LEWISTON-AUBURN WATER POLLUTION CONTROL AUTHORITY SLUDGE COMPOSTING FACILITY

OPERATION AND MAINTENANCE MANUAL

Penley Corner Road

Auburn, ME

August 2020

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CHAPTER 1

INTRODUCTION

A. GENERAL

The Lewiston-Auburn Water Pollution Control Authority (LAWPCA) Sludge Composting Facility has been designed and constructed to provide efficient and effective stabilization of sludge. The facility represents a substantial investment and can be a valuable asset to the community when it functions properly. Certain procedures and methods of operation must be followed to insure that the facility functions as intended. A well-operating plant not only provides sanitary waste disposal in an environmentally acceptable manner, but also can be a source of pride for those who work to provide this vital municipal service.

B. PURPOSE OF THE MANUAL

This manual has been prepared to provide the operators with methods and procedures for the operation and maintenance of the sludge compo sting facility. It is intended to serve as a guide to the facility as a whole, and as a supplement to individual equipment manufacturers' manuals. The manual is a single tool of the many required for proper operation and maintenance. It is intended to be read through thoroughly and used as a reference source.

C. MANUAL CONTENTS

The looseleaf nature of the manual is intentional for ease as a reference and easy insertion of updated material reflecting new ideas and methods as they may develop from time to time. The chapters have been arranged in a logical order for operation and maintenance. The earlier chapters cover responsibilities and information for daily routines. Later chapters cover information on emergency operation, troubleshooting and plant support systems.

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CHAPTER 2

SUPERVISOR RESPONSIBILITY

A. GENERAL

The Composting Facility Supervisor is responsible for the operation, management and maintenance of the sludge composting facility under the direction of the Superintendent and Assistant Superintendent. He* must delegate operation and maintenance tasks, and where applicable, management tasks, between his technicians and himself and make sure that those tasks are completed. He must thoroughly familiarize himself with the treatment process and the entire facility. To that end he is expected to read this manual thoroughly. The information contained herein is, however, a reference guide; it is no substitute for common sense.

B. OPERATIONS

It is the responsibility of the Composting Facility Supervisor to know the operating procedures and to document them in a clear and concise manner for times when he may be absent. His technicians must be informed of his responsibilities and schedules. It is important that the technicians understand not only their own duties, but also enough of the Composting Facility Supervisor's duties so that they may temporarily maintain operations during the Composting Facility Supervisor’s absence.

* The use of the terms "he, his, him, himself," etc. are used throughout this manual as a matter of convenience and does not presume in any manner that the Composting Facility Operator or the assistant operator must be a man rather than a woman.

C. MANAGEMENT

The Composting Facility Supervisor will assist the Superintendent and Assistant Superintendent with the general management duties of the overall facility and in keeping records. This includes sludge, amendment, recycle, and compost product quantities, records, meter readings, laboratory results, maintenance records, and service records. All records should be kept in an accurate and neat manner. The Composting Facility Supervisor should also keep a log which records general information and occurrences on a daily basis. Daily routine checks that are made should also be documented here.

As the general manager of the sludge composting facility, it is the Compost Facility Supervisor's responsibility to ensure that the everyday operations proceed smoothly. To assist in this endeavor, the Compost Facility Supervisor should be responsible for establishing training programs associated with routine and specific operational functions, as well as safety issues. These responsibilities extend further to assisting the Superintendent and Assistant Superintendent in continually monitoring staffing needs and requirements, and updating of job descriptions to accommodate these identified needs and to accommodate potential changes in facility operations. These continued updates of job descriptions and needs, associated with continued training to accommodate these changing needs, should assist with providing job security to operators.

The Compost Facility Supervisor will also work with the Superintendent and Assistant Superintendent to establish operational budgets and budgets for necessary capital expenditures based upon identified past facility needs and future expectations.

The role of the Superintendent and Assistant Superintendent regarding overall management is one shared with the Board. He is the person who must be the liaison or middle man between the operations staff and the Board. Before he can fulfill this responsibility to the fullest, he, as well as the Board, must be aware of the role that the Board must play in the treatment facilities program.

It cannot be overemphasized that the Board must lend an open ear and mind to the supervision of operations, for without adequate guidance, assurance and money, the Superintendent and his staff cannot fulfill their responsibilities. While not all encompassing, the following simplified areas of responsibility are suggested for the purpose of establishing guidelines for responsibilities to be shared between the Superintendent and the Board.

1. Maintain efficient plant operation and maintenance.

2. Maintain adequate facility operation and management records.

3. Establish staff requirements, prepare job descriptions, develop

organizational charts and assign personnel

4. Provide operations personnel with sufficient funds to properly operate and maintain the facility.

5. Ensure operations personnel are paid a salary commensurate with their level of responsibility.

6. Provide good working conditions, safe equipment and proper tools for the operations personnel.

7. Establish a harmonious relationship with operations personnel.

8. Provide operations personnel with job security and a career ladder.

9. Establish operator training and safety programs.

10. Provide incentives for employees.

11. Motivate personnel to achieve maximum efficiency of operation.

12. Make employees aware of the importance of proper plant performance.

13. Make periodic inspections of the treatment system to discuss mutual problems with the operations personnel, and to observe operational practices.

14. Create an atmosphere that will make operations personnel feel that they can bring special problems to management's attention.

15. Maintain good public relations.

16. Prepare budgets and reports.

17. Plan for future facility needs.

18. Develop standard operating procedures.

D. MAINTENANCE

The Composting Facility Supervisor is responsible for following the maintenance schedule and either conducting or overseeing all maintenance operations. He is also responsible for general housekeeping practices for neatness and to minimize health hazards, odor problems and public nuisances.

E. SAFETY

The Composting Facility Supervisor is responsible for exercising proper safety procedures and making sure safety equipment is readily accessible. The Composting Facility Supervisor and assistants should become familiar with all safety equipment and routinely check all items to insure their readiness and availability in event of an emergency.

F. REPORTING TO THE BOARD OF THE LEWISTON-AUBURN WATER POLLUTION CONTROL AUTHORlTY

The Superintendent reports directly to the Board and must keep them advised of the status of the sludge composting facility. This is an important link in helping the Authority meet its responsibility to residents. It is important that the Superintendent keep the Authority's Board abreast of plant operations and potential operations and maintenance problems. It is also the responsibility of the Superintendent to "be the eyes" of the Authority by always being alert to and reporting the presence of abnormal wastes, and other problems.

G. PUBLIC RELATIONS

It is the responsibility of both the Composting Facility Operator and his assistants to promote good public relations. Courtesy should be extended to the public at all times. From time to time officials from the Department of Environmental Protection (DEP) and other individuals may visit the facility. The Composting Facility Supervisor should be available to explain the treatment process and answer questions for all visitors. It is important to maintain good relations with both the DEP and the general public.

I. SECURITY

It is the responsibility of both the Composting Facility Supervisor and the Compost Technician to insure the Facility is fully secured prior to leaving at the end of each day. After all equipment is parked, the roll-up doors will be closed, emergency exit doors checked and lights turned off. Lights, thermostats and doors will be checked in the administration area and other areas.

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CHAPTER 3

DESCRIPTION OF SLUDGE COMPOSTING FACILITY

A. GENERAL

The Lewiston-Auburn Water Pollution Control Authority (LAWPCA) Sludge Composting Facility is located on Penley Comer Road at the Gauthier Farm. The site plan for the sludge composting facility is shown in Figure 3-1. The facility has been design to treat 6.5 dry tons of sludge per day (7 day basis), which is approximately equal to the average daily sludge production in 1992. The facility has been designed to supplement the existing land application program to provide significant reserve capacity for future growth.

B. COMPOSTING FACILITIES

The composting facilities are designed to provide stabilization of the dewatered sludge from the Authority's Lincoln Street Wastewater Treatment Plant (WWTP). The facilities consist of:

- one amendment storage area
- one mixing area
- two front end loader(s)
- composting area consisting of six agitated bins
- thirty composting blowers
- two compost turners
- one finish pit
- one curing/storage area

A floor plan of the composting facility is shown in Figure 3-2. The mixing and composting areas have been completely enclosed. The curing/storage area is covered, but not enclosed.

