLLECTION - The act of removing solid waste from the central storage point of a primary source. Types of collection include:

Alley - The picking up of solid waste from containers placed adjacent to an alley.

Carryout - Crew collection of solid waste from an on-premise storage area using a carryout container, carrycloth, or a mechanical method.

Contract - The collection of solid waste carried out in accordance with a written agreement in which the rights and duties of the contractual parties are set forth.

Curb - Collection of solid waste from containers placed adjacent to a thoroughfare.

Setout/Setback - The removal of full and the return of empty containers between the on-premise storage point and the curb by a collection crew.

COLLECTION FREQUENCY - The number of occasions collection is provided in a given period of time.

COMPACTOR -

Mobile - A vehicle with an enclosed body containing mechanical devices that convey solid waste into the main compartment of the body and compress it.

Sanitary Landfill - A vehicle equipped with a blade and rubber tires sheathed in steel or hollow steel cores; both types of wheels provide a compaction and a crushing effect.

Stationary - A machine that reduces the volume of solid waste by forcing it into a removable container.

COMPACTION RAM - An apparatus, usually hydraulically (or pneumatically) operated, whose function is the compression or compaction of waste materials into a smaller volume. It is usually constructed of a high-grade steel.

COMPACTION RATIO - The ratio of the solid waste volume prior to compaction to the volume after compaction.

CONSTRUCTION AND DEMOLITION WASTE - The waste building materials, packaging, and rubble resulting from construction, remodeling, repair, and demolition operations of pavements, residences, buildings, and other structures.

CONTROLLED-AIR INCINERATOR - A two-chamber incinerator where the first chamber is kept oxygen deficient and the second chamber is oxygen rich. The second chamber uses large amounts of clean fuel to complete combustion.

CORRUGATED CONTAINER WASTE - Discarded corrugated boxes.

CRAWLER TRACTOR - A vehicle that moves on metal treads (similar to those of an army tank) instead of rubber wheels. Also referred to as a bulldozer.

CRUSHER - Size reduction apparatus that operates by crushing material between a rotating and a stationary element. Units consist of either two rotating drums or a rotating wheel in contact with a stationary wall.

DEBRIS - Grass cuttings, tree trimmings, stumps, street sweepings, roofing and construction wastes, and similar waste material resulting from maintenance and repair work.

DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO) - The organizational entity having responsibility for and control over disposable property. A component of the Defense Logistics Agency.

DEMILITARIZATION - The act of destroying the military offensive or defensive advantages inherent in certain types of equipment or material. The term encompasses utilization, dumping at sea, scrapping, melting, burning, or alteration designed to prevent the further use of this equipment and material for its originally intended military or lethal purpose.

DISCARDING UNIT - Any organization or individual that places refuse materials or salvage at the pickup station for collection.

DISPOSAL - The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters including groundwaters.

DUMPSTER - A large container that serves as a depository for solid waste materials. When filled, the contents are dumped by mechanical means into a larger collection vehicle.

ENCAPSULATED - A method used in the disposal of hazardous substance which uses an impervious container made of plastic, glass, or other suitable material that will not be chemically degraded by the contents. This container then should be sealed within a durable container made from steel, plastic concrete, or other suitable material of sufficient thickness and strength to resist physical damage during and after burial or storage.

ENVIRONMENTAL IMPACT STATEMENT (EIS) - A provision of the National Environmental Policy Act of 1969 requires the preparation of an EIS for any proposed federal action significantly affecting environmental quality. An EIS is a statement that includes analyses of the (1) environmental impact of the proposed action, (2) alternatives to the proposed action, and (3) irreversible resource commitments that would result from the action.

FLAIL—MILL - A size reduction apparatus consisting of flexible arms rotating on an armature which break material by impact. The arms are generally light and will bypass large inert items.

FOOD WASTE - Animal and vegetable waste resulting from the handling, storage, sale, preparation, cooking, and serving of foods; commonly called garbage.

