

**Solid Waste Management
Privatization Procedural Manual**

**MEDICAL WASTE
COLLECTION, TREATMENT,
AND DISPOSAL**



SOLID WASTE TECHNICAL ASSISTANCE



Ministry of State for Environmental Affairs



U.S. Agency for International Development



Egyptian Environmental Policy Program



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**Egyptian Environmental Policy Program
Solid Waste Technical Assistance Program
Solid Waste Management Privatization Procedural Manual**

CHAPTER 11

**MEDICAL WASTE
COLLECTION,
TREATMENT, AND
DISPOSAL**

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INTRODUCTION

An effective Integrated Solid Waste Management (ISWM) program must incorporate all forms of solid waste found within your service area. It must include municipal solid waste (MSW) generated from residential and commercial sources as well as solid waste generated from industrial plants and health care facilities. In particular, industrial and medical waste must be managed carefully since they can have a significant health impact on people coming into contact with them.

Chapter 11 provides information specific to the medical waste component of the overall solid waste stream. How medical waste is managed depends on a number of initial decisions relative to the ISWM process and the approach to private sector involvement. For example, medical waste management may be just one component of a larger scale contract that includes all forms of solid waste in an integrated program. Medical waste may also be managed as a free-standing contract that includes only the specialized collection, transport, treatment, and disposal processes required to safely manage medical waste. In either case, the management of medical waste is unique because of the dangerous properties of the material.

Because of its properties, medical waste is often managed independently of residential, commercial, and industrial waste. If improperly handled, infectious medical waste can lead to the transmission of disease to workers who physically handle the material. It is also dangerous for the public who may come into contact with it. Scavengers who attempt to retrieve materials of value during solid waste collection and disposal are a good example of people who can come into contact with medical waste and may be subject to its dangerous properties.

The general process by which medical waste is managed with private contractor involvement is illustrated in Figure 11.1. Each step in the management sequence is important in the overall success of any medical waste management program. Since the initial steps in the structure must remain the responsibility of medical waste generators, any contract for a private medical waste management service must foster a close working relationship between the private sector contractor and the medical waste generators.

When the private sector is involved in handling medical waste, each activity in the process must be clearly understood for the success of the project. Only then can you develop a comprehensive Request for Tender (RFT) that stipulates in detail the required performance of the contractor. Worldwide experience has shown that a well-structured RFT that establishes enforceable performance standards is the best way to involve the private sector in solid waste management and to achieve desired results. This chapter focuses on defining a procedure for gathering the needed information prior to soliciting a contractor. The steps in that procedure are aimed at accomplishing a number of objectives including:

1. Understanding the medical waste management needs of the service areas.
2. Deciding the best approach to effectively manage medical waste.
3. Developing the means for securing a contractor through a structured tender process that clearly defines what is expected of a contractor if they are successful in the bidding process.
4. Creating the framework for monitoring the contractor's performance during the full term of the contract.

The five steps for planning improvement of medical waste management explained in this chapter are:

Step 1: Define Existing Medical Waste Management Practices.

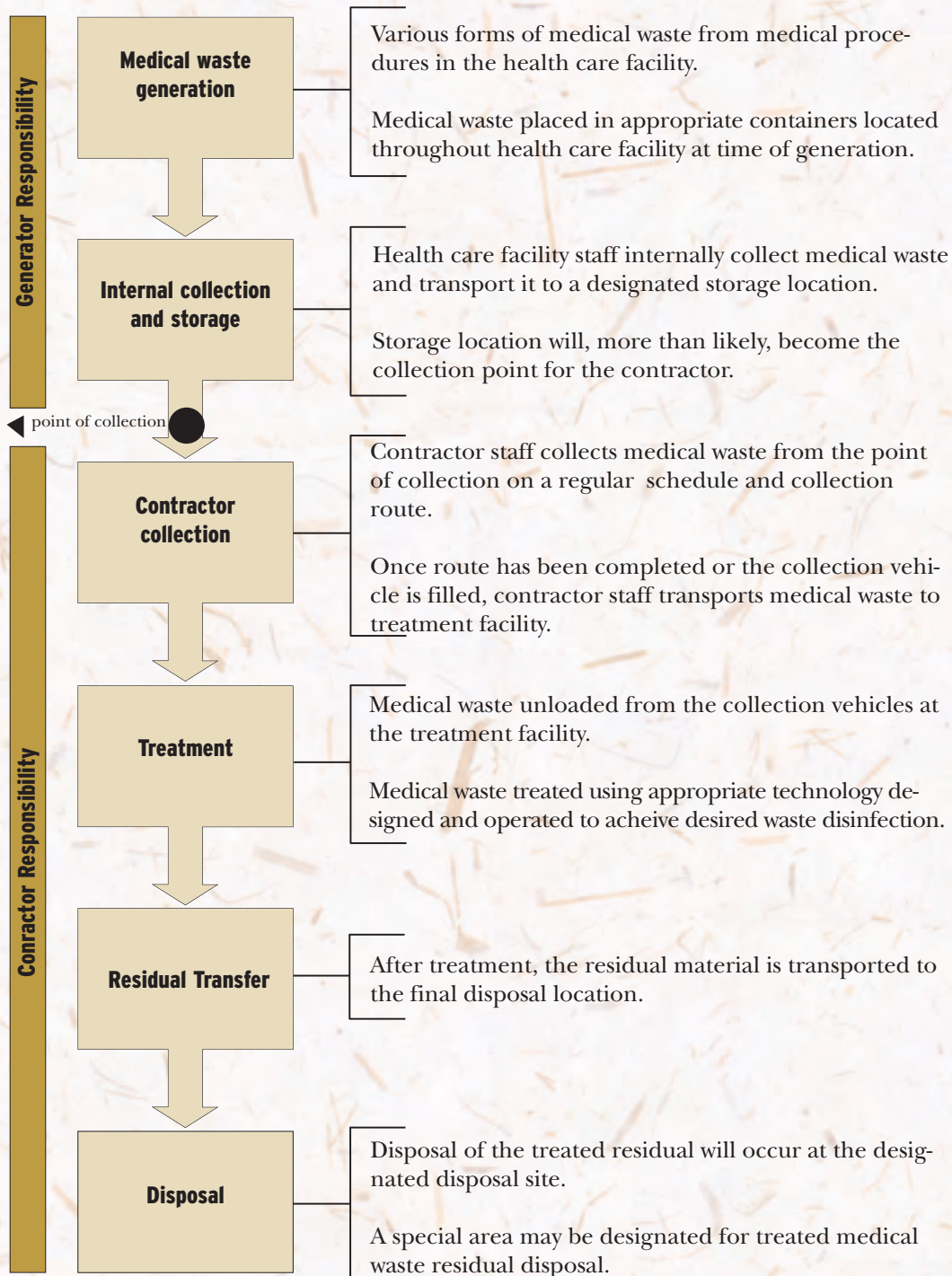
Step 2: Assess Medical Waste Management Program Option.

Step 3: Compile Findings in an Assessment Report.

Step 4: Select the Preferred Medical Waste Program.

Step 5: Implement the Selected Program.

Figure 11.1: THE MEDICAL WASTE MANAGEMENT PROCESS



Medical Waste Generation

Medical waste is also sometimes referred to as pathological waste or infectious waste. As used in this chapter, the term will not include toxic waste, hazardous waste, or radiological waste. However, these wastes may also be generated at health care facilities and may or may not be part of a private contractor's responsibilities because of their unique properties.

The World Health Organization (WHO) estimates that:

- 80 percent of all waste generated at health care facilities may be dealt with by normal domestic and urban waste management systems.
- 15 percent will be pathological and infectious waste.
- 1 percent will be sharps waste.
- 3 percent will be chemical or pharmaceutical waste.
- Less than 1 percent will be considered special waste such as radioactive or cytotoxic wastes, pressurized containers, or broken thermometers, and used batteries.

As a result, about 80 percent of the total health care waste stream has minimal risk comparable to that associated with municipal solid waste. This non-hazardous waste is mostly derived from administrative and housekeeping functions at health care facilities. The remaining fraction (about 15 percent) of the total health care waste stream should be regarded as hazardous. This fraction of the total waste stream will be the source of the waste to be managed through the contracted medical waste management service.

Medical waste is typically defined as: Any infectious or non-infectious solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, or in research pertaining thereto, or in the production or testing of biological materials.

The general categories of waste derived from health care facilities are shown in Table 11.1. These wastes can include both solids and liquids with their own unique and dangerous properties. The properties of these various categories are as follows:

1. **Infectious Waste:** Infectious waste is that portion of the health care waste that may contain pathogens in the form of bacteria, viruses, and other microorganisms that are in sufficient concentration to cause a disease in a susceptible host. The mishandling of infectious waste creates the potential for infection and transmission of diseases such as hepatitis and Acquired Immune Deficiency Syndrome (AIDS). Infectious waste may contain:
 - Cultures and stocks of infectious agents from laboratory work.
 - Waste from surgery and autopsies on patients with infectious diseases (e.g., tissues and materials or equipment that have been in contact with blood or other body fluids.)
 - Waste from infected patients in isolation wards (e.g. excreta, dressings from infected or surgical wounds, clothes heavily soiled with human blood or other body fluids).
 - Waste that has been in contact with infected patients undergoing dialysis (e.g., dialysis equipment such as tubing, filters, disposable towels, gowns, aprons, gloves, and laboratory coats).
 - Infected animal carcasses from laboratories.
 - Any other instruments or materials that have been in contact with infected persons or animals.
 - Sharps that may have been used in treating infected persons. (Because of their particularly dangerous nature, sharps are often given special consideration in the development of infectious waste management programs.)

2. **Pathological Waste:** Pathological waste consists of tissues, organs, body parts, human fetuses, animal carcasses, blood, and body fluids. (In some cases, recognizable human and animal body parts are also called anatomical waste.)
3. **Sharps:** Sharps are any items that can cause a cut or puncture wound on a person handling or coming into contact with the item. This can include needles, hypodermic needles, scalpels, and other blades, infusion sets, saws, broken glass, and nails. Since sharps can cause a direct pathway for a disease into a susceptible host, they should always be considered as a highly dangerous health care waste.

Rural Considerations

Small clinics and health care offices in rural areas will generate many of the same forms of medical waste as generated at larger facilities in urban areas. This may be the case in isolated rural areas as well as in some suburban areas of urban centers. Attempting to collect medical waste from rural generators can be difficult because of the distances that are often involved between collection locations. In rural areas, it may be worthwhile to consider using on-site treatment and possibly disposal rather than attempting to integrate rural sources into the collection element of a medical waste management contract. This could significantly decrease the cost of collection while still providing the means for effective management. During the medical waste source inventory, rural sources should be identified and integrated into the overall planning of the medical waste management program. The education and awareness program may, therefore, include provisions for improving the knowledge of rural medical waste sources as to the proper procedures that they should follow to manage their wastes safely.

Contracted medical waste management programs may be limited to handling only the above health care waste types. However, as shown in Table 11.1, there are other types of waste generated at health care facilities that also need to be safely managed. These wastes may remain the responsibility of the generator or they may be included in the contract. If excluded, the contractor's medical waste collection staff and your Contract Monitoring Unit (CMU) personnel should understand the physical characteristics of these other wastes so that they are not mistakenly placed with the medical waste that will be handled through the contract service. The process of contract monitoring is covered in Chapter 6. Examples of these other health care wastes include:

1. **Pharmaceutical Waste:** Pharmaceutical waste includes expired, unused, spilled, and contaminated pharmaceutical products, drugs, vaccines that are no longer required and need to be disposed of appropriately. This category would also include discarded items used in the handling of pharmaceuticals such as bottles and boxes with residues, gloves, masks, connecting tubing, and drug vials.
2. **Genotoxic Waste:** Genotoxic waste is highly dangerous and may contain mutagenic, teratogenic, or carcinogenic properties. An

Table 11.1: CATEGORIES OF MEDICAL WASTE

Category	Description	Examples
INFECTIOUS WASTE	Waste suspected to contain pathogens.	Laboratory cultures, wastes from isolation wards, tissues (swabs), materials or equipment that have been in contact with infected persons, excreta.
PATHOLOGICAL WASTE	Human tissue and organs.	Body parts, blood, and other body fluids, and fetuses.
SHARPS	Sharp waste.	Needles, infusion sets, scalpels, blades, knives, broken glass, and broken plastic.
PHARMACEUTICAL WASTE	Waste containing pharmaceuticals.	Pharmaceuticals that have expired or that are no longer needed, and bottles or boxes contaminated by or containing pharmaceuticals.
GENOTOXIC WASTE	Wastes containing substances with genotoxic properties.	Waste containing cytotoxic drugs often used in cancer therapy, and waste containing genotoxic chemicals.
CHEMICAL WASTE	Waste containing chemical substances.	Laboratory reagents, photographic chemicals, and disinfectants that are expired or no longer needed, solvents.
WASTE WITH HIGH CONCENTRATIONS OF HEAVY METALS	Consumables and replacement equipment.	Batteries, broken thermometers, blood pressure gauges, etc.
PRESSURIZED CONTAINERS	Gas cylinders, gas cartridges, aerosol cans.	Operating room gas cylinders, and laboratory cylinders.
RADIOACTIVE WASTE	Waste containing radioactive substances.	Unused liquids from radiotherapy and laboratory research, contaminated glassware, packages or absorbent paper, urine or excreta from patients treated, or tested with unsealed radionuclides, and sealed radionuclide sources.