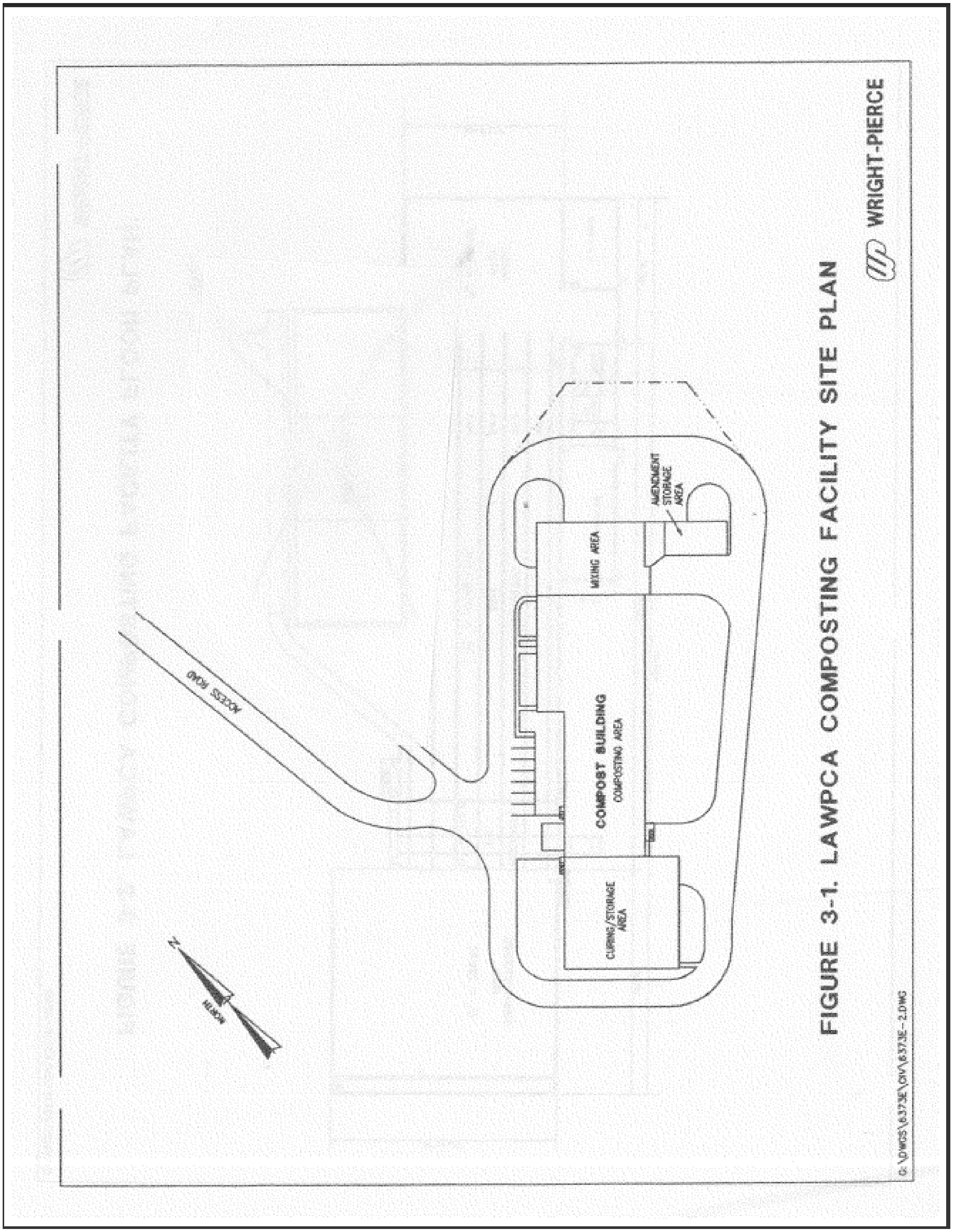

FIGURE 3-1. LAWPCA COMPOSTING FACILITY SITE PLAN

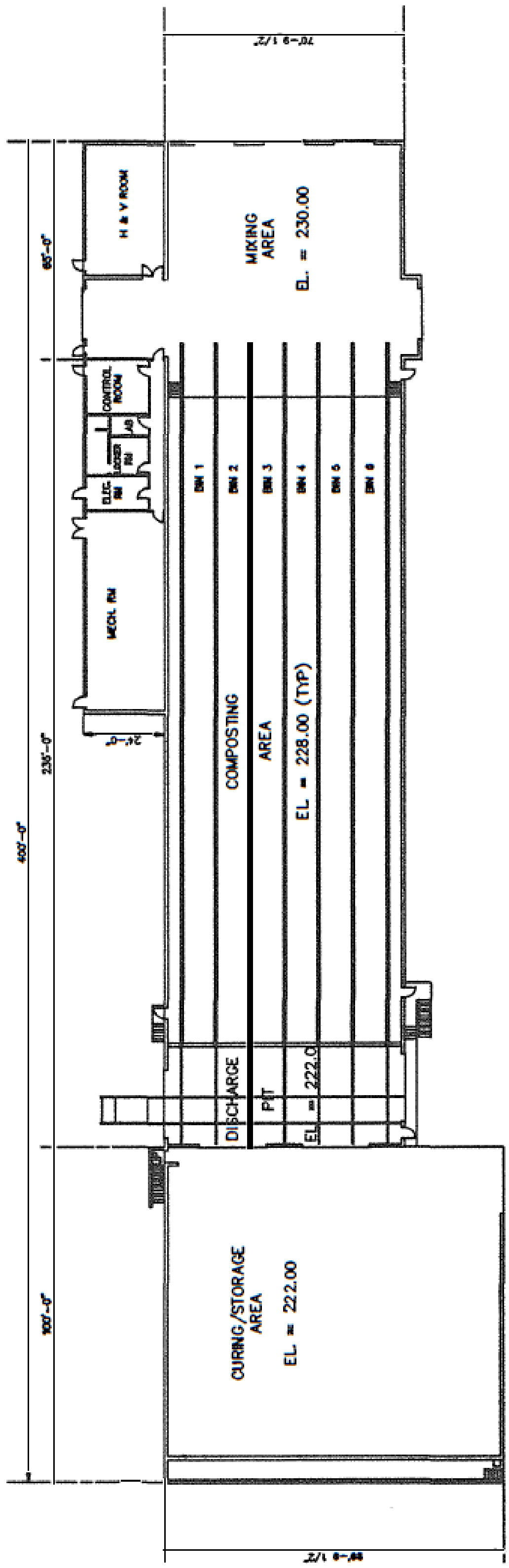

FIGURE 3-2. LAWPCA COMPOSTING FACILITY FLOOR PLAN

WRIGHT-PIERCE

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C. PROCESS DESCRIPTION

The LA WPCA Sludge Compo sting Facility uses agitated bin compo sting to stabilize dewatered sludge into compost. The dewatered sludge and amendments are delivered to the mixing area where they are stored in day piles. An amendment storage area has been provided for long-term storage of amendment. In the mixing area, a front end loader transfers the sludge and amendment from the day piles into the feed zone of the bins. The agitated bins are worked by the compost turners which start at the finish end mixing and transferring the compost 14 feet with each pass. This creates room at the feed end for more feed mix. The finished compost is transferred to the curing/storage area. A portion of the finished compost may be returned to the mixing area for use as an amendment. Following curing, the compost product is transferred in bulk to distribution sites and end-users

D. REGULATORY LICENSE

The sludge composting facility is licensed for operation under CMR 06-096 Chapter 419. The license clearly states the monitoring requirements for the State of Maine Department of Environmental Protection (MDEP) and the Environmental Protection Agency (EPA). It is the Composting Facility Supervisor’s responsibility to thoroughly familiarize himself with the license.

CHAPTER 4

OPERATION AND CONTROL

This chapter provides a detailed discussion of operational aspects of the LA WPCA Sludge Composting Facility. It contains descriptions of each process and associated major equipment, start-up procedures and modes of operation. This information is to be used in conjunction with the manufacturer's literature to establish efficient plant operation. The operating staff should be thoroughly familiar with the contents of this chapter.

A. GENERAL

Basically, the operating staffs involvement in the operation of the sludge composting facility consists of:

1. Observing the quality of the sludge, amendment, compost feed, and finished compost.

2. Performing tests to aid in process control.

3. Adjusting equipment operation to economically meet composting and odor control requirements.

4. Recording and reporting laboratory tests, maintenance, repair and cost information.

5. Inspecting electrical and mechanical equipment.

6. Performing preventive maintenance and emergency repairs.

7. Performing clean-up and housekeeping work.

8. Maintaining buildings grounds and structures.

9. Maintaining compost amendment and other supplies.

B. VISUAL OBSERVATIONS

The operator should make a quick visual survey of the sludge composting facility daily. Any sludge or compost that is tracked on the roads should be cleaned up. The finished compost should be dry and dark brown with a musty, earth type odor.

All mechanical equipment should be operating normally. Any observed variations from normal conditions should be immediately investigated and corrective action taken before proceeding with routine operation and maintenance work.

C. AGITATED BIN COMPOSTING

1. General Description

The agitated bin composting facilities include the Mixing Area with batch sludge mixer, the Amendment Storage Area, the Composting Area with agitated bin composting equipment, and the Curing/Storage Area. A process flow diagram of the facilities is shown in Figure 4-1. A summary of the basic design data for these facilities is shown in Table 4-1.

Composting will be used to stabilize the dewatered sludge that will be delivered by truck from the Authority's Lincoln Street WWTP. The stabilization process will transform these materials to dry humus matter. The resulting compost product is suitable for distribution in a wide variety of soil conditioning applications.

a. Sludge Conditioning. Composting is a process of aerobic, microbial degradation of organic matter. The dewatered sludge will be mixed with amendments to make up the compost feed. Amendment materials are provided to supplement the solids balance and energy balance of the compost feed. The solids balance is used to produce a compost feed of adequate porosity for aeration. Mass balance techniques will be used to determine the amendment requirements to bring the compost feed to approximately 35 to 40 percent solids for aeration purposes. Many bulking materials have been used for this purpose including wood chips. Recycled compost is the recommended structural amendment, because it is available at no cost and reduces the overall amount of compost produced. This requires that the facility be producing a dry product which is dependent on the energy balance.

In addition to obtaining a well stabilized end-product, a primary goal of the composting process is to dry the sludge to a level suitable for distribution and reuse as structural amendment. The heat released during the composting process vaporizes the water in the compost feed. The energy balance is used to ensure that adequate levels of degradable organic matter (heat generation) are available to achieve the desired moisture level in the end-product. Sawdust, and leaf and yard waste are among the possible energy amendments for the sludge composting facility in meeting energy balance requirements.

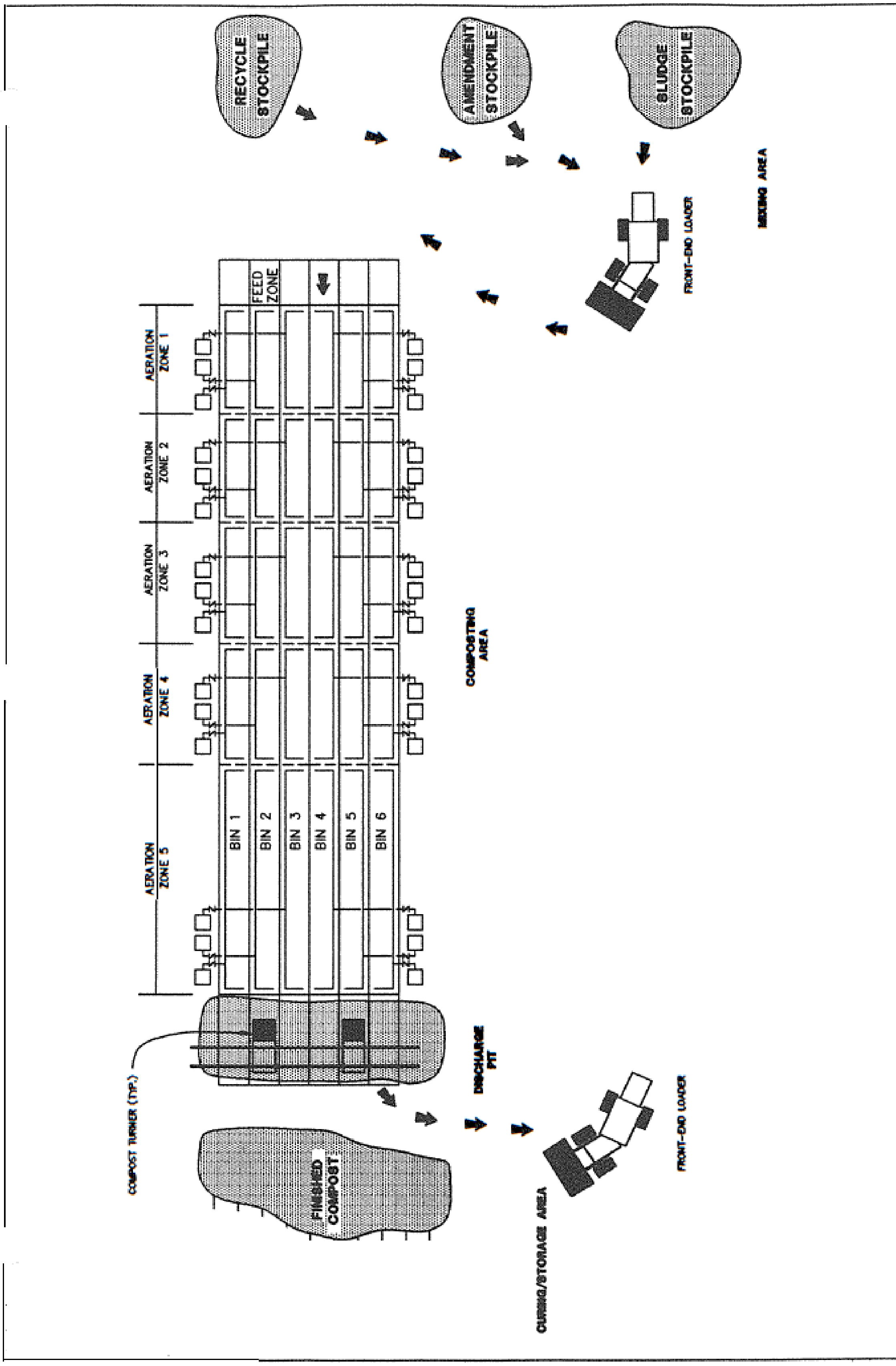

FIGURE 4-1. AGITATED BIN COMPOSTING PROCESS FLOW DIAGRAM

WRIGHT-PIERCE

Table 4-1. Agitated Bin Composting Design Data Summary.