GARBAGE - Animal and vegetable waste and containers resulting from the handling, preparation, cooking, and consumption of foods. Edible, or hog-food, garbage is the portion of waste food that has been segregated for sal vage.

GROUNDWATER - Water present in the saturated zone of an aquifer.

HALOGENATED SOLVENTS - Defined in 40 CFR 264 - FOOl. Includes freon. Most halogenated solvents are considered hazardous wastes.

HAMMERMILL - A broad category of high-speed equipment that uses pivoted or fixed hammers or cutters to crush, grind, chip, or shred solid wastes.

HAZARDOUS WASTE - A solid waste or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

1. cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or

2. pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

HEAVY METALS - Metallic elements of higher atomic weights including, but not limited to, arsenic, cadmium, copper, lead, mercury, manganese, zinc, chromium, tin, thallium, and selenium.

HEURISTIC ROUTING - The direction and organization of collection vehicles* pickup paths based on previous experience and accepted rules of thumb. It is considered advantageous to computer (or deterministic) modeling in that heuristic routing is less time consuming and less costly.

HIGH—GRADE PAPER - Letterhead, dry copy papers, miscellaneous business forms, stationery, typing paper, tablet sheets, and computer printout paper and cards.

HYDRAULIC CONTINUITY - In direct contact with a water-bearing formation (aquifer) or body of water (pond or stream) with no flow interruptions.

INCINERATION - The process of burning refuse in an incinerator.

INFECTIOUS WASTE - (See Section 4.4)

1. equipment, instruments, utensils, and fomites of a disposable nature from the rooms of patients who are suspected to have or have been diagnosed as having a communicable disease and must, therefore, be isolated as required by public health agencies;

2. laboratory wastes, such as pathological specimens (for example: tissues, specimens of blood elements, excreta, and secretions obtained from patients or laboratory animals) and disposable fomites (any substance that may harbor or transmit pathogenic organisms) attendant thereto;

3. surgical operating room (pathological) specimens and disposable fomites attendant thereto, and similar disposable materials from outpatient areas and emergency.

KNIFE MILL - Size reduction apparatus where material is caught between fixed and rotating kr:ives located on an armature. Size reduction is by shearing.

MAGNETIC SEPARATOR - A device that removes ferrous metals by means of magnets.

MODIFIED CIRCULAR REGISTER BURNER - One of five common suspension fired burners that can be easily adapted for use in burning pulverized coal and fluff RDF in boilers.

OFFICE WASTES - Solid wastes generated in the building, room, or series of rooms in which the affairs of a business, professional person, branch of government, etc., are carried on, but excluding wastes generated in cafeterias or snack bars, or other food preparation and sales activities in those buildings.

OPEN DUMP - Any facility or site where solid waste is disposed of that is not a sanitary landfill meeting the requirement of RCRA Section 6944 and which is not a disposal facility for hazardous waste. RCRA includes a ban on open dumps and provides for state plans to identify and develop measures to eliminate health hazards and minimize potential health hazards associated with existing open dumps.

PAPER HOGGER - A device that reduces paper (by tearing) into small pieces and expels them into other waste handling components.

PELLETIZER - A device that compacts refuse-derived fuel (RDF) into small (pellet size) usable form.

PERCOLATE - To seep through a layer of porous material (layers of either earth or refuse). A liquid percolating through a layer of refuse material may become contaminated.

PERSONAL PROPERTY - Property of any kind or any interest therein, except real property and records of the federal government.

PICKUP STATIONS - Designated locations within the installation, where refuse and salvage are assembled and stored for collection.

PROCESS CHEMICALS - The chemical(s) remaining after or produced by a given industrial process (chrome plating, aluminum etching).

PROTECTIVE CLOTHING AND EQUIPMENT (AR 385-32) - Prescribes responsibilities, policy, and procedures for providing protective clothing and equipment.

PUSH PLATE - A large plate of thick steel located in a compactor truck whose function is to compact the waste materials deposited into it. Its function is analogous to the compaction ram in a stationary compactor.