Source: World Health Organization

example of this type of waste is cytotoxic drugs that have the ability to kill or stop the growth of living cells and are often used in cancer chemotherapy.

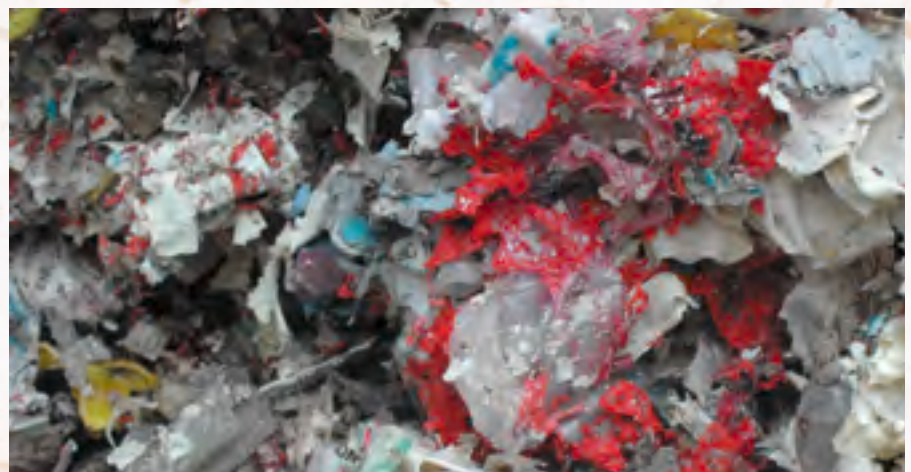
3. **Chemical Waste:** Chemical waste can consist of discarded solid, liquid, or gaseous chemicals used for diagnostic or experimental purposes or for general cleaning, housekeeping, and disinfecting procedures. Health care facility chemical waste may be hazardous or non-hazardous. Hazardous chemical waste will generally have properties that are similar to conventional hazardous industrial waste in that they may be toxic, corrosive, flammable, and reactive. Some chemicals typically used at health care facilities include formaldehyde, photographic chemicals, solvents, and other chemicals.
4. **Wastes with High Content of Heavy Metals:** These materials can be highly toxic such as is the case with wastes with high concentrations of mercury.

5. **Pressurized Containers:** Many different types of gas are used in health care. These gases are often stored in pressurized containers such as cylinders, cartridges, and aerosol cans. These containers once empty or of no further use, must be disposed and may appear in the medical waste stream. In addition to the dangers associated with the type of gas in the container, the containers themselves must be handled carefully since they may explode if incinerated or accidentally punctured during handling.
6. **Radioactive Waste:** Ionizing radiation is commonly used in medical treatment. Examples include the use of x-rays or the use of radionuclides in a laboratory setting. Radioactive waste can consist of solid, liquid, and gaseous materials produced from a number of medical procedures such as the analysis of body tissue, organ imaging, and other investigative or therapeutic practices.

The types and forms of the above waste categories will vary depending on the type and size health care facility generating them. Your service area will most likely contain both major and minor medical waste sources. Some of the major medical waste sources may include:

- Hospitals.
- Other health-care establishments such as emergency medical care services, health-care centers, and dispensaries, obstetric and maternity clinics, outpatient clinics, dialysis centers, long-term health-care establishments and hospices, and military medical services.
- Laboratories and research centers such as medical and biomedical laboratories, biotechnology laboratories, and medical research institutions. Waste produced in research can range from small items such as culture dishes to large animal carcasses and may also include sharps. Depending on the type of research carried out at the facility, these wastes may be highly infectious.
- Mortuaries.
- Animal research and testing locations.
- Blood banks and blood collection services.
- Nursing homes for the elderly (medical waste from nursing homes may consist of swabs, soiled dressings, sharps, and incontinence pads.)

The generation rate of medical waste at these major sources depends on number of factors such as the established waste management methods, types of health care facilities, hospital specializations, proportion of reusable items em-



Autoclaved medical waste.

ployed in health care practices and the proportion of patients that are treated on a daycare basis only. Because of this, the design of the contractor’s medical waste management program needs to closely look at the characteristics of the actual medical waste sources within the service area. This is one of the important steps that you should take in the medical waste management process.

The World Health Organization estimates a range of medical waste generation rates according to national income level. As shown in Table 11.2, the unit medical waste generation rate of any health care facility can vary significantly and must be evaluated on a case by case basis to determine the overall amount of medical waste that will need to be managed in the designated service area.

Your service area may also include a number of minor medical waste sources such as doctors and dentists’ offices, and pharmacies. These smaller health care sources will generate medical waste that is a function of the particular medical services that they provide. For example, physicians and dentists’ offices will usually generate infectious waste and some sharps. In developing the project RFT, you will need to decide the level of service that the contractor’s medical waste management program will cover. This will be one of your most important decisions since overall cost of the contractor’s service may be influenced by the degree to which smaller medical waste generators are included.

Table 11.2: MEDICAL WASTE GENERATION

National Income Level	Annual Waste Generation (kg per person)
High income countries: <ul style="list-style-type: none"> • All health care waste • Hazardous health care waste 	1.1 - 12.0 0.4 - 5.5
Middle income countries: <ul style="list-style-type: none"> • All health care waste • Hazardous health care waste 	0.8 - 6.0 0.3 - 0.4
Low income countries <ul style="list-style-type: none"> • All health care waste 	0.5 - 3.0

Internal Collection and Storage

In a contracted medical waste management program, health care facilities will retain the responsibility for managing their waste at their site. This will include their internal collection and storage of the medical waste at the health care facility. Within major sources such as a hospital, various units will generate different types of medical waste. For example, the different units of a typical hospital will generate the following:

- **Medical wards:** Infectious waste such as dressings, bandages, sticking plaster, gloves, disposable medical items, used hypodermic needles and intravenous sets, body fluids and excreta, contaminated packaging, and meal scraps.
- **Operating rooms and surgical wards:** Anatomical waste such as tissues, organs, fetuses, and body parts as well as other infectious waste and sharps.
- **Laboratories:** Pathological (including some anatomical), highly infectious waste (small pieces of tissue, microbiological cultures, stocks of infectious agents, infected animal carcasses, blood and other body fluids), and sharps plus some radioactive and chemical waste.

- **Pharmaceutical and chemical stores:** Small quantities of pharmaceutical chemical waste consisting mainly of packaging (containing only residues if dispensaries are well managed), and general waste.
- **Support units:** General waste comparable to municipal solid waste.

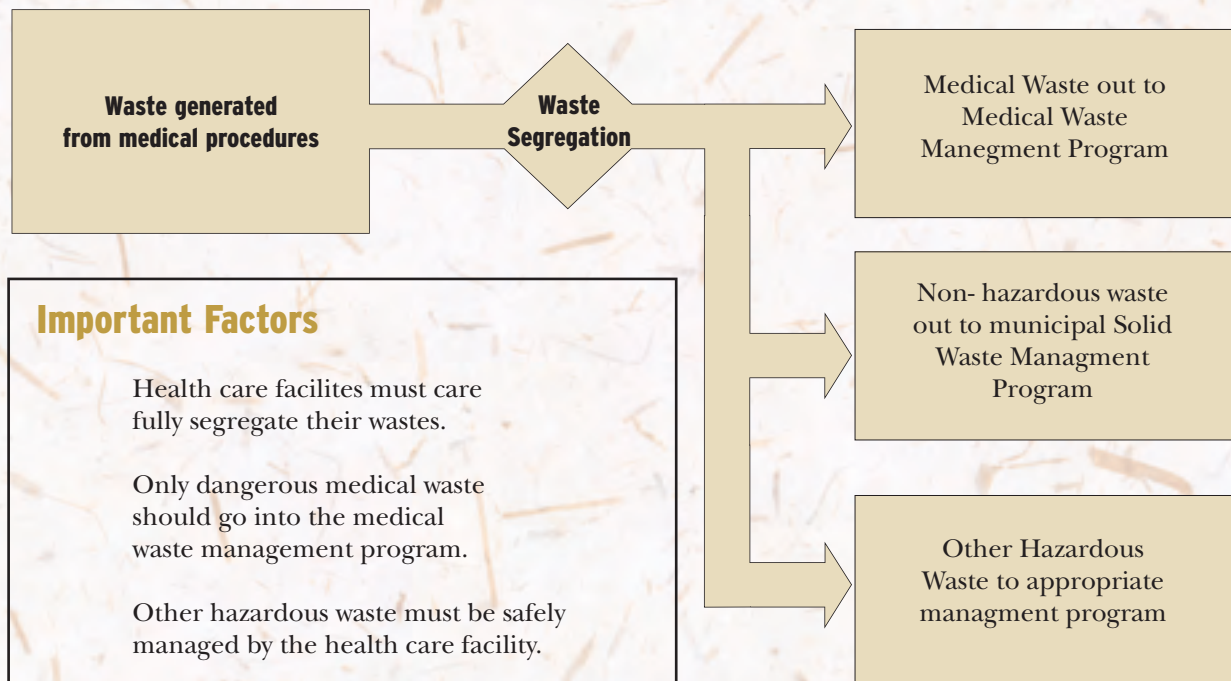
One of a health care facility's primary responsibilities in a contracted medical waste management program will be their careful characterization and segregation of their medical waste (see Figure 11.2). Since the costs of treatment and disposal of medical waste are typically much higher than the cost for general waste, health care facilities must do their part to assure that only the appropriate waste enters the contractor's medical waste management system. The overall costs associated with the contractor's medical waste management program will increase if a significant amount of waste must be managed within the program that is not truly medical waste. This will require close coordination and sustained communication between you, the contractor, and health care facilities. This will especially be the case if there are no direct charges to the health care facility for medical waste collection and disposal. This may eliminate their incentive to minimize the quantity of true medical waste that must be collected by the contractor.

Health care facilities must demonstrate that public health is a top priority. Because of this, waste management staff at health care facilities should be appropriately trained. Health care facilities should also establish detailed procedures that maintain close and safe control of the medical waste prior to its collection by the contractor. This may include the placement of various categories of solid waste into color-coded plastic bags or containers. This allows the medical waste to be safely handled with knowledge of the underlying properties of the material within the container. There are a number of common universal color coding systems that have been developed for managing various forms of medical waste. The technical documents of the RFT should define in detail the type of containers and control system that will be used in providing the medical waste service.



Cart transport truck.

Figure 11.2: HEALTH CARE FACILITY WASTE SEGREGATION



The following are a number of the common procedures followed at health care facilities in managing medical waste. Many of these procedures will influence the contractor's point of waste collection.

1. General non-medical waste should be handled within the health care facility's domestic refuse system.
2. Sharps should all be collected together, regardless of whether or not they are contaminated. Sharps containers should be puncture-proof and usually are made of metal or high-density plastics. Sharps containers should be tamperproof and fitted with covers that do not allow access to the sharps contained within. The containers should be rigid and impermeable so that they safely retain not only the sharps but also residual liquids from syringes.
3. Bags for infectious waste should be red and marked with the international infectious substance symbol.
4. Bags and containers should be removed when they are no more than three quarters full to enhance their safe handling. Some bags can be closed by tying the neck of the bag while heavier gauge bags may require plastic sealing ties of the self locking type.
5. Cytotoxic waste should be collected in strong, leak proof containers that are clearly labeled as cytotoxic wastes.
6. Large quantities of obsolete or expired pharmaceuticals stored at hospital wards or departments should be returned to the pharmacy for disposal.
7. Large quantities of chemical waste should be placed in chemical resistant containers and sent to specialized treatment facilities if they are available. The identity of the chemicals should be clearly marked in the containers and hazardous chemical wastes of different types should not be mixed.
8. Wastes with high content of heavy metals such as cadmium and mercury should be collected separately for disposal at appropriate locations.

9. Aerosol containers may be collected with the general health care waste once they are completely empty provided that the waste is not destined for incineration.
10. The internal waste management plan for the health care facility should stipulate regular procedures and schedules by which waste is collected daily or as frequently as required and transported to a designated central storage site which, more than likely, will be the contractor's point of collection.
11. If it is necessary to transport medical waste on-site from generation locations to the point of collection or storage, health care facilities must assure that this is done safely. This may require the use of wheeled trolleys, containers, or carts that are not used for any other purpose. Generally these will meet the following specifications:
 - Easy to load and unload.
 - No sharp edges that could damage waste bags or containers during loading and unloading.
 - Easy to clean and disinfect at least daily.
12. To the degree possible, medical waste should be stored in a separate area, room, or building of a size appropriate for the quantity of waste produced and frequency of collection.
13. Unless a refrigerated storage room is available, storage times for health care waste should not exceed the length of time in which the waste can be stored without creating odor problems. In countries with warm climates such as Egypt, this time should not exceed 48 hours in the cool season and 24 hours during hot weather months. The following is a listing of the general characteristics of good waste storage areas at health care facilities:
 - Storage areas should have an impermeable hard floor with good drainage that can be easily cleaned and disinfected.
 - They should have a water supply for cleaning purposes.
 - Storage areas should afford easy access for staff in charge of handling the waste.
 - It should be possible to lock the storage area to prevent access by unauthorized persons.