Item	Capacity
Sludge Quantities:	
Percent of average production	100
Volumetric production:	
6 day, cu.yd./d	50
7 day, cu.yd./d	43
Sludge bulk density, lb/cu.yd.	1,600
Wet weight. - 7 day, lb/d	68,600
Solids level, %	19
Dry weight. - 7 day:	
lb/d	13,000
dry ton/d	6.5
Amendment Quantities:	
Average solids level, %	57
Wet weight. - 7 day, lb/d	42,000
Average bulk density, lb/cu.yd.	400
Volumetric consumption - 7 day, cu.yd./d	104
Recycle Quantities:	
Average solids level, %	60
Wet weight. - 7 day, lb/d	36,400
Average bulk density, lb/cu.yd.	840
Volumetric consumption - 7 day, cu.yd./d	43
Compost Feed:	
Average solids level, %	40
Wet weight. - 7 day, lb/d	147,000
Average bulk density, lb/cu.yd.	1,000
Volumetric production - 7 day, cu.yd./d	147
Compost Product:	
Average solids level, %	60
Wet weight. - 7 day, lb/d	82,300
Average bulk density, lb/cu.yd.	840
Volumetric production - 7 day, cu.yd./d	55
Amendment Storage:	
Length, ft	80
Width, ft	20
Area, sq.ft.	1,600
Stacking height, ft	15
Storage capacity, cu.yd.	900

Table 4-1. Agitated Bin Composting Design Data Summary (Cont.).

Item	Capacity
Mixing Area:	
Length, ft	60
Width, ft	71
Height, ft	18
Sludge Mixer:	
Batch capacity, cu.yd.	18
Discharge conveyor capacity, cu. yd./hr	200
Front-end loader:	
Bucket capacity, cu.yd.	3
Max. overall height, ft	18
Agitated Bin Reactor:	
No. of bins	6
System length, ft	
Bin length, ft	210
Discharge pit length, ft	30
Overall length, ft	240
System width (including blower pits), ft	71
System height (working bins), ft	14.84
No. of turner passes per cycle	15
Hydraulic retention time, days	21
Solids retention time, days	38
Reactor volume required, cu. ft.	83,400
Reactor volume provided, cu. ft.	83,800
Compost Turners	
No. of compost turners	2
Bin height, ft	7.26
Bin width, ft	9.33
Loading height, ft	7.20
Length transferred per pass, ft	14
Motor, hp	50
Aeration blowers:	
No. of blowers	30
Capacity, cfm	1,000
Back pressure, in.	10
Motor, hp	5

Table 4-1. Agitated Bin Composting Design Data Summary (Cont.).

Item	Capacity
Curing/Storage Area:	
Length, ft	100
Width, ft	80
Stacking height, ft	8
Storage capacity, cu.yd.	2,200
Aeration blowers:	
No. of blowers	2
Capacity, cfm	1,000
Back pressure, in.	10
Motor, hp	5

b. Process Strategy. Although a wide variety of factors affect the composting process, control of temperature has been found to be perhaps the most critical to effective stabilization of the compost feed mix. Composting of municipal sludge is almost exclusively carried at temperatures greater than 40°C which selects for thermophilic bacteria. Slightly higher rates of degradation could be achieved if temperatures were maintained below 40°C to select for mesophilic bacteria, which have higher activity levels. However, thermophilic degradation has advantages in regards to pathogen destruction and lower operating costs.

The Beltsville method of sludge composting was the basis for most of the municipal facilities designed in the U.S. in the 1970's and early 1980's. The Beltsville method was developed under EPA and emphasized the benefits of high temperature on pathogen destruction. Aeration rates were based on requirements to maintain aerobic conditions throughout the compost mass based on the stoichiometric oxygen demand for microbial degradation of the biodegradable material. Thermophilic pile temperatures greater than 55°C could be reliably produced in even cold weather conditions. In fact, the typical pile temperature exceeds 70°C using this process control strategy.

The main advantage of the Beltsville method was that acceptable pathogen destruction was demonstrated when pile temperatures were maintained above 55°C for three days in a row for an aerated static pile. This strategy took advantage of the good insulating capacity of the compost to retain the heat released during microbial decay. Problems with this process control strategy included a wet end-product of poor stability and excessive odors. In fact, on a microbial level the Beltsville method failed to optimize the composting process.

The higher temperatures of the Beltsville method actually retarded microbial action and growth limiting the actual degradation rate to very low levels. The rate of microbial degradation can be optimized by using temperature feedback control of aeration rates to insure that adequate heat removal is provided to prevent debilitating temperature conditions. Using temperature feedback controlled aeration, a more stable product could be produced in the same amount of time using the heat released by the resultant biological activity to improve moisture removal.

Widespread implementation of temperature feedback controlled aeration to limit the maximum temperature in a compost pile and its debilitating effect on microbial activity is generally attributed to proponents of the Rutgers strategy. With this process control strategy, significantly higher aeration rates are used as the mechanism to remove the heat released by microbial activity. The aeration rates for temperature feedback control are typically ten times the amount needed to maintain oxygen levels in the piles. This has resulted in significantly larger blower capacity requirements than for the Beltsville method.

The most common setpoint for the maximum temperature throughout the pile is 60°C, above which microbial activity is impaired. However, maximum rates of degradation for thermophilic composting are produced as the setpoint temperature approaches 45°C. The temperature feedback setpoint should be set so that a maximum of 60°C is achieved in the interior of the piles. This means that temperatures at the walls or surface of the bins will actually be lower.

The benefits of temperature feedback control of the compo sting process include reduced odor generation, dryer, more stabilized product, and improved pathogen destruction. Although the compo sting process always releases odors, the temperature feedback control strategy maximizes the rate of degradation of the organic material in the compost feed. This shortens the period required to compost to a given level of stability and reduces the potential for anaerobic odor producing conditions. It is important to note that additional factors impact the amount of odors generated. However, even under optimum conditions, treatment and dispersion of the process air from compo sting is necessary to avoid odor problems.

Moisture removal during the compost process is driven by the heat released from microbial activity. Using a compost solids and energy balance, the compost feed mix can be amended with an energy source such as sawdust or leaf and yard waste as necessary to produce a product of the desired dryness. Since moisture removal is tied to heat release, temperature feedback controlled aeration will always insure that the maximum moisture removal rates are achieved.

One concern that proponents of the Beltsville method have raised about temperature feedback control of aeration is that it is contrary to EPA pathogen destruction criteria of maintaining the temperature throughout the pile above 55°C for a given time period depending on the compo sting method (three days for aerated static pile composting). However, there are a variety of strategies that can be used to meet the EPA criteria including using lower aeration rates at the start of the composting cycle to immediately meet pathogen destruction requirements. Although this method technically satisfies the criteria, it may provide the worst pathogen destruction performance, because it is subject to re-inoculation of the unstabilized compost by pathogens. This is, in fact, one of the main concerns with the poorly stabilized composts that can be produced using the Beltsville strategy.

Proponents of temperature feedback controlled aeration maintain that the most effective disinfection will result from maximizing the rate of microbial activity at the start of the composting cycle. The high levels of microbial activity create greater competition for the available substrate which has been shown to reduce levels of the pathogenic bacteria in itself. The EPA criteria can be met either at the end of the first reactor stage of composting or during the curing stage. As long as an active microbial mass exists, the insulating qualities of compost are such that it is typically possible to reach temperatures greater than 55°C regardless of how well stabilized the material is during the first reactor stage.

Another factor that has been shown to improve the rate of stabilization of the composting process is mixing. Mixing increases the rate of stabilization by breaking up the compost exposing new surfaces to microbial activity. This minimizes the occurrence of micro-sites with anaerobic conditions (common in sludge balls) that are responsible for odor generation in even highly aerated systems. Mixing also redistributes the compost so that pockets with poor aeration are eliminated and material at the surface and bottom are moved to other areas.

The value of mixing to the compost process should not be underestimated for any raw material. Windrow and aerated windrow compo sting have proven more effective than aerated static pile composting on a variety of wastes and municipal sludges. Windrow composting has been effective on low energy sludges such as digested or waste activated sludge that tend to clump because they do not dewater well to begin with. Aerated windrow composting provides all the advantages of aerated static pile composting with the added benefit of mixing.

The agitated bin composting system is a mechanized version of the aerated windrow process that typically requires less space and manpower to operate. This system is able to combine the advantages of temperature feedback controlled aeration and mixing on a daily basis. The technology has been shown to be extremely effective at stabilizing a variety of raw materials including municipal wastewater sludge.

c. Compost Feed Preparation. The components of the compost feed mix are the dewatered sludge, amendment, and recycled compost. The required quantities of the amendments and recycled compost, will be determined by mass and energy balance analysis. The feed mix ratios will have to be adjusted whenever there is a change in the dewatering performance of the screw presses and when there is a change in amendment characteristics.

Material handling for the compost feed at the LAWPCA Sludge Composting Facility is not automated. The dewatered sludge, amendment, and recycled compost are transferred to the bins by front-end loader. Dewatered sludge is delivered to a day pile bin through the central roll-up door at the end wall of the Mixing Area. Day piles of the amendment and recycled compost are also to be maintained in the Mixing Area.

The amendment and recycled compost will be transferred to the day piles (within the Mixing Area) prior to starting the compost feed mixing operation. The Amendment Storage Area has a capacity of about 10 days storage at full capacity. The Amendment Storage Area is protected from the elements on three sides, but open on the forth side for easy access. Amendment deliveries are made through a doorway at the end wall, similar to deliveries to the Mixing Area. The front-end loader is then used to relocate the amendment to other portions of the Storage Area or to the day pile in the Mixing Area.

The recycled compost (structural amendment) would be taken from the Curing/Storage Area to a day pile bin in the Mixing Area.

d. Agitated Bin Composting. The agitated bin composting system is automated once the feed has been loaded until discharged at the finish end. Two compost turner units have been provided and typically rest in their home position over the discharge pit. The compost turners move to work any of the six bins using crossrails over the discharge pit.
The compost turners start at the finish end, mixing and moving the compost approximately 14 feet down the bin with each pass. This creates space at the feed end to load more compost.