PYROLYSIS - The chemical decomposition of a material by heat in the absence of oxygen.

QUEUE TIME - The time spent waiting in line or waiting to be serviced.

RABBLE ARMS - Short projections whose function is to break open bags or containers of refuse. They are usually located inside incineration equipment.

RFD - Refuse-derived Fuel - The burnable fuel that is the result of special processing of various types of solid wastes.

REAL PROPERTY - Lands, buildings, structures, utilities systems, improvements and appurtenances thereto. Includes equipment attached to and made part of building and structures (such as heating systems) but not movable equipment (such as plant equipment).

RECEPTACLES OR CONTAINERS - Cans, drums, bins, or similar receptacles, which can be handled easily, and multiple containers, which are handled by mechanical truck-mounted hoists.

RECOVERABLE RESOURCES - Materials that retain useful physical or chemical properties after serving a specific purpose and can, therefore, be reused or recycled for the same or other purposes.

RECYCLING - The process by which waste materials are transformed into new products in such a manner that the original products may lose their original form or appearance.

REFUSE - Garbage, ashes, debris, rubbish, and other domestic and commercial solid waste material. Not included are garbage or other salable material sold under contract and delivered to a buyer at point of generation; explosive and incendiary wastes; and contaminated wastes from medical and radiological processes.

REFUSE COLLECTION - A system of transporting refuse, including nonaccountable salvage, from pickup stations to points of disposal. (Includes hauling garbage to the transfer station which is required by the terms of a salvage contract.)

RESIDENTIAL SOLID WASTE - The food wastes, rubbish, and trash resulting from the normal activities of households.

RESOURCE RECOVERY - The recovery of material or energy from solid waste.

ROTARY-KILN INCINERATOR - A two-chamber incinerator whose primary chamber is a refractory-lined cylinder that rotates about its centerline.

ROUTE ELEVATIONS - Any hills or grades encountered in a given collection route. Route elevations are (when possible) located near the beginning of a given collection route.

RUBBISH - Rubbish consists of a variety of salvageable waste material such as broken glass, crockery, floor sweepings, paper, wrappings, containers, cartons and similar articles not used in preparing or dispensing food. Rubbish is further subdivided into: combustible rubbish, which can be burned readily in an incinerator, or noncombustibe rubbish, which cannot be burned at ordinary incinerator temperatures (800°F to 1800°F).

SAFETY SYSTEM ENGINEERING AND MANAGEMENT (AR 385-16) - Prescribes safety policies and responsibilities to ensure that hazardous materials on military installations are properly identified and associated risks properly managed.

SALVAGE OR SALABLE MATERIALS - Metal scrap, scrap lumber, crating materials, empty barrels, boxes, textile bags, waste paper, cartons, kitchen waste, and similar materials which are reclaimable or have sales value for basic material content. These items are processed through Defense Reutilization and Marketing Office (ORMO) and disposed of in accordance with Defense Reutilization and Marketing Manual (DoD 4160.21-M).

SANITARY LANDFILL - A facility for the disposal of solid waste which meets the criteria of Section 6944 of RCRA; i.e., there is no reasonable probability of adverse effects on health or the environment from disposal of solid waste at such facility.

SCAVENGING - The uncontrolled and unauthorized removal of materials at any point in the solid waste management system.

SCRAP - Discarded or rejected material or parts of material that result from manufacturing or fabricating operations and are suitable for reprocessing, but excluding paper, cardboard, newspaper, and all high-grade paper to be source separated in accordance with EPA solid waste guidelines.

SEGREGATION OF MATERIALS - The process of sorting refuse, debris, and salvage and placing the sorted materials in designated receptacles at the pickup station.

SLUDGE - Any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effects.

SOLID WASTE - Garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. Solid waste does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under 33 USC 402 of the Federal Water Pollution Control Act, or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954.