Incinerator cart handling system.



Modern medical waste processing.

- Easy access for waste collection vehicles is essential.
- Storage areas should be protected from the sun.
- Storage areas should be inaccessible to rodents, dogs, cats, insects, birds, and other animals.
- There should be good lighting and ventilation.
- Storage areas should not be situated in proximity of food storage or preparation areas.
- A supply of cleaning equipment, protective clothing, and waste bags or containers should be located conveniently close to the storage area for use by waste management staff.

Contractor Collection

An efficient collection network will be one of the most important elements of a contractor's medical waste management program. Health care facilities will expect and must be provided with a reliable collection service. The collection service should be designed to be as routine as possible with collection occurring at times that can be relied on by the generators. In many cases, health care facilities will not have the ability to store medical waste for a long time and they will have to rely on the performance of the contractor in providing reliable collection.

In a contracted medical waste service, the first major activity that the contractor will undertake is the collection of the medical waste at the health care facilities. Once medical waste has been collected, the contractor will be responsible for safely transporting the material to the treatment facility. This will be accomplished by a fleet of dedicated vehicles operated by staff that has been trained to safely handle the medical waste that they collect.

It is also extremely important that collection staff clearly understand the responsibilities that health care facilities have in interfacing with the contractor's collection system. The contractor's collection staff should only pick up medical waste that has been properly packaged and placed at the designated collection point. Your contract monitors will need to be knowledgeable of the responsibilities of both the health care facilities and contractor to assure that the program is running smoothly and to the contracted level of service.

The medical waste collection process will be the activity where the general public may come into the closest contact with the medical waste. As a result, the contractor's collection program needs to be designed to maintain secure and effective control of the medical waste so that it is isolated from direct human contact.

Transport Vehicles and Containers: Waste bags may be placed directly into the transportation vehicle but it is usually safer to place them in additional containers such as a cardboard box or a wheeled, rigid, plastic, or galvanized bin. While this results in an advantage of reducing the handling of filled medical waste bags, it may also result in higher transportation costs. Any vehicle used to transport medical waste should have the following general design characteristics:

1. The body of the vehicle should be of a suitable size commensurate with the amount of medical waste that it must transport.
2. There should be a bulkhead between the driver's cab and the vehicle body designed to retain the load if the vehicle is involved in an accident.
3. There should be a suitable system for securing the load during transport.
4. Empty plastic bags, suitable protective clothing, cleaning equipment, tools, disinfectant, and special kits for dealing with liquid spills should be carried in a separate compartment in the vehicle.



Incinerator for medical waste in Luxor.

5. The internal finish of the vehicle should allow it to be steam cleaned.
6. The internal angles of the waste storage compartment should be rounded for easier cleaning.
7. The vehicle should be marked with the name and address of the contractor.
8. The international biohazard sign should be displayed on the vehicle or container as well as an emergency telephone number.
9. Vehicles used for transporting medical waste should not be used for the transportation of any other material.
10. Vehicles should be kept locked at all times except when loading and unloading.

The technical documents of the RFT should clearly outline in detail the minimum technical specifications of the vehicles that will be required for medical waste transport.

The RFT should also stipulate the minimum technical requirements of collection routing to be used by the contractor. The required routing structure should mandate that the contractor transport the medical waste by the quickest possible route. The development of collection routing will be a function of a number of factors including:

1. Distance between collection points within the service area.
2. Extent of traffic during various times of day.
3. Amount medical waste collected at each health care facility.
4. Condition of roadways within the service area.
5. Transport distance from the various health care facilities to the treatment facility.

The efficiency of the routing structure is extremely important in determining the regularity and reliability of the collection service. Ideally, collection staff will appear at a health care facility within a regular and specified time frame on each collection day. As a result, health care facility waste management staff can assure that all medical waste is at the point of collection and appropriately prepared for collection and transport. When situations occur that create delays in the collection process, effective communication between the contractor and the health care facility can assist in maintaining good coordination between the internal and external collection processes. It is important to note that the collection of medical waste may occur at any time during the day and that collection for some health care facilities located in densely populated or heavy traffic areas may occur at night when there is less traffic to disrupt the collection process.

Treatment

Medical waste treatment is a function of the type of medical waste to be processed and the ultimate disposal of the waste after treatment. If there is any possibility of human contact after treatment, then the medical waste should be completely disinfected so that waste workers or scavengers who may come into contact with the material are not exposed to potentially infectious properties.

As laws or regulations regarding the management of medical waste have evolved, there are a number of approaches that health care facilities have used to treat medical waste. These approaches include:

- The development of on-site treatment systems at individual health care facilities.

- The development of regional or cooperative treatment facilities often supplemented by individual systems for outlying hospitals.
- The treatment of medical waste in existing industrial or municipal treatment facilities such as municipal incinerators if they are available.

The general advantages of on-site medical waste treatment include the following:

- Convenience.
- Minimization of risk to public health by confining the waste to the health care premises.

However, there are also some disadvantages of this individualized approach including:

- High costs.
- More technical staff may be required at each health care facility to operate and maintain their treatment system.
- It may be difficult for government agencies to monitor the performance of many small facilities resulting in poor compliance with operating standards and increased environmental pollution.

In some cases, regional medical waste treatment facilities have been developed which provide a number of advantages:

- Greater cost-effectiveness through an increased economy of scale.
- More economical spare or expanded capacity.
- Better opportunity for privatization.
- Increased ability to monitor performance.
- Increased efficiency of operations as a result of a centralized, skilled staff.
- Decreased air pollution as a result of more effective monitoring and control.

There are a number of available technologies that can effectively treat medical waste. In the RFT, you may choose to designate a preferred technology or simply leave it to the contractor to propose a technology that will fulfill the performance standards you stipulate in the RFT. The following factors should be considered in selecting a treatment technology:

- Required disinfection efficiency.
- Health and environmental considerations.
- Volume and mass reduction.
- Occupational health and safety.
- Quantity of waste to be treated and the capacity of the selected technology.
- Types of waste to be treated.
- General infrastructure and space requirements.
- Locally available treatment options and technologies.
- Type of final disposal.
- Training requirements for the operation of the technology.
- Operational and maintenance considerations.
- Location and surroundings of the treatment site and disposal facility.
- Investment and operating costs.
- Public acceptability of the selected technology.
- Regulatory requirements.



Medical waste incinerator in Luxor.

Commercially available medical waste treatment technologies can be grouped into four different classifications including:

- Mechanical.
- Thermal.
- Chemical.
- Irradiation.

These technologies are further explained in the sections that follow, and a summary of the advantages and disadvantages of each described system is presented in Table 11.3.

Mechanical

Mechanical systems are used to supplement the other three system classifications shown above. Mechanical systems change the physical form or characteristics of medical waste. Shredding, granulation, grinding, pulping, etcetera are types of mechanical systems used to break up the waste into smaller pieces for more effective treatment. The smaller pieces allow greater surface access of disinfecting agents to the infectious properties to be treated. It also has the advantage of making the medical waste unrecognizable. Mechanical systems, by themselves are not considered acceptable medical waste treatment processes but can be an important component of a system that also uses one of the following processes.

Thermal

Thermal processes use heat to decontaminate or destroy medical waste since most microorganisms are rapidly destroyed at temperatures ranging from 49 to 91°C. The two categories of thermal processes are high heat and low heat thermal systems.

High Heat Thermal Systems: High heat systems operate at temperatures sufficient to cause chemical and physical changes leading to the destruction of the medical waste. These systems use combustion, pyrolysis, and/or high-temperature plasma to decontaminate and destroy the waste and operate at temperatures ranging from as low as 600°C to more than 5,500°C.

Incineration is an example of a high heat thermal system. Incineration uses high temperature combustion under controlled conditions to convert wastes containing infectious and pathological material to inert mineral residues and gases. The process of incineration results in a significant reduction in the weight and the volume of the waste combusted. Historically, incineration has been used for all forms of solid waste including municipal and hazardous wastes in addition to medical waste. Incineration technologies have evolved through the years as both a means of waste treatment and as a way to recover the energy value of solid wastes prior to its disposal. In systems where energy is recovered, steam is often produced using the energy content of the combusted solid waste. This steam can either be directly used by industry as process steam or used in more general applications for heating and cooling. In many of the large waste to energy facilities located around the world, the produced steam is used to generate electricity either for sale or for internal use. There are three types of incinerators typically used for medical waste treatment:

1. Multiple-hearth.
2. Rotary kiln.
3. Controlled-air design.

Medical waste is normally suitable for incineration since the heating value (the organic energy content that burns and sustains a combustion process) of the waste exceeds that which is required to support the combustion process. For example, incineration only becomes practical if the heating value of a waste material is at least 2,000 kcal/kg. The heating value of medical waste is typically twice that amount. In state-of-the-art incineration systems, supplemental fuels are only used during startup and shutdown of the system. During normal operations, the heating value of the waste placed into the incineration units should be sufficient to maintain combustion without the assistance of supplemental fuels. As a result, the heating value of any waste to be combusted is an extremely important element since the need for supplemental fuel has a significant effect on the overall costs of incineration.

Based on our current knowledge about incineration, the use of this treatment technology should be carefully considered, weighing its benefits and risks. Incineration has become controversial in many areas of the world because of concerns about air emissions resulting from the combustion process. In addition, there are a number of medical waste components that should not be incinerated including:

- Pressurized gas containers.
- Large amounts of reactive chemical waste.
- Photographic or radiographic wastes.
- Halogenated plastics such as polyvinyl chloride (PVC).
- Waste with high mercury or cadmium content such as broken thermometers and used batteries.
- Sealed ampoules or ampoules containing heavy metals.

The advantages and disadvantages of incineration as a form of medical waste treatment are shown below:

- Advantages
 - Can accept the greatest variety of waste.
 - Treated waste is unrecognizable and exists as ash.
 - Significant volume reduction (80 to 90%).
 - Waste totally sterilized.
 - Energy recovery potential in larger systems.



Ash from incinerated medical waste.

- Disadvantages
 - Incinerators convert biological problem into potential air quality emission problems.
 - Acid gases and heavy metals in air emissions.
 - Heavy metals found in ash residues.
 - Identified as a major source of dioxin and furan emissions.

Pyrolysis and plasma systems are other forms of high heat thermal processing. Pyrolysis systems attempt to process the waste materials through an oxidative process similar to combustion but with little or no oxygen. Plasma units use extremely high temperatures to breakdown the processed waste into its basic elements. However, these systems are not yet commercially available and generally applied to medical waste treatment.

Low Heat Thermal Processing: There are a number of commercially available technologies that utilize wet or dry thermal processing for low heat disinfection. These processes will be effective in killing most types of microorganisms as long as the temperature and contact time is sufficient. Sufficiency is usually determined by the reaction of the most resistant microorganisms that may be found in the medical waste. For example, the inactivation of bacterial spores requires a minimum temperature of 121° C.

Autoclaving is a wet thermal disinfection process. Autoclaves use steam sterilization as a low heat thermal process. This technology has the advantage that there is considerable experience in most health care facilities with the use of smaller scale autoclaves for the sterilization of reusable medical equipment. Autoclaves are the most commonly used medical waste treatment alternative in the United States and are growing in popularity in other countries.

For this technology to be effective, the medical waste must be exposed to sufficient contact time and temperature for disinfection. The minimum contact time and temperature will depend on several factors such as the moisture content of the waste and the ease of penetration of the steam into the solid forms within the waste. Research has shown that for an autoclave to be effective, it should provide a minimum retention time of 60 minutes at 121° C (minimum) at 1 bar pressure. This will normally allow full penetration of

The Incineration Debate

For a number of years, incineration was the preferred technology alternative in many countries because of the manner in which it destroyed medical waste and made it unrecognizable. Incineration was viewed as an effective means of volume reduction while also decreasing the attractiveness of the resulting ash residue for scavengers. In recent years, medical waste incineration has been viewed by many as a potential health and environmental hazard. For example, in the United States medical waste incinerators are believed to be a primary source of dangerous trace organic emissions such as dioxins and furans. (The basis for this concern is the higher concentration of chlorinated plastics often found in medical waste.) As a result, alternative technologies to incineration have been developed and have become commercially available to provide effective medical waste treatment without combustion.