One cycle through a bin for the compost turner unit involves the following steps:

1) The units rest at their storage areas at the discharge pit end of the bins. When the sequence to be worked is activated the compost turner moves to the first bin and brakes lock. The turner raises the crossrail wheels to position itself on the bin rails.

2) The turner moves forward to just behind the bin walls and lowers the drum and conveyor into working position against a positive stop.

3) The drum and conveyor are activated and the turner travels forward engaging the compost in the bins. The drum kicks the compost onto the conveyor moving it approximately 14 feet down the bin. If for some reason the drum or conveyor begin to stall, the turner wheel drive slows to permit the drum and/or conveyor to unload. Then after clearing, the carriage will move forward. If overload continues for 30 seconds, the system will shut down.

4) At the feed end, the turner stops and elevates the rotor and conveyor to the travel position. The rotor/conveyor assembly is run for a short period to clear itself.

5) The turner travels back to the crossrail end of the bins.

6) The turner lowers its crossrail wheels. The unit is now ready to move to the next bin to be worked or back to the storage area.

Each compost turner has local control panels mounted on the units. The compost turners have rotating parts that cannot be properly enclosed to protect workers and others from the equipment itself or from material that it may project. Consequently, special safety precautions are required when the compost turners are in operation. This is particularly the case at the feed end of the bins.

Emergency stop buttons have been provided at eight locations along the length of the bins to immediately stop the compost turners. Emergency stops are also located at the unit mounted control panels and at Panel PI. Operators should be particularly cautious when stepping on the compost in the bins. It is recommended that a second operator always be present if it is necessary to walk on the compost.

In general, it is advisable to keep as much distance as possible between the compost turners and people when the drum and conveyor are operating. The tines on the drum and the flights on the conveyor should be checked regularly to determine whether any pieces need tightening or replacement.

The thirty single-stage centrifugal blowers deliver process air independently to the five aeration zones in each of the six bins. The blowers operate by timers) based on setpoint. The blowers are all of 1000 cfm capacity at 10 inches water column. The blowers are all of the same capacity for ease of operation and maintenance. The need for more aeration at the start of the composting cycle than at the finish has been addressed by varying the length of the five aeration zones per bay. The first two zones are 26 feet long, the next two zones are 39 feet long, and the final zone is 54 feet long.

The blowers are controlled through use of an H-O-A switch. The automatic setting operates the system using control with a base line timer. Run status and elapsed time meter functions have been provided for each blower through the video graphics display located in the office.

When the blowers are in operation and particularly when the compost tuners are also in operation, significant compo sting off-gases will be released. The refrigerated space type strip curtain was provided between the Mixing Area and Composting Area to limit diffusion of that air to. It is advisable to take all precautions possible to improve the air quality when operators or visitors are in the Composting Area including shutting down the blowers and compost turners.

e. Curing/Storage. The finished compost drops into a discharge pit for short-term storage prior to transfer to the Curing/Storage Area. The space requirements for curing/storage were dictated by the criteria to provide 40 days of curing at a maximum 8-foot stacking height. This does not preclude stacking the material at greater heights to achieve greater storage capacity during the winter season when demand for compost is generally low.

f. Odor Control Strategies. Composting operating parameters have been shown to have a large impact on the amount of odorous compounds released. Persistent, problem odors are most typically associated with production of reduced sulfur compounds. Operating parameters that can impact the quantity of reduced sulfur compounds generated include temperature, pH, aeration rates, and moisture content.

The most significant factor in controlling reduced sulfur compound generation is proper temperature control to keep the compost mass below 60°C. This ensures optimum microbial activity and rapid stabilization of degradables.

Reduced sulfur compound generation is also impacted by the pH of the compost mass. The pH of the compost mixture should be greater than 8.5 if possible and even as high as 12 if found to be necessary. Although this will promote the removal of ammonia, it will limit the release of reduced sulfur compounds that require greater dispersion to dilute to the threshold limit. Although ammonia release is not considered a problem in terms of off-site odors, levels in the mixing and composting area should be carefully monitored to limit operator exposure. The OSHA limit for short-term workplace exposure to ammonia is 35 ppm.

The recommended mechanism for alkalinity addition to raise the pH of the sludge is by use of wood ash as an amendment in the compost feed (See Alternate Operations). It should be noted that when the pH of the compost feed is raised as high as 12, microbial activity may be limited for several days, but it will eventually take off. Composting will then cause the pH to approach neutral.

The aeration cycle time, also impacts odor generation. The more continuous the aeration, the lower the odor generation. This factor was accounted for in the final sizing of the aeration blower for the composting operation and must be balanced by the need to provide sufficient aeration capacity to maintain the desired temperatures. The operator can create artificial head, which will reduce the aeration rate and increase cycle time, by throttling the discharge butterfly valve on each blower.

The initial moisture content of the compost feed also has a significant impact on odor release. The higher the initial moisture content, the lower the odor release will be. This is apparently because the odorous compounds are absorbed in the water and are more likely to be degraded than in a lower moisture content feed. The porosity of the feed must be maintain for proper aeration. Although 60 percent moisture in the feed is typically presumed for design, actual operations are commonly able to use compost feeds with initial moisture contents as high as 65 percent. The facility should be operated at the highest moisture content that the system allows to limit odor release.

2. Start-up.

a. Agitated Bin Composting. The agitated bin compo sting equipment includes the compost turner units and the aeration blowers. The compost feed is delivered to the bins using the front end loader. During initial startup, the bins should be loaded one (or two) at a time to minimize the time to completely fill each bin. The compost turners should work the start-up bins as many times as necessary to load the available compost feed. The blower for each aeration zone of a bin need not be started until that zone is completely filled with compost. Otherwise the air flow will short circuit through the unfilled portion. All of the compost generated from the initial filling process should be recycled to insure that a stable product is produced.

The compost turners can be started as follows:

1) Check that the compost turner units are in condition for operation. In particular, check that all electrical plugs associated with the festoon system of the compost turner units are connected. Check that the units are free of material that might tend to bind the drum or conveyor.

2) Activate the units manually so that they are controlled from the control panel located on the compost turner.

3) Use the compost turner panel controls to activated and raise the unit to the traversing mode. Position the turner to lock into the desired bin and lower the unit onto the bin rails.

4) Using the compost turner panel controls, activate to the unit to work the bay. Check the operation of the turner throughout the operation sequence.

5) Once the turner has returned to the resting position, use the unit mounted panel controls to move the turner back to the storage position.

The blowers may be started as follows:

1) Check that butterfly damper on discharge of blower to be activated is open.

2) Turn the blower switch to the AUTO position. Reduce the timer OFF setting and check for proper operation of the timer. Increase the timer OFF setting and check for proper operation of the temperature feedback controls. Use a portable thermocouple to check the temperature.

The central processing unit at Panel P I provides automatic record keeping for the agitated bin compo sting system. Data stored includes historical temperature and detention time data for each zone of each bin and elapsed run time data. Panel PI includes a printer for hard copies of this data.

3. Normal Operations.

An understanding of compost feed conditioning, system detention time, and aeration requirements is critical to a successful compo sting operation. The system detention time and aeration capabilities have been designed into the system and limited operator input is required during the composting cycle. The compost feed conditioning requires an understanding of compost mass and energy balance principals balanced with practical field application.

a. Feed Conditioning. The feed components for the composting operation include the dewatered sludge, energy amendment (such as sawdust), structural amendment (recycled compost), and wood ash (odor control amendment). To simplify the analysis and equations, the differences in the characteristics of the wood ash and the energy amendment will be ignored, since it is expected to be a relatively small component of the overall feed mix.

Each component of the compost feed can be broken down to fractions for water and solids. The solids fraction can be broken down further into volatile and fixed solids. Finally, the volatile solids can be broken down to the biodegradable and the non-biodegradable. In this case the percent biodegradable is based on those volatile solids consumed during the composting cycle. Slowly degradable volatile solids that would degrade following the composting stage would be considered part of the non-biodegradable volatile solids.

The compost feed requirements are determined based on the solids balance and the energy balance. The compost feed must be brought to 35 to 40 percent solids to have sufficient porosity for aeration. Achieving good dewatering and thereby a high solids content in the sludge cake is the key requirement for minimizing the amount of amendment needed. In addition, the solids level of both the structural and energy amendments should be as high as possible, preferably 60 percent solids or better. When recycled compost is used as the structural amendment, obtaining optimum drying during the compost cycle is critical. The covered Amendment Storage Area was provided to insure that the solids content of the energy amendment is not reduced by rain while on-site.

The compost end-product should have a solids content greater than 50 percent, and preferably 60 percent, to maximize the value for distribution. End-product solids concentrations above 60 percent are difficult to achieve because microbial activity becomes moisture limited. To insure that the compost end-product meets the 60 percent solids goal for use as recycle and for distribution, the feed mix must include sufficient biodegradable volatile solids to generate sufficient heat to remove the moisture. This is because the removal of water (in the presence of excess aeration capacity) is driven by the release of heat during the microbial degradation of the biodegradable volatile solids.

The potential for moisture limited conditions in the bins exist which could lead to problems with dust and could negatively impact microbial activity. Impacts begin at approximately 55% solids, but it is still desirable to have an end product with 60% solids. However, if the end product solids content exceed 60%, the following should be done:

1) Water should be sprayed on Zone 4 just prior to turning the piles, which would in effect evenly distribute water throughout Zone 4.

2) Decrease the amount of energy amendment and increase the amount of recycled compost in the feed mix so less heat is generated and more water is retained by the compost.

The solids balance approach outlined below minimizes the amount of energy amendment that is used, thereby reducing operating costs. When recycled compost is used as the structural amendment, the energy requirements are limited to removing the moisture in excess of the desired endpoint within the sludge and the energy amendment. The amount of recycled compost is not needed for this determination, since it is at the desired end-point solids level and contributes no excess moisture to the feed. By estimating the degradable organic content of the sludge and the energy amendment and the heat released by their degradation, the quantity of energy amendment can be determined based on the amount of heat needed to vaporize the excess moisture in the feed. Once the quantity of energy amendment is known, the amount of recycled compost needed to achieve the desired initial solids content (for porosity) can be determined based on the solids level of the combined sludge and energy amendment.

The quantity of energy amendment can be determined as follows:

$$X_a = \frac{H_e\left(\left(X_c - S_c X_c\right) - \left(S_c X_c - K_c V_c S_c X_c\right)\left(\frac{1}{Sp} - 1\right)\right) - \left(K_c V_c S_c X_c H_c\right)}{\left(K_a V_a S_a H_a\right) + H_e\left(\left(\frac{S_a}{Sp} - 1\right) - K_a V_a\left(\frac{S_a}{Sp} - S_a\right)\right)} \quad (1)$$

where X_a = wet weight of energy amendment in lb/day.
H_e = energy demand in Btu/lb of water evaporated. Typically 1500 Btu/lb.
X_c = wet weight of dewatered sludge in lb/day.
S_c = fractional solids content of dewatered sludge.
V_c = volatile solids content of dewatered sludge, fraction of dry solids.
K_c = fraction of dewatered sludge volatile solids degradable during composting cycle.
Sp = fractional solids content of compost product.
H_c = energy content of biodegradable dewatered sludge organics, Btu/lb.
S_a = fractional solids content of energy amendment.
V_a = volatile solids content of energy amendment, fraction of dry solids.
K_a = fraction of energy amendment volatile solids degradable during composting cycle.
H_a = energy content of biodegradable energy amendment organics, Btu/lb.