SOLID WASTE MANAGEMENT - The purposeful, systematic control of the generation, storage, collection, transport, separation, processing, recycling, recovery, and disposal of solid wastes.

SOLID WASTE STORAGE CONTAINER - A receptacle used for the temporary storage of solid waste while awaiting collection.

STORAGE OF HAZARDOUS WASTE - Containment of hazardous waste, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal. A generator may accumulate hazardous waste onsite for 90 days or less without a storage permit or without having interim status provided that the hazardous waste is stored in such a way as to meet the requirements of 40 CFR 262.34. A generator who accumulates hazardous waste for more than 90 days is an operator of a storage facility and is subject

to the requirements of 40 CFR 264 and 265, and the permit requirements of 40 CFR 122.

SPECIALLY DESIGNATED LANDFILL - Landfill at which complete long-term protection is provided for the quality of surface and subsurface waters from pesticides, pesticide containers, and pesticide-related wastes deposited therein, and against hazard to public health and the environment. Such facility complies with the Agency Guidelines for the Land Disposal of Solid Wastes as prescribed in 40 CFR Part 241.

STOKER - A mechanical device to feed solid fuel or solid waste to a furnace.

STREET WASTES - Materials picked up by manual or mechanical sweepings of alleys, streets, and sidewalks; wastes from public waste receptacles; and materials removed from catch basins.

TILT—FRAME VEHICLE - A vehicle whose chassis is designed to tilt downward toward the rear thereby facilitating the loading or unloading of a large container such as a roll-off container.

TRANSFER STATION - A site where solid wastes are concentrated from transport to a processing facility or land disposal site. A transfer station may be fixed or mobile.

TREATMENT OF HAZARDOUS WASTE - Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological characteristics or composition of any hazardous waste so as to neutralize such waste or so as to render such waste nonhazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume.

TRIPLE RINSE - The flushing of containers three times, each time using a volume of the normal diluent equal to approximately 10% of the container s capacity, and adding the rinse liquid to the spray mixture or disposing of it by a method prescribed for disposing of the pesticide.

TROMMEL (rotary screen) - An inclined, meshed cylinder that rotates on its axis and screens material placed in its upper end.

UNIFORM HAZARDOUS WASTE MANIFEST - 40 CFR Part 262 Appendix - Uniform Hazardous Waste Manifest and Instruction (EPA Forms 8700-22 and 8700-22A) must be completed before transporting hazardous waste or offering hazardous waste for transport off the site of generation.

USABLE PROPERTY - Commercial and military type property other than scrap and post-consumer waste.

USED OIL - Any refined oil which, through use, is contaminated by physical or chemical impurities. RCRA places special emphasis on the recycling of used oil (PL 96-463, 1980).

VECTOR - A carrier, usually an arthropod, that is capable of transmitting a pathogen from one organism to another.

VIBROELUTRIATOR - A dry classifier that is used to separate a light fraction from a heavy fraction. The material on a screen is vibrated while an air stream moves past the screen. The light fraction is removed by the air stream while the heavy fraction falls from the bottom of the moving air column.

WET CYCLONE SCRUBBER - A device designed for the removal of air-suspended particulates.

WHITE GOODS - Discarded kitchen and other large, enameled appliances such as refrigerators and freezers.