Medical waste facility in Luxor.

the steam into the waste material. Advantages and disadvantages of autoclave systems are shown below:

- Advantages
 - Tested and proven technology with extensive use.
 - On-site or regional treatment of various sizes.
 - Low capital operating cost.
 - No hazardous emissions since combustion is not involved.
 - Complies with current rules in most industrialized countries.
 - Quality control procedures are well established through extensive use.
 - Less manpower required.
 - No pre- or post-treatment required.
- Disadvantages
 - Shredding may be required to make treated waste unrecognizable.
 - Only 30 to 35% volume reduction.
 - If autoclave does not have proper drying mechanism, foul odors can be emitted.
 - Requires plastic liners or bags.
 - Cannot treat all types of medical waste.
 - Disposal areas may have a concern about disinfection quality control.

Hydroclaves use a process similar to autoclave system except that indirect heating is accomplished by providing steam into the outer jacket of a double-walled container while the waste inside the unit is mechanically turned. This causes the waste to fragment and be continuously tumbled against the hot vessel walls to accomplish disinfection.

Chemical

Chemical disinfection is commonly used to kill microorganisms on medical equipment and on floors and walls in health care facilities. In addition, technologies have been developed that utilize chemical disinfection as a means of treating medical waste. The intent of these systems is to simply provide a means by which a chemical disinfectant is placed in contact with the infectious waste to kill or inactivate contained pathogens. Generally, chemical disinfection is most suitable for treating liquid waste such as blood and urine. However, solid medical waste can also be treated with chemical disinfection subject to the following limitations:

1. Shredding of the waste is usually necessary to increase the surface area contact between the disinfectant and the material to be treated.
2. Powerful disinfectants are required which can be hazardous themselves and should only be used by well-trained and adequately protected personnel.
3. The use of chemical disinfection must also consider the ultimate disposal of the liquid that will result from the disinfection process.
4. Human body parts and animal carcasses should not normally be disinfected chemically since it is difficult for the disinfectant to penetrate into their solid structure.
5. Some microorganisms are resistant to disinfectants. For example, some bacterial spores and viruses may be difficult to treat with chemical disinfection.

Chemical treatment involves the direct use of chemicals for disinfection. Common disinfectant chemicals include chlorine compounds, phenol compounds, iodine, alcohol, hexachlorophene, formaldehyde/alcohol combinations. Most chemicals are used as aqueous solutions. Water is needed to bring chemicals and microorganisms together to achieve the elimination of infectious properties. Most chemical processing systems start with shredding in order to provide better contact between the waste material and the chemical. Shredding also helps to make the waste unrecognizable when it gets to the disposal site. Advantages and disadvantages associated with chemical treatment are as follows:

- Advantages
 - Economical with low capital investment.
- Disadvantages
 - Only for surface contaminated or penetrable waste.
 - Not suited for pathological waste.
 - Shredding required for most medical waste.
 - Environmental risk to air and water associated with the chemical use.

There are other types of technologies that are evolving for the treatment and disinfection of medical waste. These include systems that rely on ionizing radiation created from radioactive sources such as Cobalt-60 or ultraviolet radiation sources.

Microwave Irradiation

Commercial equipment is now available that disinfects medical waste using microwave irradiation. Most microorganisms are destroyed by the action of microwaves of a frequency of approximately 2,450 MHz and a wavelength of 12.24 cm. Unlike other thermal treatment systems, which heat wastes externally, microwave heating occurs inside the waste material. Through the microwave irradiation process, water contained within the medical waste is rapidly heated by the microwaves and the infectious components are destroyed by heat conduction.

Typically, a loading device is used to transfer the waste into a shredder where it is reduced into small pieces. The waste is then humidified by adding water, and then transferred to the irradiation chamber. This chamber is usually equipped with a series of microwave generators that irradiate the shredded medical waste for about 20 minutes and heat it to about 95°C. After irradiation, the waste is then discharged into a container and transported to the disposal location.



Example of problematic medical waste storage: Overloaded container with uncontrolled access. .

The efficiency of microwave disinfection must be checked routinely through bacteriological or virological tests similar to those performed for non-incineration treatment technologies. For example, a routine bacteriological test is often used to demonstrate a 99.99 percent reduction in viable spores. (See Inset Box, Treatment Quality Control). This kind of test for routine treatment quality-control should be an important requirement of the performance specifications stipulated in the RFT to assure the contractor is operating and maintaining the treatment system to accomplish full disinfection.

While the use of microwave processing is growing in popularity in many countries, it is a relatively high cost technology that is coupled with relatively sophisticated operation and maintenance issues. The advantages and disadvantages of microwave irradiation treatment are shown below:

- Advantages
 - Hi-tech state-of-art technology.
 - Shredding makes biomedical waste unrecognizable.
 - On site treatment of varying capacities.
 - No hazardous emission since combustion is not involved.
 - Complies with current rules in most industrialized countries.
 - Proven technology with world-wide installations including larger regionally-based systems.
- Disadvantages
 - High capital cost.
 - Pre-shredding and wetting of waste required.
 - All waste cannot be processed.
 - Highly skilled manpower required.
 - High operating and maintenance cost.

Each of the above technologies will provide some treatment to the various components of medical waste. However, it must be noted that some technologies are better at treating some forms of medical waste than others. Table 11.4 presents the suitable treatment methods for different categories of medical waste.

Treatment Quality Control: Bacillus subtilis and Bacillus stearothermophilus
The following steps describe a common protocol that is used to verify the effectiveness of medical waste treatment.

1. *Dried test spores are placed in a thermally resistant and steam-permeable container near the center of the waste load and the treatment system is operated under normal conditions.*
 2. *The test organisms are removed from the load at the end of the cycle.*
 3. *Within 24 hours, test discs or strips are aseptically inoculated in 5.0ml soybean-casein digest broth medium and incubated for at least 48 hours, at 30° C for Bacillus subtilis and at 55° C for Bacillus stearothermophilus.*
 4. *The media is then examined for turbidity as a sign of bacterial growth.*
 5. *Any growth is subcultured onto appropriate media to identify the organism either as the test microorganism or as an environmental contaminant.*
-

Table 11.3: ADVANTAGES AND DISADVANTAGES OF TREATMENT OPTIONS

TREATMENT METHOD	Advantages	Disadvantages
ROTARY KILN INCINERATION	<ul style="list-style-type: none"> • Adequate for all infectious waste, most chemical waste, and pharmaceutical waste. • Significant reduction of weight and volume of waste. 	<ul style="list-style-type: none"> • High investment and operating costs. • Concern about air emissions.
CONTROLLED AIR INCINERATION	<ul style="list-style-type: none"> • Very high disinfection efficiency. • Adequate for all infectious waste and most pharmaceutical and chemical waste. 	<ul style="list-style-type: none"> • Incomplete destruction of cytotoxics. • Relatively high investment and operating costs. • Concern about air emissions.
MULTIPLE HEARTH INCINERATION	<ul style="list-style-type: none"> • Good disinfection efficiency. • Significant reduction of weight and volume of waste. • The residues may be disposed of in landfills. • No need for highly trained operators. Relatively low investment and operating costs. 	<ul style="list-style-type: none"> • Significant emissions of atmospheric pollutants. • Need for periodic removal of slag and soot. • Inefficiency in destroying thermally resistant chemicals, and drugs such as cytotoxics.
CHEMICAL DISINFECTION	<ul style="list-style-type: none"> • Highly efficient disinfection under good operating conditions. • Some chemical disinfectants are relatively inexpensive. • Reduction in waste volume. 	<ul style="list-style-type: none"> • Requires highly qualified technicians for operation of the process. • Uses hazardous substances that require comprehensive safety measures and safe disposal. • Inadequate for pharmaceutical, chemical, and some types of infectious waste.
WET THERMAL TREATMENT	<ul style="list-style-type: none"> • Environmentally sound. • Drastic reduction in waste volume. • Relatively low investment and operating costs. 	<ul style="list-style-type: none"> • Shredders are subject to frequent breakdowns and poor functioning. • Operation requires qualified technicians. • Inadequate for anatomical, pharmaceutical, and chemical waste and waste that is not readily steam-permeable.
MICROWAVE IRRADIATION	<ul style="list-style-type: none"> • Good disinfection efficiency under appropriate operating conditions. • Drastic reduction in waste volume. • Environmentally sound. 	<ul style="list-style-type: none"> • Relatively high investment and operating costs. • Potential operation and maintenance problems.

Residual Transport

The contractor will be responsible for transporting treatment residue to the disposal site after treatment. The type of trucks that will be required for this purpose is a function of the treatment system used. If shredding of the medical waste is required before processing, the treatment residual will consist of small, moist particles of shredded medical waste. Some thermal treatment systems such as autoclaves will process the medical waste in the condition that it is received without shredding. The treatment residue from these systems will maintain some of the same structural characteristics of the untreated medical waste. For example, bags of medical waste may be loaded in-

Table 11.4: TREATMENT SUITABILITY OF CATEGORIES OF MEDICAL WASTE

TECHNOLOGY OR METHOD	Infectious Waste	Anatomical Waste	Sharps	Pharmaceutical Waste	Cytotoxic Waste	Chemical Waste	Radioactive Waste
ROTARY KILN INCINERATOR	Yes	Yes	Yes	Yes	Yes	Yes	Low-level infectious waste
CONTROLLED AIR INCINERATOR	Yes	Yes	Yes	Small quantities	No	Small quantities	Low-level infectious waste
SINGLE-CHAMBER INCINERATOR	Yes	Yes	Yes	No	No	No	Low-level infectious waste
CHEMICAL DISINFECTION	Yes	No	Yes	No	No	No	No
WET THERMAL TREATMENT	Yes	No	Yes	No	No	No	No
MICROWAVE IRRADIATION	Yes	No	Yes	No	No	No	No

tact in the treatment system and will be slightly shriveled after treatment. In either case, the RFT technical documents should require that the residual transport vehicles have the following characteristics:

1. The body of the vehicle should be of a suitable size commensurate with the amount of treatment residual that it must transport.
2. The treatment residual cargo area should be watertight to prevent leakage.
3. There should be a bulkhead between the driver's cab and the vehicle body designed to retain the load if the vehicle is involved in an accident.
4. There should be a suitable system for covering the load during transport.
5. Empty plastic bags, suitable protective clothing, cleaning equipment, and tools should be carried in a separate compartment in the vehicle.
6. The internal finish of the vehicle should allow it to be steam cleaned.
7. The vehicle should be marked with the name and address of the contractor.

Disposal

The treated residual should be disposed at an appropriate disposal site. If treatment has been effective, the residue will not be any more dangerous than the municipal solid waste brought to the site for disposal. However, it is usually prudent to view treated medical waste as still being potentially dangerous in handling it at the disposal site.

If possible, the treated residual should be placed in a dedicated spot within the disposal location. The treated residual transport staff should coordinate

their deliveries with disposal area staff. The actual procedures that the contractor uses in placing the treated medical waste into the disposal area will be a function of the type of disposal area used and the manner in which the disposal area is operated. In a comprehensive ISWM contract, the contractor will have responsibility for the operation of the disposal area. This will aid in coordinating the delivery of treated medical waste in accordance with the requirements of the disposal area. If medical waste management is a free standing contract, you should determine the requirements that the medical waste management contractor will have to meet in delivering treated medical waste to the disposal area. These requirements should be clearly outlined in the RFT technical documents and performance standards (and appropriate penalties for non-performance) established.

Each of the steps presented in this chapter is aimed at assisting solid waste planners determine the characteristics and needs of their designated service area and to make the necessary choices as to the approach to develop an effective program. The intent is to provide sufficient information and direction to prospective contractors in a tender process so that they clearly understand what is expected of them throughout the term of any contract that they are awarded.

Rural Considerations

Many of the medical waste treatment technologies described in this chapter are available in small capacities that could provide medical waste treatment in rural areas. Many of the commercially available technologies, such as autoclaves, are manufactured in the small sizes that would be required at rural healthcare facilities. However, the unit cost of treatment is apt to be higher as a result of the loss of the economy of scale that would be realized in a larger regional facility.



Medical waste incinerator, indoors.

STEP 1: DEFINE EXISTING MEDICAL WASTE MANAGEMENT PRACTICES

The first step in the implementation process is intended to define and evaluate existing medical waste management conditions. This will form the basis for much of the information that will be necessary to make informed decisions as to the type and level of service desired. It will also be the basis for providing information to prospective contractors so that they can submit detailed proposals in response to the RFT. The level of detail that will be required for proposals will be based on the RFT. More information on technical specifications for an RFT is given in Appendix A.

Define Medical Waste Management Service Area

The starting point of the planning effort is to develop a good understanding of how medical waste is currently managed in the service area. In some urban areas, service areas will consist of an entire municipality or it may consist of various districts with common characteristics. Service areas may be consistent with those already established for residential collection services or other elements of an integrated solid waste management program. Ultimately, the technical documents will need to define the service area in which the contractor will provide its services. If it is possible that the contractor's medical waste management program will be expanded in the future by increasing the service area, you will need to explore that potential before issuing the RFT. This will be important in defining the degree of expansion potential that will be necessary in key elements such as the treatment facility.