Although Equation 1 may appear to be an intimidating calculation, this and the following solids balance equations can be easily automated using a spreadsheet applications program.

Once the mass of energy amendment, X_a, to be added has been determined, the solids content of the sludge and energy amendment mixture can be determined as:

$$S_m = \frac{S_c X_c + S_a X_a}{X_c + X_a} \quad (2)$$

where S_m = fraction solids content of the sludge and energy amendment mixture.

The value of S_m must be compare to the desired feed solids content level. This value should be a minimum of 40 percent until operating experience shows whether a lower value is acceptable. If S_m is equal to or greater than the desired feed solids content level, then no additional structural amendment (recycled compost) is required. If S_m is less than the desired feed solids content, then the required amount of recycled compost (structural amendment) can be determined as follows:

$$X_r = \frac{S_f(X_c + X_a) - S_c X_c - S_a X_a}{S_r - S_f} \qquad (3)$$

where X_r = wet weight of recycled compost in lb/day.

S_f = desired fractional solids content of the compost feed.

S_r = fraction solids content of the recycled compost.

With the sludge feed quantity, X_c; the energy amendment quantity, X_a; and the recycled compost quantity, X_r, known, the compost feed and compost product quantities can be determined. The compost feed must be determined on a component basis to allow the determination of the compost product quantity. The quantity of water in the compost feed can be determined as follows:

$$W_f = (1 - S_c)X_c + (1 - S_a)X_a + (1 - S_r)X_r \qquad (4)$$

where W_f = the weight of water in the compost feed in lb/day.

The quantity of biodegradable volatile solids in the compost feed can be determined as follows:

$$B_f = K_c V_c S_c X_c + K_a V_a S_a X_a \qquad (5)$$

where B_f = the weight of biodegradable volatile solids in the compost feed in lb/day.

Please note that there is no factor for the recycled compost in the biodegradable volatile solids determination, since all biodegradables are presumed to be degraded. The quantity of the non-biodegradable volatile solids in the compost feed can be determined as follow:

$$N_f = (1 - K_c)V_c S_c X_c + (1 - K_a)V_a S_a X_a + V_r S_r X_r \qquad (6)$$

where N_f = the weight of non-biodegradable volatile solids in the compost feed in lb/day.

V_r = volatile solids content of the recycled compost, fraction of the dry solids.

S_r = Sp, the solids fraction in the compost product.

All of the volatile solids in the recycled compost are considered non-biodegradable. The fraction of volatile (non-biodegradable) solids in the recycle can be determined as follows:

$$V_r = \frac{\left(\left(X_c S_c V_c \left(1\text{-}K_c\right)\right) + \left(X_a S_a V_a \left(1\text{-}K_a\right)\right)\right)}{\left(\left(XS\left(\left(V\right)\left(1\text{-}K\right)\right) + \left(1\text{-}V\right)\right)\right) + \left(XS\left(\left(V_a\left(1\text{-}K_a\right)\right) + \left(1\text{-}V_a\right)\right)\right)} \qquad (7)$$

The quantity of fixed solids in the compost feed can be determined as follows:

$$F_f = (1\text{-}V_c)S_c X_c + (1\text{-}V_a)S_a X_a + (1\text{-}V_r)S_r X_r \qquad (8)$$

where Ff = the weight of the fixed solids in the compost feed in lb/day.

The mass of feed solids can be determined by summing the components as follows:

$$X_f = W_f + B_f + N_f + F_f \qquad (9)$$

where Xf = the wet weight of the compost feed in lb/day.

The quantity of compost product can be determined from this data as follows:

$$X_p = \frac{N_f + F_f}{Sp} \qquad (10)$$

where Xp = the wet weight of the compost product in lb/day.

Equations 1 through 10 provide the tools for determining the feed and product quantities on a mass basis. Typical parameter values for input to the mass and energy balance equations are displayed in Table 4-2. These can be used initially until facility specific data is generated.

The wide range in the value of the solids content for sawdust in Table 4-2 depends for the most part on whether the sawdust is kiln dried or green. The kiln dried sawdust with a solids content of 90 percent results in significantly lower total amendment requirements. This essentially increases the capacity of the composting facility. The kiln dried sawdust must be protected from the elements to maintain the high solids content.

Table 4-2. Typical Parameter Values for Composting Components.

Material	Solids Content, %	Volatile Solids, %	Degradable Volatile Solids, %	Energy Content, Btu/lb	Bulk Density, lb/yd^3
Dewatered Sludge	20-25	75	50-60	10,000	1600
Sawdust	50-90	95	20-60	7,490	405
Compost Feed	35-40				1150
Finished Compost/Recycle	60		0		840

The solids content for green sawdust varies from 50 to 65 percent. An air dried sawdust that has been protected from the elements would typically have a 65 percent solids content. A solids content of 50 percent is typical of a sawdust that has been stored in the open. The solids content will also vary depending on the type of tree.

Alternative amendments, such as; leaf and yard waste, are not listed in Table 4-2, but should be assumed to have a solids content of approximately 50 percent until facility specific data can be developed.

The batch sludge mixer has been equipped with a scale to facilitate feed mix preparation on a mass basis. Feed mix preparation on a mass basis should be used to check the volumetric recipe, because the density of all of the components can vary significantly. In particular, moisture level can have a significant impact on the actual density of a given product.

Table 4-2 also includes typical bulk densities for the compo sting streams. The volumetric quantities of compost feed and product are also needed for estimating the hydraulic and solids retention time in the system.

The importance of the mass and energy balance concepts are demonstrated in Table 4-3, which displays compost feed mix ratios for varying dewatered sludge solids. Amendment (sawdust) requirements decrease with improved dewatering performance. Recycle requirements increase slightly because of the reduced energy amendment requirements. The overall energy and structural amendment (sawdust and recycle) requirements decrease as the dewatered sludge solids increase from 1.7 parts by weight to 0.8 parts by weight.

The data in Table 4-3 can be used as a guideline for conditions that are reasonably close to those presumed. For example, 1 part of dewatered sludge solids at 19 percent solids would require 2.4 parts by volume (0.6 parts by weight) of sawdust at 57 percent solids and 1 parts by volume (0.5 parts by weight) of recycle at 60 percent solids.

Table 4-3. Compost Feed Mix Ratios for Varying Dewatered Sludge Solids.

Dewatered Sludge Solids, %	Compost Feed Mix Ratio (1)					
	By Weight (2)			By Volume		
	Sludge	Amendment	Recycle	Sludge	Amendment	Recycle
11	1	1.4	0.3	1	5.3	0.6
13	1	1.2	0.4	1	4.6	0.7
15	1	1	0.4	1	3.9	0.8
17	1	0.8	0.5	1	3.1	0.9
19	1	0.6	0.5	1	2.4	1
21	1	0.4	0.6	1	1.7	1.1
23	1	0.2	0.6	1	0.9	1.2
25	1	0.1	0.7	1	0.2	1.3

Notes: 1) Presumes amendment is sawdust at 57% solids, recycled compost at 60% solids, and a feed solids of 40%.
2) Based on wet weight of materials.
3) Based on bulk densities of 1600 lb/cu. yd. for sludge, 405 lb/cu. yd. for amendment and 840 lb/cu. yd. for recycled compost.

The feed mix ratio will also vary if the percent solids of the amendment or recycle vary. Table 4-4 shows the impact of the energy amendment (sawdust) solids content on the required quantities. Drier energy amendment can cost substantially more and still be cost effective because of the reduced quantities required. Use of a drier amendment is also an effective means to increase the sludge processing capacity of the composting facility, because of the overall reduction in amendment (energy and structural) requirements. The overall energy and structural amendment (sawdust and recycle) requirements decrease as the energy amendment solids increase from 1.5 parts by weight at 50% solids to 0.7 parts by weight at 90% solids.

b. Detention Time. The detention time in the agitated bin composting system is defined by two terms analogous to those for activated sludge, the hydraulic and solids detention times. The hydraulic retention time (HRT) of a composting system is the single pass, mean residence time of the mixed materials including recycle. This is the time the material is in the agitated bin reactor or curing area.

To determine the HRT of the agitated bin system, the active working volume of the reactor must be determined. As shown in Table 4-1, the working volume for each bay is based on the length, width, and operating depth. For the agitated bin system, the compost feed is loaded in to a working depth of up to 7.2 feet. Because of the microbial degradation of the biodegradable solids, the product at the finished end is at

Table 4-4. Compost Feed Mix Ratios for Varying Amendment Solids.

Amendment Solids, %	Compost Feed Mix Ratio (1)					
	By Weight (2)			By Volume		
	Sludge	Amendment	Recycle	Sludge	Amendment	Recycle
50	1	1	0.5	1	4.1	1
60	1	0.5	0.5	1	2.0	1
70	1	0.3	0.5	1	1.4	1
80	1	0.3	0.5	1	1	1
90	1	0.2	0.5	1	0.8	1

Notes: 1) Presumes sludge is at 19% solids, recycled compost at 60% solids, and a feed solids of 40%.
2) Based on wet weight of materials.
3) Based on bulk densities of 1600 lb/cu. yd. for sludge, 405 lb/cu. yd. for amendment and 840 lb/cu. yd. for recycled compost.

approximately a 4.8 feet working depth. In determining the HRT for a given period, only the on-line reactor volume should be used. This can be determined by multiplying the individual bin working volume in Table 4-1 by the number of bins on-line.

The HRT of the system can be determined as follows:

$$HRT = \frac{V}{Q_f} \qquad (11)$$

where HRT = the hydraulic retention time in days.
V = the agitated bin reactor working volume in ft^3.
Q_f = the volumetric feed rate of the compost feed in ft^3/day (X_f times the bulk density).

The LAWPCA Sludge Composting Facility has been designed with a typical HRT of 21 days. Based on the seasonal variation in loads and in the amount of sludge that is diverted to land application, it may be possible to reduce the number of bins in operation at certain times of the year.

The HRT of the agitated bin reactor is controlled by the number of times per week that the traveling mixer unit works the bays. Each pass through the bays, the traveling mixer moves the material 14 feet. If the bays are worked once per day, 7 days per week, this would result in a 15 day HRT. To achieve the desired 21 day HRT, the bins must be worked 15 times in a 21 day period. The automatic controls of the agitated bin system include tracking of the HRT in each of the bins.

The number of times a week that a bin can be worked will depend on the quantity of compost feed generated. Consequently, the HRT must be considered to be a goal and not an absolute value. The HRT can be kept in the desired range by increasing or reducing the number of bins on-line based on seasonal and long-term variations in load. The loading height into the bins can also be used to adjust processing capacity slightly. When all the bins are on-line, additional capacity can only be provided by processing the material more quickly, thereby reducing the HRT. The minimum HRTs during peak load conditions will be dictated by the need to load the compost feed quantities into the system. HRTs as low as 15 days may be allowable to meet short-term needs. On the other hand, if the HRT is anticipate to exceed 28 days for the foreseeable future, the number of bins on-line should be reduced to lower operating costs.