ACRONYMS

AAFES - Army and Air Force Exchange Service
AF - Air Force
AFB - Air Force Base
AFM - Air Force Manual
AFR - Air Force Regulation
AIChE - American Institute of Chemical Engineers
ANSI - American National Standards Institute
API - American Petroleum Institute
AQL - Acceptable Quality Level
ARS - Agricultural Research Service
ASTM - American Society for Testing and Materials
BACT - Best Available Control Technology
BMP - Best Management Plan
CA - Commercial Activities
CDC - Centers for Disease Control
CDR. - Contract Discrepancy Report
CERCLA - Comprehensive Environmental Response, Liability Act
CFR - Code of Federal Regulations
COR - Contracting Officer's Representative
CR - Change Recommendation
CSI - Component Sponsored Investment
CSIP - Component Sponsored Investment Program
CWA - Clean Water Act
DA - Department of Army
DCAS - Defense Contract Administration Services
DCASPRO - Defense Contract Administration Services Plan Representative Offices
DCASR - Defense Contract Administration Services Region
DEH - Directorate of Engineering and Housing
DEQPP - Defense Environmental Quality Program Policy
DISC - Defense Industrial Supply Center
DLA - Defense Logistics Agency
DLSC - Defense Logistics Service Center
DoD - U.S. Department of Defense
DOT - U.S. Department of Transportation
DODAAC - Department of Defense Activity Address Code
DRMO - Defense Reutilization and Marketing Office
DRMR - Defense Reutilization and Marketing Region
DRMS - Defense Reutilization and Marketing Service
DTID - Disposal Turn-In Document
EIS - Environmental Impact Statement
EOD - Explosive Ordnance Disposal
EPA - U.S. Environmental Protection Agency
ESP - Electrostatic Precipitator
FAA - Federal Aviation Administration
FAR - Federal Acquisition Regulations
FASCAP - Fast Payback Capital Investment
FOB - Free on Board
FOR - Fuel Oil Reclaimed
FPO - Fleet Post Office
FSN - Federal Stock Number

FTS - Federal Telecommunications System
FWPCA Federal Water Pollution Control Act
GSA - Government Services Administration
HAZMAT - Hazardous Materials
HCS - Hazardous Communication Standard
HHW - Household Hazardous Waste
HSWA - Hazardous and Solid Waste Amendments
HWMP - Hazardous Waste Management Plan
ISA - Interservice Support Agreements
LEL - Lower Explosive Limit
MCL - Maximum Contaminant Level
MHE - Materials Handling Equipment
MILSPEC - Military Specification
MRA&L - Manpower, Reserve Affairs, & Logistics
MSW - Municipal Solid Waste
MSWLF - Municipal Solid Waste Landfills
MVO - Motor Vehicle Operator
MWC - Municipal Waste Combustion
MWR - Morale, Welfare and Recreation
NAF - Naval Air Facility
NAVFAC - Naval Facilities
NCEL - Naval Civil Engineering Lab
NEESA - Naval Energy and Environmental Support Activity
NPDES - National Pollutant Discharge Elimination System
NRC - U.S. Nuclear Regulatory Commission
NTIS - National Technical Information Service
O&M - Operation and Maintenance
0MB - Office of Management and Budget
OOR - Office of Operating Responsibility
OPNAVINST - Operating Naval Instruction
OPR - Operational Project Requirements
OSHA - Occupational Safety and Health Act
PAL - Position Authorization Listing
PCB - Polychlorinated Biphenyl
PCDD - Polychlorinated Dibenzo-P-Dioxins
PCDF - Polychlorinated Dibenzofurans
PECI - Productivity Enhancing Capital Investment
PIF - Productivity Investment Fund
PL - Public Law
PMRP - Precious Metals Recovery Program
POTW - Publicly Owned Treatment Works
PVC - Polyvinyl Chloride
QRP - Qualifying Recycling Programs
RCRA - Resource Conservation and Recovery Act
RDF - Refuse-derived Fuel
RRRP - Resource Recovery and Recycling Program
RTDS - Reutilization, Transfer, Donation and Sale
SARA - Superfund Amendments and Reauthorization Act
SCS - Soil Conservation Service
SPSA - Southeastern Public Service Authority
SQG - Small Quantity Generator
SWMF - Solid Waste Management Facility

TCDD - tetrachlorodibenzo-p-dioxins
TM - Training Manual
TPD - Tons Per Day
TSD - Treatment, Storage and Disposal
TSDF - Treatment, Storage and Disposal Facilities
TSP - Total Solid Particulates
USC - United States Code
USE - Used Solvent Elimination
USGS - United States Geological Survey
WHO/ISWA - World Health Organization/International Solid Waste Association

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