Review Legal, Policy, and Regulatory Framework

Medical waste, like any other form of solid waste, must be managed within the context of the laws and regulations that exist at the national, governorate, or local level. The basic foundation for the laws and regulations that affect medical waste management in Egypt is Law 4/1994 and its Executive Regulations. Law 4/1994 establishes the legal framework for the development of an effective means for safely managing waste materials with hazardous properties including medical waste and some forms of industrial waste.

Law 4/1994 required that six administrative authorities (Ministries of Agriculture, Electricity, Health, Industry, Interior and Petroleum) develop a list of hazardous materials that are within their jurisdiction. The Ministry of Health issued Decree (192/2001) on August 8, 2001. Article 1 of the Decree listed the following waste forms:

- Infectious waste including pathological waste and sharps.
- Chemical hazardous waste including pharmaceutical waste, insecticides, off-spec products, wastes from laboratories and research institutes, and wastes containing heavy metals.



Safe disposal of treated medical waste at landfill.

- Radiological waste (responsibility of the Atomic Energy Authority for collection and disposal).
- Empty containers of the above.

The Decree also stipulates technical specifications for on-site interim storage and transport of health care waste. The Decree forms the basis for many of the standards and criteria that should be presented in the technical documents of the RFT. These establish the minimum technical requirements that the contractor will need to meet in providing the medical waste management service.

One of the initial planning activities is to review the current requirements of laws and regulations governing medical waste management. These will be important in defining your planning activities as well as defining the regulatory process that the contractor will have to follow in putting all elements of their program into place. The RFT should place the responsibility for knowing and meeting all of the regulatory requirements on the contractor. However, you should supply enough information in the RFT for prospective contractors to understand the level of work that they will have to undertake to secure all permissions for their work. This should also include some indication of evolving legislation at all levels that could influence the contract.

Another important element of the review of existing laws and regulations pertaining to medical waste management is the basis by which health care facilities will be compelled to participate in the contracted service. If health care facilities have a definite economic incentive (lower costs, etc.) to participate, they more than likely will. However, if the cost or convenience advantage is not well defined, a regulatory means for assuring their participation may be necessary.

Inventory Medical Waste Sources

The privatization of an integrated solid waste management service will cover a defined service area. The service area will more than likely include different types of health care facilities that will generate medical waste. Since each of these is apt to be a collection point for the medical waste, you should develop a detailed inventory of health care facilities to generate core data by which the active elements of the medical waste management program will be designed and implemented. For example, the location of various health care facilities within the service area will determine the design and routing of the vehicles involved in the medical waste collection program.

If possible, the RFT technical documents should include a map of the service area that shows the location of the health care facilities that will be serviced. This inventory will also allow you to determine the desired contractor's level of service for small medical waste generators. A sample health care facility inventory data form is shown in Appendix B of this chapter. A thorough inventory requires the following tasks:

1. Assign the responsibility for developing the inventory data form to one individual or department.
2. Develop an initial listing of health care facilities within the defined service area.
3. Distribute the inventory data form with requested responses by a specified date.
4. Receive completed inventory data forms.
5. Follow up on delinquent submittal.
6. Develop the initial health care facility database.
7. Follow up on specific questions or to verify the accuracy of the information submitted and gather more information if required.
8. Finalize the health care facility database for inclusion in the RFT.

Determine Types and Quantity of Medical Waste

Based on the results of the service area inventory, you should complete an analysis of the type and quantity of medical waste that will be generated and which must be managed by the contractor. Data concerning the type and quantity of medical waste should be collected through the inventory process outlined above. The contractor will use this data in preparing their tender and to do preliminary design individual collection routes as well as key program elements such as the treatment system.

Define Current Management Practices

Based on the inventory, you should also complete an evaluation of the current medical waste management practices in the service area. This will be important in determining the degree of improvement that can be accomplished through the contractor's program. Knowledge of existing practices will be important for the public education and awareness elements of the program. It will help you to explain what improvements will occur as a result of the contracted program.

Important questions for defining current practices:

Answers to these questions will help you understand the severity of the medical waste issue in your area. It will also help you to develop a defensible justification for the process of getting a contractor involved.

- 1. Do health care facilities segregate their various medical waste forms? If so, how?***
 - 2. Do various health care facilities treat their medical waste at their sites? If so, how?***
 - 3. How is medical waste transported from the health care facilities in the service area?***
 - 4. How do the health care facilities dispose of their various types of waste materials?***
-

Identify Current Private Sector Participants

There may already be a number of private sector entities who perform some current function in medical waste management within your service area. You should determine who those participants are and the nature of their services. You need to determine whether the contracted medical waste management service will displace them and the manner that they may end up competing with the contractor in some form.

Define Current Medical Waste Management Economic Model

In many cases, an improved level of service will result in an increase in direct cost of a waste management program. Unfortunately, the indirect cost of health effects and environmental damage due to poor practices are not always factored into an evaluation of cost. An economic model of the existing manner in which medical waste management services are paid for is important in defining how they will be handled after implementation of the improved system.

If individual health care facilities will be charged for medical waste management services based on what they generate, their current costs need to be understood to see how they will compare to the cost of improved service.



STEP 2: ASSESS MEDICAL WASTE PROGRAM OPTIONS

After developing an understanding of the current medical waste management situation in the service area through Step 1, you will need to define the opportunities for service improvement. This can be defined by resolving the following questions:

1. How can public exposure to the dangerous properties of medical waste be decreased?
2. Are there benefits to involving a private contractor in the management of medical waste in the service area?
3. How can a collection and treatment service be provided to health care facilities that will be convenient and cost effective?
4. Can minor medical waste generators be included in a contracted service and if so, how can this be accomplished?
5. What level of contractor performance will be required as a result of evolving laws and regulations governing the management of medical waste?

Answers to these questions will define the desired service improvements that should then be emphasized in the design of the technical documents of the RFT. The service improvements will also serve as the justification for issuing the RFT and undertaking the work required to develop the contracted service.

In defining the desired service improvements, there are a number of underlying fundamental principles that should be followed. An improved medical waste management system should be developed to:

- Prevent and minimize waste production.
- Reuse and recycle waste to the extent possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of the final treatment residues by landfill in confined or carefully designed sites.

The first two principles apply particularly to medical waste generators who have a major role in defining the type and amount of medical waste they generate and the contractor will have to collect. Because of their importance to the overall success of the medical waste management program, you should endeavor to make sure that health care facilities understand what they can do to help. This should be an important part of the awareness program that needs to be developed as part of developing the contract. The health care facility awareness and training program must emphasize the importance of segregating waste to assure that only acceptable medical waste is collected by the contractor.

The manner in which medical waste will be collected, transported, and treated will be the responsibility of the contractor. The RFT should provide sufficient detail to define how the contractor is to accomplish these activities. This detail should include specifications on the equipment and procedures to be used and the performance standards to be met. The content of the stipulated service specification should be based on your willingness to pay for the desired level of service. Examples of service specifications are shown in Appendix A.



Medical waste needs to be clearly marked.



STEP 3: COMPILE FINDINGS IN AN ASSESSMENT REPORT

A detailed assessment report of the findings after accomplishing the first two steps needs to be prepared. This report should include the definition and detailed evaluation of the service area with respect to medical waste management. Sufficient detail should be provided in the report so that decisions can be made as to the best means for improving medical waste management in the service area. This report will be the basis by which others (political officials, approval agencies, etc.) can review your initial findings and provide input into the contract development process. The assessment report should, at a minimum, include the following sections:

1. Assessment of existing medical waste sources in the defined service area.
2. Summary of current medical waste management practices.
3. Summary of alternative scenarios for improved medical waste management.
4. Recommended preferred approach to improve conditions.
5. Recommended implementation plan.
6. Recommended schedule for implementation.



Lift for incinerator cart.

STEP 4: SELECT THE PREFERRED MEDICAL WASTE PROGRAM

The preferred option or development scenario for medical waste management in the service area will be a function of the characteristics of the service area and its health care facilities. The selection of the preferred approach may be specific to the manner that medical waste is collected, transported, or treated. A range of acceptable options may also be acceptable, as this will allow the contractor some flexibility in achieving the service specifications and performance standard. Whatever you select for preferred approaches to achieving the desired results, they should be clearly defined in detail in the RFT. This will prevent the contractor from basing their proposal on technical options that you deem unacceptable or less desirable. For example, the governorate may not view incineration as an acceptable or preferred means of achieving medical waste treatment.

Designating a preferred site for a treatment facility in the RFT is important for a number of reasons, including:

- A contractor will not be as knowledgeable about all of the conditions that may influence siting of the treatment facility.
- Designating a treatment site helps to define collection routing and treated residue disposal transportation requirements. These will be very important in defining the technical resources (trucks, etc.) that the contractor will need to provide effective service.
- A private contractor may have more difficulties in securing and permitting a site for their proposed treatment facility.

Site selection should be based on a number of factors including:

1. Current ownership and availability of the site.
2. Current or proposed land use adjoining or near the proposed site.
3. Accessibility to the health care facilities to be served (road conditions, distances, and transportation times).
4. Quantities of medical waste expected for the various health care facilities with the service area.
5. Potential changes in the size or treatment characteristics of health care facilities that could affect medical waste capacity requirements in the future.
6. Potential environmental or health impacts associated with specific sites (such as a proposed location within a concentrated industrial area).
7. Public attitude toward the treatment system to be employed and its proposed location.



STEP 5: IMPLEMENT THE SELECTED PROGRAM

There are a number of implementation steps that should be undertaken once the preferred options for managing medical waste in the service area have been selected. These are aimed at securing a qualified contractor and developing the means for monitoring the contractor's performance after award of the contract. They are also aimed at educating participating health care facilities as to their responsibilities in the program as well as to the level of service that they can expect.

Establish Program Funding Mechanism

Before a contracted service commences, you will need to define and assure the means for funding the service after commencement of the service. Chapter 3 provides further information on how solid waste management services can be financed.

If a "user pays" principle is employed, the manner in which these fees are collected from medical waste generators must be developed. If medical waste management is only part of a larger scale integrated solid waste management project, the funding mechanism for the overall project will, more than likely, cover the medical waste component. In either case, all of the necessary approvals and budgets will need to be in place before the service begins. You should try to provide as much information as possible in the RFT as to how the service will be funded. This will help assure prospective contractors that the project will go forward so long as their terms for providing it are reasonable. It will also assure them that it is worth their investment to submit a proposal in the detail that is required through the structured RFT process recommended in this manual.

Procure a Contractor

The competitive procurement or bidding process requires the preparation of two major documents by the contracting agency:

- A Request for Qualifications (RFQ).
- A Request for Tender (RFT).

Both of the above documents are prepared by or under the guidance of a technical or tender committee.



Autoclaved medical waste.

The RFQ is used to pre-qualify contractors who then will be allowed to submit bids or tenders in response to the RFT. Generally it provides the contracting industry with an overview of the project and outlines the disciplines and level of expertise needed to perform the project. The RFQ provides guidance on how the contractors should respond and how their responses will be evaluated.

The RFT is the document the pre-qualified bidders use to prepare their tenders. It generally consists of a book of conditions and annexes, including technical specifications. It provides great detail about the required services and typically becomes a part of the contract between the governorate and the selected contractor. Guidance on how both of these documents are prepared and used is presented in Chapters 4 and 5.

The draft contract, general conditions of the contract, and appendixes are all part of the RFT and ultimately will form the basis for the contract between the governorate and the successful bidder. It is extremely important to prepare these documents carefully to ensure that the long-term contract relationship is properly formulated and that the responsibilities and risks are appropriately assigned between the parties.

Appendices to the general conditions are used to set forth specific information necessary to completely define the requirements of the work and to provide any information affecting the performance of the service. Typical topics covered include the following:

- Technical Specifications.
- Bidder's Technical Proposal.
- Facilities and Equipment.
- Contract Performance Letter of Guarantee.
- Supplemental Information.

Instructions on how to prepare a draft contract, general conditions, and appendixes are provided in Chapter 5. Specific instructions on how to prepare technical specifications for the appendixes of an RFT for medical waste management services can be found in Appendix A of this chapter.

Develop and Implement Means of Contract Administration and Monitoring

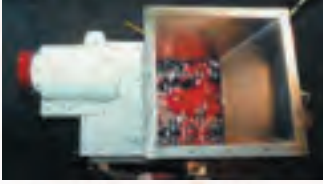
An effective contract administration and monitoring program must be established to maintain the performance standards that will be stipulated in the contract. Chapter 6 defines the means by which a Contract Monitoring Unit (CMU) can be established. Developing the means for contract monitoring is extremely important in the ongoing effectiveness of the program. The CMU will provide the basis by which medical waste management services can be maintained at the level agreed to in the contract. The CMU also provides the means by which service issues can be addressed and rectified to maintain the contracted level of service.

CMU staff should be provided detailed training on a number of issues because of the specialized aspects of medical waste management. This training should, at a minimum include:

1. Understanding of the characteristics of medical waste.
2. Contract terms and specifications as they pertain to the contractor's performance.
3. Procedures to take in the event of failure of the contractor or health care facilities to follow program rules.



Medical waste carts.



Medical waste grinder.