The solids retention time accounts for the impact of using recycled compost in the feed mix to establish the mean residence time of the feed solids. A variety of methods can be used to determine the solids retention time of the system. These methods vary only slightly in their interpretation and results. The following approach is relatively straightforward to determine:

$$SRT = HRT \frac{X_p}{(X_p - X_r)} \quad (12)$$

where SRT = the solids retention time in days.

The total system SRT should be no less than 25 days (in active composting bins, and in curing), unless shorter cure times and active composting times are permitted by ME DEP and/or US EPA if applicable.

The 25 day SRT will not be met by the first stage agitated bin composting system alone, unless recycle rates are very high. Typically, the SRT requirements of the system are met during the curing stage. During the curing stage, the SRT is the same as the HRT, since there is no recycle. The minimum required detention time for the compost in the curing stage can be determined from the minimum total system SRT and the SRT for the first stage agitated bin system determined from Equation 12.

In fact, the facility was designed based on an even more conservative approach and has the capacity to ensure 60 days of hydraulic retention time between the agitated bin reactor and the curing/storage area.

c. Aeration. The timer should be set to a very high OFF time setting initially in every zone except the first. In the first zone of each bin, the timer is expected to control blower operation. An initial setting of 2 minutes ON every 10 minutes should be used until it can be determined how the compost feed responds. Eventually, the percent run time for the blowers in each zone will be known and will allow the timer to be set at typical values.

The temperature of the center of the compost mass should be checked daily using the portable thermocouple to confirm the temperature. Whenever bringing bins on-line or off-line, the impact on temperature must be considered.

Each aeration zone of a bay must be completely filled with compost for the aeration system to operate properly. The process air will short circuit if an aeration zone is not completely filled. When loading a bin that has been emptied previously, the blower for each aeration zone need only be turned on-line when completely filled with compost. Likewise, when a bin is being emptied, the blower can be shut off for any aeration zone that is not completely filled.

d. Pathogen Reduction. During startup of the composting facility, the temperature for the aeration system will be managed to achieve pathogen reduction to EPA Class A standards in the final aeration zone of each bin. This requires that the composting mass be maintained at temperatures of 55°C or higher for a minimum of 72 hours. Temperature and detention time will be recorded. The data for the final zone will be used to document that the temperature-duration requirements have been met.

EPA Class A standards also require that vector attraction reduction criteria be met. One criteria in achieving vector attraction reduction for aerobic systems (including composting) is to maintain a minimum temperature of 40°C and an average temperature of at least 45°C throughout the compo sting mass for a minimum of 14 days. This will typically be achieved in aeration zones 2 through 5, which have an average detention time of 16 days.

4. Alternate Operation.

a. Amendments.

The preferred amendment for the facility is shavings. It is recommended that at least initially a portion of the amendment requirements always be provided by sawdust and shavings as a quality control measure for the final product. However, to reduce amendment costs a variety of alternatives could be used including other waste wood sources, leaf and yard waste, coffee grounds, and wood ash.

Waste Wood. Sawdust is an ideal amendment, but is a commodity item that is getting more expensive and can be difficult to find as well. Sawmills and other woodworking operations can be a good source of inexpensive sawdust. Often this sawdust will be from kiln dried wood as well. A kiln dried sawdust is always preferable in terms of reducing total amendment requirements, but regular green sawdust should be adequate throughout the life of the facility. Hardwood sawdust is significantly more degradable because of the higher lignin content. Reported sawdust degradability ranges from 20 percent (softwoods) to 60 percent (hardwoods). The higher degradability of hardwoods has a favorable impact on the energy balance for the compost feed resulting in significantly lower requirements.

A lower cost alternative to sawdust is wood shavings from woodworking operations. The mixing provided by the agitated bin compo sting system will tend to break up the wood shavings so that the end result is very similar to using sawdust. This is particularly relevant if hardwood shavings are available. The primary concern is that source not have a significant quantity of oversize chips, since these would negatively impact product appearance for distribution.

Another source of sawdust is wood waste pulverization operations. These facilities typically use a tub grinder to pulverize the wood to varying consistencies. The output can vary from a coarse wood mulch to a fine wood particle material approaching sawdust in size depending on the size screen used in the tub grinder. The fine wood particle size is a suitable substitute to sawdust if this type of facility is available. The only precaution is that it would be desirable for the material to be classified to remove nails and other contaminants.

Finally, it should be noted that wood chips can be a viable amendment alternative in many cases. Depending on the energy and solids content of the dewatered sludge, the low energy contribution of the wood chips may not be a problem. Screening of the final product is recommended for product distribution and should allow recycling of the wood chips. A trommel screen would be recommended for the application.

Wood Ash. Wood ash has proven to be a highly desirable amendment both in terms of end product quality and odor control. The wood ash has very high alkalinity (PH over 1 0), which contributes to odor control. (Elevated pH is one mechanism that has been shown to reduce the release of the more persistent reduced sulfur compounds.) The absorbtive nature of the wood ash has also been noted as a potential mechanism for the observed odor control effect. High alkalinity in the compost product could reduce the value of the product for certain high-end horticultural uses, but the overall impact should be enhanced product marketability.

Wood ash generally has a low moisture content and consequently favorably impacts the overall solids balance. A high carbon wood ash is generally sought for compo sting applications, since this will also contribute to the energy balance. The ideal application rate for wood ash has not been well established, but it is recommended that the facility start with 5 percent by weight of amendment requirements. Trials using wood ash for up to 30 percent of amendment requirements could be carried out. The wood ash imparts a dark color to the compost that tends to improve its visual appeal, even when used at only 5 percent.

Bark Mulch. Bark mulches from many softwoods can be valuable as an amendment as they are acidic and can assist in the control of ammonia emissions. (Lowered pH is a mechanism that has been shown to reduce the release of ammonia.)

Various gradations of bark mulch exist and could contribute to the operation of the facility. Whereas finely ground bark mulch may be suitable as an energy amendment and not require post-process screening, bark mulch with large particles may not be useful as an energy amendment and would require post-process screening.

b. Diesel Fuel Fill-ups.
Both front end loaders are diesel engine driven. Since it will not be convenient to bring these units to a diesel fuel station every time they require refueling, the Authority has a diesel fuel transfer system.

5. Emergency Operation.

Power Outage. The facility does not have an emergency power system so it will not be possible to operate during a power outage.

Fire. Several composting facilities have experienced fires caused by spontaneous combustion of the composting mass. In Schenectady, New York, analyses following their fire indicated that the compost would spontaneously combust when the solids content was 80 percent or greater. The solids content of the material at the finish end of the agitated bin system and in the Curing/Storage Area should be monitored regularly.

The compost should be watered down anytime the solids content exceeds 55 to 60 percent to minimize the potential for fire. In addition, at these solids levels the moisture content is limiting to microbial activity. The addition of moisture would facilitate consumption of the degradable volatile solids. In fact, the occurrence of solids levels above 55 percent would indicate that it may be possible to reduce the amount of energy amendment in the feed mix as well as increase the amount of recycled compost. For immediate reduction of the solids content, water can be sprayed in Zone 4 or earlier prior to turning the bins.

Long Term Shutdown. In the unlikely event that long term shutdown of the facility is required, removal and appropriate disposal of all uncured compost and sludge will be required. Compost already in the curing area will be loaded into trucks by the on-site front end loader and transferred to either a landfill capable of accepting the material or to another sludge compo sting facility. Contracts for disposal would need to be arranged in advance of shipment by LAWPCA. Removal of compost from the bins would be accomplished by continually operating the turners in the bins until all compost has been removed. Approximately 15 passes per bin would be required.

LEWISTON-AUBURN POLLUTION CONTROL AUTHORITY SLUDGE COMPOSTING FACILITY OPERATION AND MAINTENANCE MANUAL

CHAPTER 5

ANALYTICAL TESTING AND MONITORING

A. GENERAL

The purposes of performing analytical testing and monitoring are: (1) to meet regulatory reporting requirements concerning quality of the compost and environmental impacts. (2) to monitor process efficiencies and effectiveness. (3) establish a basis for controlling process performance, and (4) to create a historical record of the composting operation's performance. This chapter discusses sampling required to conform with the facility's Maine DEP permit(s), to meet EPA 40 CFR Part 503 regulations, and to insure processes are efficient and effective.

Proper and sound sample collection and analytical techniques used in testing must be strictly adhered to in order to produce accurate results and records from representative samples.

B. MONITORING PROGRAM

1. GENERAL

Tests will be conducted to determine the concentrations of specific constituents and particular characteristics of the following (if required by ME DEP Permits, State and/or Federal Regulations): dewatered wastewater sludge, amendments, compost mixture and finished product, detention pond water, groundwater monitoring wells, wells, water supply wells, and odor.

2. SAMPLING

Schedules for sample collection for normal operating conditions should follow that which is required by the Maine DEP and EPA by regulation(s) or by permit(s). LAWPCA may conduct additional sampling as needed.

Sampling, sample collection, preservation, sampling frequency, parameters sampled for, containers used, and other sampling details will be in accordance with LAWPCA’s ME DEP Approved Sampling Analytical Work Plan (SAWP), ME DEP/USEPA Regulations and/or Permits, LAWPCA’s ME DEP approved Environmental Monitoring Program, or any other legal requirements.

LEWISTON-AUBURN WATER POLLUTION CONTROL AUTHORITY
SLUDGE COMPOSTING FACILITY
OPERATION AND MAINTENANCE MANUAL

CHAPTER 6

MAINTENANCE

A. GENERAL

Efficient maintenance management is essential to achieve production of environmentally acceptable compost of the highest quality at the lowest possible cost. It is the responsibility of plant personnel to establish and maintain sound maintenance practices. A carefully planned maintenance program will minimize operating costs and the frequency of equipment breakdowns, help avoid permit violations, extend equipment life and provide efficient use of manpower. Actual maintenance can be generally divided into the following categories:

1) preventive maintenance;
2) corrective maintenance; and
3) major repairs or alterations.

Preventive maintenance is a program of systematic procedures which serve to keep equipment in good operating condition by continual inspection, lubricating, exercising, cleaning, adjustments, replacement of small parts, and painting. Corrective maintenance is repair or replacement of parts after a malfunction or failure has occurred. Much corrective maintenance can be avoided by practicing a sound preventive maintenance program. Naturally, some malfunctions or failure may occur regardless. Proper preventive maintenance has repeatedly proven the old adage "an ounce of prevention is worth a pound of cure."

Major equipment repairs may be beyond the capabilities of plant personnel and/or may require specialized tools. When plant personnel have determined that the repair is beyond their capabilities; the repair must be contracted out to the original manufacturer or a competent service company.

This chapter provides recommendations for a maintenance management system. This consists of maintenance programs, equipment records systems and inventory record systems, which accommodate the three-basic maintenance categories. The maintenance management system should be reviewed and revised as experience dictates.

The basic features of the maintenance management system will consist of:

1. An equipment record system.

2. Maintenance planning and scheduling.

3. Inventory system.

4. Cost and budgets.

B. EQUIPMENT RECORD SYSTEM

The equipment record system should contain information on each item of equipment requiring maintenance. An equipment record system should provide information on preventive maintenance tasks with their frequencies, corrective maintenance work performed and maintenance cost data. Information used in making cost analyses, preparing maintenance budgets and evaluating maintenance problems will be found in the records system. Data collected includes the following:

1. Name and location of equipment.

2. Name of manufacturer and supplier.

3. Cost and installation date.

4. Type or model.

5. Capacity, size and rating.

6. Serial and code numbers.

7. Nature and frequency of maintenance and inspection.

8. Lubricants and coatings.

9. Special tasks

10. Spare Parts

An individual record of important data should be provided for each piece of equipment. This equipment includes, but is not limited to, the following:

Process Equipment

Agitated Bin Composting Turner
Process Blowers
Exhaust Fans
Instrumentation
Front-End Loader
Heated Make-up Air Units
Control Panels

Mechanical, Electrical and Miscellaneous Equipment

Well Pumps
Kitchen Equipment
Valves
Water Meters
Gas Fired Water Heater
Compressed Air System
Portable Fire Extinguishers
Temperature Controls
Fuel Transfer System
Fuel Storage Tank
Plant Water System
Electric Unit Heaters
Air Conditioners
Ventilation Fans
Dampers
Louvers
Pressure Gages
Motor Control Centers (MCCs)
Fire Alarm System
Public Telephone System

An equipment record system should be maintained for the LAWPCA Composting Facility by the Facility Supervisor and should contain the information listed above. The established system should provide a complete history of the maintenance for each piece of equipment including repairs, downtimes, manhours and expenses.

C. MAINTENANCE PLANNING AND SCHEDULING

Planning and scheduling of maintenance work is essential to the maintenance management system. If done properly, the operator and his work force will be used in the most efficient manner. Maintenance must be scheduled so that there is no idle time or peak work load periods for maintenance personnel. Obviously, this is easier said than done! Operation personnel must constantly tailor the maintenance schedule system to achieve a balance of work load.

Maintenance scheduling should account of various factors such as inclement weather, low load periods, and whether or not the task to be performed is indoors or outdoors. Maintenance work needs to be scheduled, just as the operating routine has to be scheduled. Preventative maintenance should not be a haphazard procedure to be done only if time permits.

Seasonal items to be scheduled would include lawn mowing and landscaping work, snow removal and exterior building maintenance. Some items may occur annually or others with much longer intervals, including roofing, paving and road repairs, fencing, electrical system updating or plumbing revisions.

The manufacturer's maintenance manual is generally the best guide for preventative maintenance instruction. Each piece of equipment should be rated as to its critical position in the plant operating system and its maintenance priority. Unnecessary maintenance can be as wasteful as improper maintenance procedure.

All non-routine corrective maintenance tasks should also be tracked. This will provide a record of when the work was initiated and completed and the cost of this work.

D. STOREROOM AND INVENTORY SYSTEM

An adequately stocked inventory of equipment spare parts and supplies will aid in maintaining a successful maintenance program. Having the proper tools or parts when required to perform preventive or corrective maintenance will prevent extended shutdown periods of the equipment being maintained. A limited shutdown period may in turn prevent process upsets, permit violations, etc. However, in order to make efficient use of and maintain a well-stocked inventory, a complete detailed stockroom inventory record must be established.

The inventory procedure will help maintain control of items on hand, will recognize when to reorder needed supplies, will help locate items on hand and will provide for efficient purchasing and receiving of supplies.

The inventory records should be used to maintain your inventory, part number, part subscription, cost, date, supplier and the minimum and maximum quantities to be maintained.

The procedure should include a purchase order system that should be established to obtain the items required and to maintain the stock of consumable items as the quantity is depleted. By maintaining the purchase order system, the operator will have a complete record of all transactions and a check on accountability.

E. MAINTENANCE BUDGET

Maintenance costs can be a significant percentage of the facility's total budget. The facility operator must take positive action to ensure that proper maintenance is performed, within the limitations of the budget.

Before an accurate estimate of maintenance costs for the budget can be prepared, the operation should be divided into categories as follows:

1. <u>Preventative Maintenance (PM)</u>
   This can generally be performed while the facility is in operation by facility personnel. It includes routine inspection of equipment, lubrication and minor equipment adjustments.

2. <u>Corrective Maintenance (CM)</u>
   This is usually performed with a minimum of equipment downtime while the facility is in operation. These functions include packing pumps, changing belts and replacing bearings, brushes, etc. They are performed by facility personnel or contracted out.

3. <u>Major Repairs</u>
   These generally occur when a unit is out of service and are performed by facility personnel or contracted out. Usually they involve large expenditures of money. Budget appropriations for this service category should never be depended upon to justify long term maintenance manpower assignments.

Summary reports on various costs, parts used, and labor used, should be generated periodically.

The most effective way to develop a budget is to utilize the system of records established, and the historical cost data collected. The items which should be included in the proposed budget consist of the following:

1. Preventative maintenance, which can be derived from the historical records of man-hours, supplies, lubricants and related costs.

2. Corrective maintenance which can be derived from historical records on work orders which contain corrective maintenance man-hours, supplies and parts.

3. Major repairs or alterations include estimated costs and propose major task and capital improvements.

4. Contract maintenance or repair services includes all cost related to maintenance services provided by outside contract.

5. Special project costs. These are typically long-range planning aspects associated with major modifications to the facility to accommodate growth or advances in technology.

Budgeting for maintenance and operating costs always contains an inevitable occurrence that cannot be readily anticipated, such as an expenditure for a major emergency repair. Money for this type can be handled by establishing a replacement fund over and above the normal maintenance budget. If the money is not used then it is usually carried over to the next year.

F. HOUSEKEEPING

The general care of buildings and grounds is an area of preventive maintenance which is often wrongly given a position of secondary importance. Good housekeeping practices go a long way toward promoting public confidence and support by way of preventing unnecessary odors and by presenting a clean and pleasing appearance of the facility. These habits are also helpful in developing employee's pride in his work while making a significant contribution to his overall safety.

The dewatered sludge and amendment storage piles should be kept neat and orderly. The mixing area likewise will need to be kept clear of spills and sludge and amendment. Also, the finished compost curing area needs to be maintained in an orderly fashion to adequately provide for curing and material inventory.

Floors inside the buildings should be cleaned when needed. Bare concrete floors should be kept clean and free of grease, oil or other accumulations. Door glass

should be kept clean. Walls should be kept clean, with particular attention given to those in the bathroom.
Outside the buildings, sidewalks and other paved areas should be kept clean and free from snow and ice or other hazardous obstructions. Any deterioration of paved areas should be patched as soon as practical.

Landscaping maintenance will take up any spare time.

It is not considered necessary to have a formal housekeeping schedule. Housekeeping tasks are to be completed as their need becomes apparent.

G. LUBRICATION

The operator must establish a lubrication system based upon manufacturers' lubrication data. Lubrication specifications developed from manufacturers' recommendations are usually based on ASTM Standards. The operator should establish lubrication groups on every item of equipment. Each equipment's lubrication points, types and frequencies should be defined. The basic data are gathered on selected equipment and assembled into a lubrication handbook. From this handbook, equipment can be color coded with decals or tags to indicate the point service, frequency of application and type of lubricant.

There are many trade-name lubricants on the market and usually the producers number or SAE number will be designated.

H. MAINTENANCE SCHEDULE

The basis of effective maintenance is strict compliance by competent plant personnel to an efficient maintenance schedule. Completing each maintenance task as required will ensure that all equipment is maintained in top operational condition. However, maintenance should not only be limited to the tasks required by the maintenance schedule. All plant personnel should be continuously on the alert for any signs of equipment malfunctions or unusual conditions. Be aware of early signs of equipment failure such as noises, vibration, excessive heat, odors, smoke, leaks, etc. Use your senses to detect any of these indicators. LOOK, LISTEN, TOUCH, SMELL. Also, use your common sense. Report the presence of any of these indicators as quickly as possible. Maintenance personnel are to immediately remedy the situation and/or implement alternate operation as required.

In the development or modification of a preventative maintenance program, the operator should refer to the manufacturer's literature for recommended maintenance frequency and procedures. See the manufacturers' O&M Manual for more information.

I. MAINTENANCE PERSONNEL

The importance of qualified maintenance personnel in the implementation of a successful maintenance program cannot be over-emphasized. All personnel should become familiar with established facility maintenance procedures and should become actively involved with programs to improve these procedures, actively pursue training to improve their maintenance skill/knowledge of equipment specific to the facility, and develop a sense of pride in the proper maintenance and operation of all equipment. Maintenance personnel should adopt a strong belief in preventative maintenance as a tool to be utilized to ensure continued and successful operations of all equipment and therefore the overall facility in general.

J. TOOLS. SPECIAL TOOLS AND EQUIPMENT

Implementation of a successful maintenance program not only requires a proper blending of all the components noted above, but requires that the tools necessary to perform this maintenance are readily available within the facility. Further, personnel must have a working knowledge of these tools.

It is recommended that the maintenance area be kept in a clean, neat and orderly manner to facilitate maintenance. Tools which cannot be located, or are in a state of disrepair themselves, serve little use in a maintenance program. The operation and maintenance personnel should adopt a policy of quickly returning all tools to their proper storage location subsequent to each use.

While the majority of maintenance tasks associated with this facility are anticipated to be accomplished utilizing readily available tools, occasionally there exists a need for use of specialized tools and equipment for a specific task. If the need arises, and the specialized tools is not available at the facility, the Operator should contact the equipment manufacturer directly to obtain the necessary tools. If specific training is required to utilize these types of tools then the operator should receive this training prior to use of the tool. No special tools should be utilized without the benefit of the necessary instructions in its proper use.

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CHAPTER 7

RECORDS AND REPORTS

A. GENERAL

Keeping accurate records and reporting the necessary information to the proper agencies or individuals is an important part of the operation of the facility. Proper records are necessary for monitoring the performance of the facility and to make operational decisions. Qf great importance is establishing a reliable continuing record of proof of performance, thus justifying decisions, expenditures and recommendations. Daily operational records also provide information useful in process adjustments required due to climatic or seasonal changes, or other recurring problems of a specific nature. This information is useful for this facility, as well as to operators of other facilities who may have related problems. Records and reports also provide valuable information for release in public relations efforts, as well as legal reference should a lawsuit or other action be threatened. Accurate records also provide the basis for planning future facility expansion, planning future modifications, establishing and adjusting operating budgets and providing evidence of performance in compliance with regulatory agencies.

The State regulatory agency requires record keeping and reporting on a continuing basis which allows them to determine the facility's efficiency and effectiveness. Annual reports are required by the Department of Environmental Protection (DEP). Personnel from the DEP may make periodic visits to this facility. During these inspections a review of operational and other records may be requested.