4. Monitoring reporting.
5. Health and safety.

Develop Public Awareness and Communications Program

An awareness and education program should be developed once the desired medical waste management program has been defined. Refer to Chapter 7 for comprehensive instructions on how to develop a public awareness and education campaign.

Elements of this program should incorporate the following objectives:

- Provide information to health care facilities on what they can expect from the contractor and what they must do to fulfill their responsibilities within the program.
- Provide information to the public on the intent of the contracted service and the benefits to be derived from it.
- Educate the public as to the proper management of small quantities of medical waste derived from home health care. An example of this is the proper disposal of sharps associated with insulin injections by diabetics.





APPENDIX A: INSTRUCTIONS AND EXAMPLES FOR TECHNICAL SPECIFICATIONS

Developing the technical specifications for the RFT is one of the most important components in assuring the success of the contracted medical waste management service. The technical specifications must include all of the information that prospective contractors will need to formulate a good and responsive proposal.

The RFT should include detailed information concerning the requirements of prospective contractors to pre-quality and to submit a responsive bid. The technical specifications provide specific information on the various technical elements (medical waste management, industrial waste management, etc.) that will be covered by the contractor's bid. The technical specifications for medical waste management should, at a minimum, include the following sections:

- Definitions
- General Description of Services.
- Service Specifications.
- Minimum Technical Requirements.
- Performance Standards.
- Performance Monitoring.
- Penalties.

Detailed instructions on how to prepare all these sections is provided in Chapter 5. Information specific to providing technical specifications for medical waste treatment and disposal services is presented in this appendix.

General Description of Services

This section of the technical documents is intended to define the level of service that will be required of the contractor. The target level of service would normally be defined during the planning process undertaken to develop the RFT. This required level of service can be defined by presenting the following information to the contractor.

Health Care Facilities and Medical Waste Generation

Since this level of service is a function of the number and types of health care facilities that are in the service area, specific information must be provided to assist the contractor in preparing their tender. At a minimum, information must be presented on the health care facilities within the defined service area by ownership and general location. This information should be provided with the caveat that it is the contractor's responsibility to verify the information provided and updating it as necessary during the preparation of their bid and performance of the contract.

This section should also define for the contractor the various responsibilities of the parties that will be involved in the contract. For example, it is important for the contractor to know that you will require all health care facilities to take part in the program and that regulations will be adopted that will require health care facilities to segregate their solid waste stream into its municipal solid waste and medical waste components. To the degree possible, the technical specifications should provide a breakdown of the amount of non-hazardous and medical waste generated at each health care facility that will be part of the program. Because of the overall cost of treating medical waste, this will be a very important issue for the contractor in assuring that their overall costs are not influenced by having to manage material as medical waste that does not belong in the medical waste stream. This will include MSW as well as other waste forms that may be generated but which remain the responsibility of the health care facility such as radiological, toxic, and hazardous waste.

The need for effective segregation will also be an important element of the educational program by which health care facility staff will be instructed about their responsibilities within the medical waste management program.

Medical Waste Management Service to be Provided

The medical waste management service will normally encompass a number of specific elements intended to manage medical waste from its point of collection at health care facilities to final disposal at a designated site. (Refer to Figure 11.1 in the introduction to this chapter.) As shown there are important steps

in the overall management program that remain the responsibility of the generator. The technical specifications must clearly define the responsibility of the health care facilities and those that will be placed on the contractor. Typical services that will be required of the medical waste management contractor include:

- Collection of medical waste from the health care facilities.
- Transport of collected medical waste from the health care facilities to the treatment facility(s).
- Design, construction, and operation of the medical waste treatment facility(s).
- Transport of the treated medical waste residue to the designated disposal facility(s).

The contractor should also be given the responsibility for the design, implementation, and operation of a medical waste “source to disposal” tracking system for infectious medical waste.

Preparation Period

The technical specifications should also provide the contractor with the time frame in which they will have to accomplish mobilization of the contract upon its issuance. While the government should be looking to implement the medical waste management program in the shortest possible period, the contractor must be given sufficient time to achieve the tasks required to begin their operations. Typical activities that will be required of the contractor after award include the following:

1. Finalize field data collection and analysis.
2. Order, receive, and mobilize equipment.
3. Recruit and train personnel.
4. Prepare routing maps and schedules.
5. Design the medical waste tracking system.
6. Prepare an Environmental Impact Assessment (EIA) report.
7. Complete permitting activities.
8. Finalize facility engineering design and drawings.
9. Establish/build facilities for treating the medical wastes.
10. Secure required service agreements with suppliers.
11. Develop and implement a Health Care Facility Education Program.

Service Specifications

The technical specifications must establish firm service specifications by which the medical waste management service will be provided. Typical service specifications that should be a requirement of the contract include the following categories.

Draft Work Plan

The draft work plan should normally be submitted as part of the contractor’s technical proposal in response to the RFT. This plan will be an important element in reviewing the contractor’s technical adequacy to undertake the project. Generally, the draft work plan will contain sufficient information to obtain EIA approval from the Egyptian Environmental Affairs Agency (EEAA) and to clearly define the contractor’s approach in providing various service and technology components of the work.

The draft work plan should include detailed descriptions of the following project elements:

1. Overall project schedule.
2. Treatment Facility site(s).
3. Plans for administration, staffing, and management of collection, treatment, and transport operations.
4. Descriptions of information database, tracking, record keeping, and reporting systems to be used by the contractor.
5. Procedures for communicating with the government project administration personnel and health care facility representatives.
6. Development and dissemination of health care facility education materials.
7. Description of how the contractor will comply with each of the service specifications and minimum technical requirements.
8. Information concerning the manner in which medical waste will be collected including
 - Maps of proposed collection routes.

- Proposed route time schedules.
 - Specifications for containers, equipment, and vehicles.
 - Schedules for procurement of containers, equipment, and vehicles.
 - The schedule for delivery of waste containers to the HCFs.
 - Descriptions of the number and type of personnel and equipment to be deployed.
 - Proposed waste collection/transport vehicle sanitation, inspection, and preventative maintenance program and schedule.
9. Specifications for all major equipment, including manufacturer's literature for all collection, transport, and treatment equipment including a description of the equipment preventive maintenance program.

Descriptions of the minimum qualifications, duties, responsibilities, and number of positions of personnel to be employed by the contractor in providing the service.

Preparation Work Plan

The intent of the preparation work plan is to describe in detail the project implementation activities that will be undertaken by the contractor during the preparation period prior to actual service operations. This plan should provide schedules for the initiation and completion of all preparation activities including, but not necessarily limited to, the following:

- Overall project schedule.
- Collection route design and scheduling.
- Final engineering design schedule.
- Recruiting and training labor and supervisory personnel.
- Procurement of supplies and equipment.
- Construction of facilities.
- Development and dissemination of education materials.

Final Work Plan

After the contract has been awarded and draft work plan government review input is provided to the contractor, a final work plan should be prepared and submitted. The final work plan will be an updated version of the draft work plan that has incorporated all of the information and desired changes presented by the government during the final contract negotiations. This final work plan should include information such as the final collection route design and schedule, the final equipment supply procurement schedule, and medical waste treatment facility design, construction, and operation plans.

Health Care Facility Addition

The service specifications should hold the contractor responsible for the extension of any routes and services within the service area that are required to accommodate new health-care facilities that are developed during the term contract. The specifications should include a minimum period (48 hours, for example) in which they contractor must extend the routes and services upon notification by the governorate.

Hours and Days of Operation

The service specifications should stipulate the hours and days of operation of the various elements of medical waste management. Generally, the service specification should allow collection, treatment, and disposal services to occur at any hour of the day so long as the activities can be performed without causing public disturbances, nuisances, or safety hazards that are deemed unacceptable by the government.

Permitting

Since project permitting is very much a function of the technical details of how the service will be provided, permitting should be the primary responsibility of the contractor. This should include the development of an EIA that must meet all EEAA permitting regulations required for design, construction, and operation of the medical waste management services. In addition, the contractor should be directed in the technical documents that they have the responsibility for obtaining any other permits that may be required from the Ministry of Housing, Ministry of Health, Ministry of Industry, and any other ministry or agency required. These permitting activities should also include any other approvals that must be achieved on a local or governorate level.

Public Disturbance, Nuisance, and Safety Hazards

In the design and implementation of their medical waste management service, systems and activities, the contractor should be responsible for all reasonable steps required to minimize off-site disturbances, nuisances, and public safety hazards.

Treatment Facility Design, Construction, and Operation

The contractor should be responsible for the design, construction, and operation of the treatment system that will be required to treat the collected medical waste prior to disposal. The RFT may provide some indication of the government's preference for treatment technologies. However, the ultimate responsibility for implementation of the treatment system should be placed on the contractor and this should be made evident in the RFT. That responsibility should cover the full construction of the facility in accordance to the approved plans and specifications as well as its effective operation of the facility during the full term of the contract. In fulfilling their construction responsibility, the contractor should be responsible for all construction of the facility and all of its associated subsystems including access roads, site fencing, scales, office buildings, utilities, utility hookups, environmental control systems, and any other ancillary system required for the function of the facility. The technical specifications should include a requirement that the contractor provide record or as built drawings of all facilities soon after completion of construction.

Treatment Quality Control

In defining the service specifications, the RFT should also require that the contractor provide a medical waste treatment quality control plan that describes in detail the quality control testing and sampling procedures and standards that will be used to assure proper treatment of the medical waste. This plan should include an indication of what remedial actions will be taken for noncompliance to the treatment standard and the procedures that will be used for calibrating all instruments that are used to determine treatment effectiveness and quality.

Waste Collection and Waste Residue Transport

The contractor should be responsible for waste collection and residue transport. At a minimum, this should include the design and operation of collection routes, the selection and procurement of necessary equipment and any other feature required for collection of the medical waste from the health care sources with the service area.

Minimum Technical Requirements

The minimum technical requirements are intended to define the standards that the contractor must meet in providing the medical waste management service. The technical specifications' stipulation of minimum technical requirements is intended to help prospective contractors understand what deliverables they must provide.

Waste Collection

Since this is one of three principal core responsibilities that the contractor must undertake in providing medical waste management services, the minimum technical requirements will be the basis by which performance standards are set that the contractor must meet in fulfilling the intent of the contract. The contractor should be responsible for purchase, operation, maintenance, and management of all collection containers and vehicles associated with the program. Some of the key technical requirements that are necessary for effective medical waste collection include the following:

1. **Frequency:** The contractor should be required to perform the necessary medical waste collection services a minimum of 6 days a week and collect medical waste of all health care facilities at least every other day.
2. **Waste Placement:** Health care facilities must be responsible for managing medical waste at their sites. This should include the placement of all medical waste into appropriate containers. Health care facility responsibilities are one of the important issues that must be part of the educational program that will instruct health care facility staff on how to interface with the medical waste management service at the point of collection. As such, health care facility staff must be instructed to clearly understand that the contractor will not collect sharps or any other medical waste that has not been properly placed into appropriate containers. The minimum technical requirements should include a procedure by which

the contractor will issue a non-collection notice to the health care facility if there is a deficiency in the manner in which the health care facility has prepared their medical waste for collection by the contractor. This procedure must include the means by which you are made aware of non-collection events.

3. **Spillage:** Responsibility for cleaning up any spillage will remain with the entity creating the spillage. For example, the minimum technical requirements should stipulate that contractor will not be responsible for cleaning up loose waste around any medical waste containers at the point of collection if this loose waste was caused by the health care facility. Conversely, the contractor must be responsible for cleaning up any spillage that occurs as a result all its actions in collecting or transporting the medical waste. Any such spillage must only be cleaned up in accordance with the medical waste environmental control plan developed for the contracted service.
4. **Required Documentation:** As part of the minimum technical requirements, the contractor should furnish each health care facility with a signed receipt for each shipment at the time of collection of the waste. This receipt will identify the generator by name and address and list of the amount of waste collected by weight, the shipment and container numbers, and the date and time of collection. This type of information will be important in tracking any actions that might lead to complaints about the contractor's activities.
5. **Waste Delivery:** The service contract should require that the contractor deliver any collected waste to the medical waste treatment facility within 8 hours of its collection.
6. **Scavenging:** The contractor must forbid all employees and subcontractors and prevent all others from scavenging or attempting to retrieve any component of the medical waste. This is a crucial issue if the health and safety of the public is to be maintained.
7. **Property Damage:** The contractor should be held responsible for all costs associated with the repair or replacement of damaged property of any kind that results from the actions of its equipment, employees or agents. Collection crews must be required to report any incident causing damage to third-party property to the contractor's general manager who must then inform the government within 12 hours of the occurrence.
8. **Noise:** The contractor should accomplish all of its activities so as to minimize noise from collection equipment and the actions of collection personnel.
9. **Street Usage Rights:** While the contractor must be granted the right to use streets and roadways for the purpose of providing medical waste collection services, the minimum technical requirements must clearly advise the contractor that they will not be granted exclusive use of the streets. As a result, the contractors should endeavor to not block the passage of other vehicles along roads at or near the point of collection. If such blockages are unavoidable, the contractor's vehicle should pull aside at the first opportunity to allow waiting vehicles to pass.

Waste Containers

The contract should require the contractor to supply all containers that will be used to collect medical waste. This will allow the standardization that is important to the overall efficiency of the program. Some of the key minimum technical requirements that pertain to waste containers follow:

1. **Supply and Delivery:** The contractor should be responsible for providing and delivering all medical waste storage and collection bags, boxes, and containers to all participating health care facilities within the service area.
2. **Container Specifications:** These containers should, at a minimum, meet United States standards for infectious medical waste storage, collection, and disposal. To meet these standards, all medical waste bags should be red and all medical waste boxes or other containers should clearly state in both Arabic and in English that the contents of the box are infectious in nature.
3. **Container Use:** The minimum technical requirements should also specify the manner in which health care facility staff will use the supplied containers.
4. **Sharps Handling:** Since they are particularly dangerous, sharps must be placed in puncture resistant containers that are specifically designed for this type of medical waste. The contractor should be required to supply these containers. Safety reasons dictate that these containers not be subjected to compaction nor should the contractor collect any sharps that are not placed in the required containers.
5. **Outer Containers:** Outer containers, if used, should be conspicuously marked with a warning in Arabic and English along with the international symbol for biohazardous material.

At a minimum, this warning must appear on the sides of the container, twice in Arabic and twice in English. The wording of the warning should be as follows: "Caution, contains infectious medical waste which may be biohazardous." In addition, the contractor should also be required to affix an identification label to the each container that contains the name and address of the generator and either the date of shipment or an identification number for the shipment.

Waste Collection and Treated Residual Transport Vehicles

The contractor will be responsible for purchase, maintenance, and operation of all medical waste collection and treated residue transport vehicles. The minimum technical requirements should establish a general specification for this equipment. The contract should require the contractor to provide a list of the vehicles and equipment to be used at least 30 days prior to the beginning of the service and annually thereafter. The minimum technical requirements should require that the following minimum standards are met:

1. **Fleet Changes:** The contractor should be required to report in writing to the government within 24 hours of the date of changing any component of the fleet.
2. **Waste Placement:** The contractor should forbid all waste collection crews from placing any medical waste inside the vehicle cab or on the outside of the collection vehicle except in the waste cargo area. The contractor should not permit anyone to scavenge or reclaim any portion of the waste from the collection vehicle.
3. **Vehicle Cargo Area:** The area of the truck used for placement of the unprocessed medical waste and treated medical waste residue must be watertight and designed to prevent spillage of any solids or leakage of any liquids onto the ground or exterior body of the vehicle. The waste cargo area should be locked when the vehicle is in motion and medical waste is contained in the vehicle.
4. **Sanitation:** The contractor should be required to wash with water and a disinfecting and deodorizing cleaning agent the interior of the waste cargo area of all vehicles that are used for transporting medical waste and treated residue. This should be done at least once every service day. In addition, all exterior surfaces of the vehicle should be washed with water and disinfecting and degreasing cleaning agents at least once a week.
5. **Maintenance:** The minimum technical requirements should require that contractor maintain all vehicles in the safe and operable condition to minimize the threat to health and safety of workers and the public. As a result, the contractor should be required to maintain accurate records for each vehicle including at a minimum:
 - Vehicle identification number.
 - Date and mileage.
 - Nature of the repair.
 - Compliance with the preventive maintenance schedules submitted as part of the final work plan.
 - Signature of the maintenance supervisor attesting to the fact that the repair was properly performed.
6. **Inspection:** The contractor should inspect each vehicle daily to ensure that all equipment is operating properly. Any vehicle that does not pass this inspection must be taken out of service until it passes inspection and operate properly. The contractor should be required to maintain accurate daily vehicle inspection reports that are made available to CMU staff immediately upon request for review. A standard checklist form should be developed for this purpose.
7. **Vehicle Operation:** The contractor must assure that vehicles are operated only by personnel that are trained in their safe and efficient operation. Vehicle operators must have all required permits and licenses to operate vehicle. The contract terms should require that the contractor provide documentation, no later than 10 days prior to the commencement of collection operations, that all vehicle operators have the required training and that they have passed a written examination and driving test. In addition, medical waste and treated residual transport vehicles should not be used for personal transportation, or to transport unauthorized passengers.
8. **Markings and Identification:** The contractor should also be required to assure that all vehicles have highly visible (greater than 10 cm) lettering on each side of the vehicle body indicating the name and telephone number of the contractor. In addition, vehicle identification numbers unique to each vehicle that are a minimum of 8 cm high should also be put on all vehicles.

9. **Licensing Inspection:** All vehicles used by the contractor should be registered, inspected, and insured and be in full compliance of all local ordinances and national laws applying to motor vehicle ownership and operation.
10. **Appearance:** The contract should also require that collection and transport vehicles be repainted at least once every 3 years.
11. **Ancillary Equipment:** The minimum technical requirements should require that, at a minimum, collection and transport vehicles will be equipped with:
 - Fire extinguisher.
 - Shovels and brooms for the collection of spilled waste.
 - Chemical disinfectants and absorbents to be used in the cleanup of small localized waste spills.
 - Personal protective equipment such as gloves, face masks, coveralls, and eye protection.
 - Leak proof containers and packaging materials.
 - An audible backup warning device that is activated when the vehicle is backing up.
 - Two-way communication with the contractor's collection supervisor and dispatch/maintenance office.
12. **Storage:** The contract should also require that contractor vehicles not be stored on public streets or other public property but should be stored at all times on private property having the proper zoning either within a building or fenced yard when not in use. The contractor should provide written notification describing the storage location of all collection vehicles.. This notification should be provided a minimum of 30 days prior to the first day of service and annually thereafter.
13. **Reserve Equipment:** The contractor should also provide reserve equipment that can be put service within 2 hours notice of any breakdown so as to prevent any prolonged interruption of any regularly scheduled waste collection service. This re serve equipment must be equivalent in size and capacity to the equipment normally used by the contractor to perform the collection or transport service.
14. **Loading:** The contractor should also assure that the vehicles are not loaded in excess of the manufacturer's gross vehicle weight rating or in excess of the maximum weight specified by the Egyptian Roads and Bridges Authority.
15. **Medical Waste Shipment Transfer:** Collected medical waste and treated residue should not be transferred from one vehicle to another except in the case of vehicle breakdown or an accident.

Treatment Technology and Capacity

The contractor should be responsible for providing an appropriate technology for the treatment of the medical waste that they collect. Through the contract, the contractor will be responsible for design, permitting, construction and operation of the treatment facility. The minimum technical requirements should provide the basis by which the contractor will select an appropriate technology. Key factors in that selection are described as follows:

1. **Treatment Facility Capacity:** Through the contract, the contractor will be responsible for verifying the medical waste generator information for the service area. Based on the contractor's assessment and projections of increases in the quantity of infectious medical waste to be generated over the term of the contract, the contractor will determine the optimal design capacity for the treatment facility. This design capacity should be based on nominal and peak generation rates of infectious medical waste within the service area.
2. **Treatment Standards:** The treatment technology selected by the contractor must be effective to fully reduce, render or combust the medical waste to non-infectious residue. The actual disinfection process selected by the contractor should not be reliant on chemical processes and it should be effective for all waste defined by the WHO as being potentially infectious (including sharps in sharp containers and bulk body fluids such as blood bags). The treatment facility should have fail-safe built in to the technology to stop the cycle and alert the operator should disinfection operating parameters not be achieved at any time. At a minimum, the technical requirements should state that the contractor provide specific laboratory evidence that demonstrates the technology's ability to provide treatment meeting acceptable standards, In its various plans to be submitted before the commencement of operations, the contractor should provide the protocols for efficacy testing. The protocols for testing should incorporate, as applicable, recognized, standard methodologies that are consistent with the proposed treatment method.

3. **Proven Technology:** Only effective technology should be selected for treatment of the infectious medical waste. At a minimum, the technology should have a history of successful commercial operation for at least 5 years, and should have been employed successfully in at least three treatment facilities of similar size. A list of these treatment facilities and contact information should be supplied with the response to the RFT.
4. **Waste Handling:** The technology should enable waste receiving and disposal with minimal manual handling and should be compliant with WHO recommendations for safe medical waste collection and disposal.
5. **Treatment Facility Design:** If on-site testing is required or desired for the treatment technology, or for any other testing needs, the treatment facility should also incorporate a laboratory with the necessary testing and analytic equipment and materials. (The RFT should require that a proposed site layout be included with the tender offer.) The medical waste treatment facility should incorporate, at a minimum the following components:
 - Scale for weighing incoming waste and outgoing residue.
 - Enclosed area for unloading waste containers from trucks.
 - Waste inspection station.
 - Radiation detection.
 - Enclosed staging area for holding of medical waste containers prior to processing.
 - Equipment including feed systems, processing, emission controls, residue/by-product handling and storage, out loading, compaction, etc.
 - Area for holding of treated medical waste residue prior to transport to the disposal site.
 - Emergency wash-down equipment.
 - Area and equipment for the washing of containers and vehicles.
 - Holding tank(s) for wash-down waters and/or liquid spills.
 - Fire detection/suppression systems.
 - Administrative/management facilities, including files and records.
 - Staff facilities, including dressing/cleanup areas and rest/eating areas.

Weighing and Materials Classification System

The treatment facility should be equipped with a permanent vehicle weighing system so that all incoming medical waste and outgoing treatment residue can be weighed and recorded. This system should be capable of weighing vehicles up to 125% of the highest gross vehicle weight proposed by the contractor. The scale system should also be able to weigh material in increments no greater than 5 Kg.

Process Controls and Record Keeping

The treatment facility should have the means to control its primary processes via a computerized system. This system should allow a print-out to be available for each and every process cycle. This system should, at a minimum, provide the following data:

1. Date and time.
2. Duration of cycle.
3. Temperature or other treatment standard achieved.
4. Quantity of waste processed.
5. Quantity of treatment residue produced.
6. Air emission data.

Fire Control and Suppression

All buildings which comprise the treatment facility should be constructed of fire resistant materials. The contractor should install and maintain a fire suppression system designed in accordance with Egyptian standards. The contractor should be required to install and maintain fire extinguishers throughout all facility buildings.

Treatment Facility Operation

The operation of the treatment facility must be covered by stringent performance standards defined in the technical documents of the RFT. These should be designed to protect the health and welfare of the public as well as that of treatment facility workers. Some of the key operating standards that should be met follow.

1. **Location of Activities:** All treatment activities performed under the contract should only take place at the approved treatment facility.

2. **Hours and Days of Operations:** Delivery of waste to the treatment facility may occur at any time of the day. The treatment facility should be open to receive waste a minimum of 6 days per week.
3. **Materials Records:** The contractor should be required to gather and maintain operating information and records throughout the term of the contract including detailed records of all incoming medical waste to be treated and outgoing treatment residue.
4. **Access Control:** The treatment facility should be surrounded by fencing or other secure structural barrier equipped with a gate that prevents uncontrolled access and vandalism to the facility. The minimum technical requirements should stipulate that all fencing, barriers, and gates must be maintained in proper working order at all times. The contractor must restrict admission to the treatment facility to its employees, subcontractors, and designated government staff or their consultants. All other individuals or parties visiting the treatment facility should be required to have prior permission from the contractor's treatment facility manager.
5. **Unacceptable Waste:** The minimum technical requirements should stipulate that vehicles delivering any unacceptable wastes must immediately leave the medical waste treatment facility. If unacceptable waste has been unloaded or dumped at the facility, the contractor should immediately load the waste back into the delivering vehicle so that it can immediately leave the facility site.
6. **Waste Storage:** The minimum technical requirements should require that all medical wastes be treated within 24 hours of delivery to the treatment facility. All medical wastes stored on site should be treated by the end of each operations day with no overnight storage of untreated medical wastes in the receiving area. Medical waste should be stored in a secure manner and location that provides protection from theft, vandalism, inadvertent human or animal exposure, rain, water, and wind. Medical wastes should be managed in a way not to provide a breeding place or food for insects, rodents, or other animals and not generate noxious odors.
The contract documents should stipulate that the contractor will not allow more than 3-days of untreated medical waste to accumulate, either at the health care facilities, within the collection system, or at the treatment facility.
In the event of malfunction of the treatment facility, the minimum technical requirements should state that the maximum downtime of the treatment facility should not exceed 72 hours. Provisions must be made that medical wastes that must be held for more than 24 hours before treatment should be stored at a temperature of 5°C or less.
7. **Residue Storage:** Treated medical waste residue should be removed from the treatment facility to the designated disposal facility within 24 hours of treatment.
8. **Residue Disposal:** Through the contract documents, the contractor should be made responsible for transporting treated medical waste residue resulting from treatment to the designated disposal facility.
9. **Residue Disposal Hours:** Delivery of treated medical waste residue to the designated disposal facility should be restricted to the hours of operation at the disposal site.

Medical Waste Treatment Quality Control Plan

The contractor should prepare a medical waste quality control plan defining the appropriate quality control testing/sampling procedures and standards. The quality control plan should also describe the remedial actions to be taken if quality control standards are not met. It should also specify the procedures for annual, or more frequent, calibration of instruments and certification.

Facility and Equipment Maintenance

The contractor should maintain all facilities in a way that does not negatively impact daily operations, site security, worker health and safety, or public health. The contractor should maintain the following items in good working condition capable of performing their intended function:

1. Buildings and other structures including, and not limited to, perimeter fencing, gates, paved surfaces, unpaved surfaces, drainage structures and yard piping, wash-down water collection and storage facilities, utilities, and truck scales.
2. Stationary equipment including, and not limited to, waste treatment equipment and waste and residue moving equipment.

3. Mobile equipment including, and not limited to, skid steers, collection vehicles, transport trucks, etc.
4. Medical waste and treated medical waste residue storage and transport containers.

Environmental Control and Standards

The treatment facility should meet all local and national air emission requirements, and all other local and national public health and safety standards.

Medical Waste Environmental Control Plan

The contractor should be required to prepare a medical waste environmental control plan defining environmental control testing procedures and standards for process air emissions, vented air, effluent, wash-down water, odors, noise, etc. The environmental control plan should describe the remedial actions to be taken whenever environmental control standards are not met. At a minimum, the environmental testing and control stipulated in this plan should include:

1. **Vented Air:** Vented air from the treatment process should be filtered or treated to remove pathogens, dust, and chemical contaminants.
2. **Effluent:** The treatment system should not produce a liquid effluent that does not conform to national and local regulations and limits for wastewater.
3. **Off-Site Run-Off:** Surface run-off from precipitation falling outside of the medical waste receiving, holding, and treatment areas and the treated residue holding and loading areas, should be diverted by drainage ditches and swales to off-site drainage features.
4. **Wash-Down Water:** Wash-down water from any area where medical waste or treated medical waste residue is handled should be separated from all other run-off, collected, and contained in a holding tank. The holding tank and any water therein should be disinfected at least once a day. Collected wash-down water may be treated or used in the medical waste treatment system if it is technically feasible, and approved by the government. Alternately, it may be disposed at a wastewater treatment facility designated by the government.
5. **Litter Control:** The contractor should inspect the entire perimeter of the facility daily and collect all litter. Collected litter must be disposed along with all other MSW generated at the facility on a daily basis.

Environmental Control Record

The contract technical documents should require environmental control records for the treatment facility documenting the control procedures taken to avoid releases, including waste spills, air emissions, effluent, wash-down water, vented air, odors, and noise levels.

Leakage and Spill Control

The contractor must be required to closely monitor for and immediately remediate any leaks and spills that may occur during their activities including the following:

1. **Fuel Leak:** In the event of a fuel leak from a collection/transport vehicle or from treatment facility equipment, the spill area must be isolated and a commercial absorbent product applied to the spill. This material must then be collected, containerized, and disposed in accordance with applicable environmental regulations.
2. **Medical Waste Spillage:** Spilled medical waste should be sprayed with a chemical disinfectant, collected, containerized, and treated in the treatment system. Equipment used to collect the spilled waste, and the area where the spill occurred, should immediately be sprayed with a chemical disinfectant. After disinfection, the area and the equipment should immediately be washed down with clean water.
3. **Treated Medical Waste Residue Spillage:** Spilled treated medical waste residue should be collected and put back into the residue holding area. All equipment used to pick up the spilled treated medical waste residue, and the area where the spill occurred, should immediately be washed down with clean water.
4. **Contaminated Water Spillage:** In the event that water comes in contact with medical waste or treated medical waste residue and does not readily flow back into the wash-down water holding tank, a commercial absorbent product should be applied to the spill. This material should be collected, containerized, and disposed in accordance with applicable environmental regulations.

5. **Spill Control Records:** All spills should be recorded in the Environmental Control Record Book. For each control action taken in response to an exceedance or release, the contractor should be required to record sufficient information to document the spill.

Analytical Records

The contractor should be required to maintain complete records of all testing and analysis performed.

Contractor's Personnel and Subcontractors

All of the personnel and subcontractors working for the contractor must be properly trained and qualified to perform the tasks that are assigned to them. At a minimum, staff and subcontractors should meet the following minimum technical requirements.

1. **Competence and Skills:** All contractor and subcontractor personnel must be competent and careful workers, specifically trained and skilled in their respective trades.
2. **Facility Management:** The contractor should assign a qualified facility manager for each facility and the collection fleet, and provide the name of this person in writing to the project administrator.
3. **Uniforms:** The contractor should provide, and all employees should wear, adequate uniforms, gloves, work boots, reflective vests, and other protective clothing. Uniforms and safety gear must be approved by the government.
4. **Demeanor:** The contractor should require all employees to conduct themselves in a courteous and helpful manner and refrain from using any loud or profane language.
5. **Fees and Gratuities:** The contractor should not permit any employee, agent, or subcontractor to offer special service beyond the scope of the contract, or to request, solicit, demand, or accept, either directly or indirectly, any compensation or gratuity for services that are included in the scope of the contract.
6. **Driving Licenses:** Each driver of a collection/transport vehicle should at all times carry a valid Egyptian driver's license and all other required permits as required by Egyptian Law.
7. **Dismissal Authority:** The governorates's project administrator may demand the dismissal of any person employed by the contractor or its subcontractors who repeatedly misconducts, is incompetent, or negligent in the performance of his/her duties, or refuses to comply with the instructions given. Any person so dismissed should not be re-employed by the contractor without the written consent of the project administrator.

Worker Health and Safety and Emergency Response

The contractor must be required to assure that priority is given to worker health and safety and emergency response. The following are some of the key requirements for an effective program to assure that priority.

1. **Fire Control Plan:** The contractor should develop a fire control plan that includes instructions for workers on fire suppression and evacuation plans, and inspection schedules for the fire suppression system and fire extinguishers.
2. **Health and Safety and Emergency Response Manual:** The contractor should develop a health and safety and emergency response manual that contains instructions for protecting worker health and safety and responding to foreseeable emergencies including fire, medical emergency, vehicle accident, and environmental hazards. All contractor and subcontractor personnel should be provided with a health and safety and emergency response manual.
3. **First Aid Kits and Personnel Protection Equipment:** The facility operator should provide emergency first aids kits at all workstations. Site workers should be provided and wear personal protective equipment including, and not limited to, steel toe shoes, hard hats, safety glasses and/or facemasks as appropriate, and ventilation masks.
4. **Vaccinations:** All employees involved in the collection, treatment, and transport operations should be receive and maintain all commonly available vaccinations for any disease that may be contained within the infectious medical waste.
5. **Monthly Safety Inspections:** The contractor should conduct a monthly safety inspection of the entire facility and inspect the condition and upkeep of all required personal protective equipment in use.
6. **Emergency Event Record:** The contractor should maintain an emergency event record that contains information for each occurrence of fire or accident causing personal injury:

Health Care Facility Education Program

The contractor should develop and implement a health care facility Education Program that instructs medical waste generators on the proper handling, segregation, collection, and storage of the medical waste and medical waste containers.

Complaint Handling

The contractor must be required to develop an effective complaint handling procedures. Key elements of this procedure are as follows:

1. **Customer Service Office:** The contractor should maintain a customer service office with toll-free telephone access where complaints can be received 24 hours per day from government project monitors and all health care facilities.
2. **Customer Service:** All calls to the contractor's customer service office should be answered in a professional and courteous manner within 3 minutes.
3. **Complaint Records:** The contractor should record all complaints in a bound book, noting the name and address of complainant, date and time of complaint, nature of complaint, and nature and date of resolution. The contractor should retain the complaint book and provide a copy to the government with the monthly operations report.
4. **Complaint Reporting:** The contractor should compile a summary statistical table of the complaint log, in a form satisfactory to the government, and submit the table to the government at the end of each quarter. The government should reserve the right to examine the complaint log at any time.
5. **Complaint Resolution:** The contractor should respond to all customer complaints within 24 hours. If a complaint involves a failure to collect from any customer as required in the contract, contractor should collect the infectious medical waste in question within 12 hours of notification.
6. **Unresolved Complaints:** In the event that any government project monitor or customer reports to the government that a complaint has not been resolved to the customer's satisfaction, the contractor should present a detailed report outlining the nature of the complaint and the proposed resolution or actions taken to resolve the complaint. If, in the opinion of the government project administrator, the proposed resolution or actions taken are insufficient to satisfactorily resolve the claim, the government at its reasonable discretion may require contractor to carry out a process to satisfactorily resolve the complaint.

Reporting Requirements

The minimum technical standards should also stipulate the reports that must be regularly submitted to the government by the contractor. At a minimum, these should include the following:

1. **Monthly Preparation Report:** During the preparation period the contractor should submit monthly preparation reports to you describing in detail the progress made on the preparation work plan during the preceding month and identifying any potential impediments to implementation in the specified time period. Each monthly preparation report should be submitted to the government project administrator by the 10th day following the last day of the month.
2. **Monthly Operations Report:** During the operation period the contractor should submit monthly operations reports that should include detailed information about the performance of medical waste management services.
3. **Annual Operations Report:** During the operation period the contractor should submit annual operations reports. The annual operations reports should include, but not be limited to, annual summaries of the results provided in the monthly operations reports, and proposals for contract changes that will increase operating efficiency. Each annual operations report should be submitted within 30 days following the end of the preceding contract year.

APPENDIX B: SAMPLE MEDICAL WASTE FACILITY CHARACTERIZATION FORMS

MEDICAL WASTE QUESTIONNAIRE		Original Date: <u> </u> <u> </u> <u> </u>
Facility Name:	Location:	
Type of Facility: <input type="checkbox"/> Hospital <input type="checkbox"/> Clinic <input type="checkbox"/> University <input type="checkbox"/> Physician <input type="checkbox"/> Dental <input type="checkbox"/> Research		
Number of Inpatients:	Number of Outpatients:	Number of Beds:
Describe briefly what happens between segregation (if any) and final disposal of:		
Sharps:		
Infectious Waste:		
Pathological Waste:		
Radioactive Waste:		
Chemical Waste:		
Pharmaceutical Waste:		
Pressurized Containers:		
Point of Collection Option		

Existing Medical Waste Management Program

1. (a) Designation of person(s) responsible for organization and management of waste collection, handling, storage, and disposal.

- (b) General qualification and level of education of designated person.

- (c) Has person responsible received any training on medical waste management? Yes No
If yes, what type of training and of what duration?

2. Indicate the number of persons involved in the collection, handling, and storage of health care waste, their designation, their training in solid waste handling and management, and the number of years of experience of this type of work.

Number	Designation	Training	Experience
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- | | | | |
|----|---|------------------------------|-----------------------------|
| 3. | Do the waste management staff have job descriptions detailing their tasks? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 4. | Are instructions/training given to newly hired waste management staff? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 5. | Are you aware of a document outlining the health care waste management policy?
If yes, give title of document (and attach a copy if possible): | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 6. | Is there a manual or guideline document on management of medical wastes available:
If yes, give title of document (and attach a copy if possible): | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 7. | Does your hospital have a Waste Management Plan?
If yes, please attach a copy. | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 8. | Does your hospital have a Waste Management Team (or Teams)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| 9. | Are there clearly defined procedures for collection and handling of wastes? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

Types of Solid Waste Produced and Radioactive Estimated Quantities

Sources	General	Pathological	Radioactive	Chemical	Infectious	Sharps	Pharma-ceutical	Pressurized Containers	Estimated Quantity (kg/day)
Patient services Medical Surgical Recovery/intensive care Isolation ward Dialysis unit Oncology unit Emergency Outpatient clinic Autopsy room Radiology									
Laboratories Biochemistry Microbiology Hematology Research Pathology Nuclear medicine									
Support services Blood bank Pharmacy Central sterile supply Laundry Kitchen Engineering Administration Public areas Long-term health care									

Types of Solid Waste Produced and Radioactive Estimated Quantities

Sources	Pathological Waste	Radioactive Waste	Chemical Waste	Infectious Waste	Sharps	Pharmaceutical Waste	Pressurized Containers
Indicate by X the type of waste (if any) that is segregated from general waste stream.							
Where is the segregation taking place (i.e. operating room, laboratory, etc.)?							
What type of containers/bags (primary containment vessels) are used to segregate waste (bags, cardboard boxes, plastic containers, metal containers, etc.)? Describe accurately.							
What type of labeling, color-coding (if any) is used for marking segregated waste? Describe.							
Who handles (removes) the segregated waste (designation of the staff member)?							
Is the waste handler using any protective clothing (gloves, etc.) during waste handling? Yes/No							
What types of containers (plastic bins, bags, cardboard boxes, trolleys, wheelbarrows, etc.) are used for collection and internal transport of the waste? Describe.							
Where is the segregated waste stored while awaiting removal from the hospital or disposal? Describe.							
Describe briefly the final disposal of segregated waste (taken to municipal landfill, buried on hospital grounds, incinerated, open burned, etc.).							