Permanent record files must be maintained at the sludge composting facility. It is the responsibility of the Facility Supervisor to assure that records are complete and current.

Records and reports can generally be divided into three categories as follows:

1. Administrative and Facility Records:

    a. Cost Records

    b. Budget information

c. Annual Report

d. Plans, Contract Specifications, Design Information and Record Drawings

e. Equipment Manufacturers' Information

f. Safety Records

g. General Communications

2. Operational and Performance Records:

a. Operation and Maintenance Manual

b. Daily Operations Log

c. Laboratory Test Records

d. Emergency and Unusual Condition Records

e. Odor Monitoring

3. Maintenance Records:

a. Equipment Maintenance System

b. Manufacturers' Information

c. Equipment and Parts Inventory

B. ADMINISTRATIVE AND FACILITY RECORDS

Administrative and facility records are generally maintained by and under the care of the Facility Supervisor. Some of the information under this heading such as certain manpower, budget and communications items should be kept confidential.

1. Cost Records

For the purpose of budgetary planning, it is recommended that facility personnel maintain records of expenditures as they occur and summarize items contributing to the cost of operation on a monthly basis. Major categories of costs will be utilities, equipment maintenance and repairs, facility maintenance, vehicle maintenance and supplies.

Bills for utilities should be reviewed and pertinent information recorded such as: quantities used, unit costs, total costs and any miscellaneous charges.

Wherever it is necessary to have maintenance or repairs performed by outside craftsmen or by representatives of equipment manufacturers, the details of these visits, including the nature of the problem, persons involved, and costs for parts and labor should be recorded and filed.

Costs incurred in the operation and maintenance of any vehicles used in connection with the facility should also be summarized as a separate item.

Records showing the description and cost of facility supplies, as well as any additional miscellaneous expenditures, should also be maintained.

2. Budget Information

The budget information file or notebook should include: a copy of an operating budget from each previous year of operation, a format for establishing a new budget utilizing data from costs records as discussed above, and trend charts developed from this recorded information to predict cost increases for future years.

3. Annual Report

Each year the Facility should prepare an annual report collecting all the pertinent information in an organized format. The report is a summary of developments and activities that occurred during the previous year.

The report should be prepared by the Compliance Coordinator in conjunction with the Authority's Superintendent.

4. Plans, Contract Specifications. Design Information and Record Drawings

Plans, specifications and design calculations or related materials provided by the Design Engineer should be maintained at the sludge composting facility office. Record drawings and shop drawings should also be filed to provide ready reference as an aid in understanding the process and locating buried piping, conduits, etc. All modifications and additions to the facility should be properly noted.

5. Equipment Manufacturers' Information

Equipment manufacturers' information consisting of shop drawings, operation manuals and maintenance instructions should be kept separately and up-to-date. This type of information supplies the operator with parts list, electrical requirements, lubrication requirements and specific operating instructions for every major piece of equipment.

6. Safety Records

Information should be kept relative to the care and operation of all safety equipment. Instructions for each equipment item should be with the item and also kept in a master safety equipment notebook or file. Records should also be kept for repairs, inspection or calibration of safety equipment items, and accident and injury reports. Additional information related to Safety can be found in Chapter 9 of this manual.

7. General Communications

A general communications file should be established to keep records of letters, telephone conversations, etc. with the general public, regulatory agencies, LAWPCA offices municipal
offices, etc. Such a file can be invaluable in settling misunderstandings, placing a time frame on a particular incident, etc. Typical sub-headings on a general communications file might be: Public, Complaints, DEP, Engineer, LAWPCA, References and Recommendations.

C. OPERATIONAL AND PERFORMANCE RECORDS

1. Operation and Maintenance Manual

This Operation and Maintenance Manual is written specifically for the LAWPCA Sludge Composting Facility. It is intended as a general guide to basic facility operations and as a more specific guide to equipment or operations unique to the facility.

2. Daily Operating Log

A daily operating log should be maintained by the operator. Information contained on the daily log might include the following:

a. Staffing.
b. Weather.

c. Volumes received of sludge, amendment.
d. Composting feed rates and daily quantities.

D. MAINTENANCE RECORDS

Planned maintenance programs should be developed from the facility records. These programs will allow major repairs to be scheduled in order to minimize effects on the composting operations.

1. Equipment Maintenance System

The equipment record system contains information on each item of equipment requiring maintenance.

2. Manufacturers' Information

Manufacturers information on repair and maintenance of individual equipment items should be kept available to facility personnel.

3. Equipment and Parts Inventory

All parts and spare equipment should be inventoried annually or more frequently if needed. Spare parts should be listed according to equipment items and manufacturers catalog numbers. A properly maintained inventory will help control budget expenditures and assure that frequently used parts are available when needed. See Chapter 6, Maintenance, for additional information.

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CHAPTER 8

EMERGENCY OPERATION

A. GENERAL

An emergency can be imposed on a sludge composting facility by natural disasters, strikes, civil disorders and equipment failures. Emergency planning is essential to ensure continued effective operation if substantial disruption is threatened by severe and unforeseen circumstances. The facility manager must be prepared to initiate an emergency response plan to ensure effective continued operation of the facility

- The objectives of an emergency response program are to:
- Eliminate or minimize adverse effects from emergency situations affecting the operation.
- Develop procedures for properly responding to emergencies.
- Provide instruction for system personnel to ensure they understand their responsibilities during emergency situations.
- Provide inventories of recommended emergency equipment and outline existing mutual aid agreements and contracts with outside organizations for specialized assistance.

As part of the emergency response program, the following conditions should be adhered to in order to meet the above objectives:

- All engineering drawings, specifications, shop drawings and equipment manuals shall be kept along with this O&M Manual in an organized manner. They should be protected from fire and water damage, and easily accessible in the event of an emergency. A spare copy of each shall be kept at the LAWPCA Office.
- A complete first aid kit should be kept on hand and personnel should be regularly trained in first aid methods.
- All personnel should regularly receive tetanus and typhoid vaccine inoculations.

B. EMERGENCY TELEPHONE NUMBERS

The operator should post specific telephone numbers that can be reached in time

of emergency. These should be in a conspicuous place and should include:
Auburn Fire, Police, Ambulance 911

State Police 1-800-482-0730

DEP 1-800-482-0777

LAWPCA 782-0917

CMP 1-800-442-9992

C. POTENTIAL EMERGENCIES

1. Power Failure

A power failure at the facility may be caused by a failure of the transmission line or substation feeding this facility. In this event, the facility operator on duty should notify the power company, Central Maine Power, to have them trace the failure. Every attempt should be made to re-establish power to the facility as soon as possible to minimize the process disruption. The facility does not have a standby electrical generator. No additional dewatered sludge should be received until power has been restored.

2. Earthquakes

The possibility of a damaging earthquake in the area is unlikely. However, if an earthquake does occur, facility personnel inside the building should stay inside. Those personnel outdoors should move away from buildings and out from under utility wires. Once the shaking stops, the operator should begin emergency operations. The following steps are recommended:

a. Turn off all electrical power.
b. Close the water supply valve.
c. Do not enter any portion of the building that appears to be unsafe.
d. Make emergency repairs where possible.

3. Hurricanes and Wind Storms

Hurricanes that strike the eastern seaboard begin in the tropical and subtropical Atlantic Ocean. They move north at speeds ranging from 15 to 60 miles an hour. Hurricanes in this area are most likely to occur during the months of August, September and October. The term "Hurricane Watch" indicates that a hurricane may threaten an area within 24 hours. A

"Hurricane Warning" indicates that a hurricane is expected to strike an area within 24 hours.
In a hurricane emergency, the operator should have on hand a supply of boards, nails, masking tape, rope, a portable radio, battery powered lighting equipment and emergency water. When a "Hurricane Watch" is posted, the plant personnel should:

a. Secure any movable outdoor object by tying, taping or nailing down.

b. Fuel up gasoline or diesel power equipment which may be needed.

c. Check all battery-powered equipment. Replace any batteries that are low.

When the hurricane strikes:

a. Stay indoors and away from windows.

b. Use portable radios to receive up-to-date weather reports.

4. Explosive and Hazardous and Gases

The composting process will naturally generate carbon dioxide and moisture. Also, ammonia, volatile organics, and dust will be released. During proper operations, the ventilation system will exhaust these gases and airborne particulate matter and replenish air from outside. Under power outage conditions or other circumstances requiring the ventilation system to be shutdown hazardous concentration of gases may develop. The operator is cautioned to utilize the portable, hazard gas detection unit to sample frequently for hazardous gas concentrations and exit the building immediately if conditions are found to be hazardous. Actions should be taken to ventilate the building until safe conditions are restored.

5. Long Term Shutdown

In the unlikely event that long term shutdown of the facility is required, removal and appropriate disposal of all uncured compost and sludge will be required. Compost already in the curing area will be loaded into trucks by the on-site front-end loader and transferred to either a landfill capable of accepting the material, another sludge composting facility, or some other ME DEP approved location for re-use or disposal. Contracts for disposal would need to be arranged in advance of shipment by LAWPCA. Removal of compost from the bins would be accomplished by continually operating the turners through the bins until all compost has been removed. Approximately 15 passes per bin would be required.

E. FIRE AND EXPLOSIONS

The compost process will result in high temperatures within the compost mixture of 50^o-60^oC. These temperatures certainly are well below the combustible value for compost. However, if the process is not controlled, excessive drying may occur and present a potentially combustible mixture. Additionally, the mixing and turning activity will create considerable dust within the building. A malfunction in the ventilation system and the resulting concentration of dust could develop into an explosive atmosphere. Facility staff should exit the facility immediately and wait for the fire department to respond and extinguish the fire.

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CHAPTER 9

SAFETY

A. GENERAL

The operation of a sludge composting facility can be a dangerous occupation if proper safety procedures are not followed. The use of vehicles such as front end loaders and dump trucks pose dangers to operators and pedestrians. Physical injuries and body infections are continuous threats. Explosions and asphyxiation from gases or oxygen deficiency are constant hazards. The injury rate of wastewater collection and treatment personnel has been relatively high compared with other industrial groupings.

The Chapter provides some general discussions regarding safety issues but shall not be construed as being all inclusive. The facility should endeavor to maintain an up-to-date data base of standard safety manuals and procedures. Common sense should be employed to the maximum extent possible regarding safety issues.

Safety measures for operation and maintenance of sludge composting facilities are effective if hazards are known and if proper safety precautions are followed. Personnel should be knowledgeable of hazards, preventive measures and emergency procedures. Any accidents or injuries which do occur should be immediately investigated and recorded. Safety should be high priority and borne in mind at all times.

Personnel should be familiar with first aid procedures. In case of serious injuries, a doctor should be called or the injured person removed to a hospital by ambulance.
The phone numbers of the nearest hospital, the police and fire stations and one or more ambulance services should be prominently posted. The phone numbers of the chemical suppliers should also be posted for ready reference in the event of an emergency.

The hazards commonly associated with this type of facility may be classified into four categories as follows:

1. Bacterial infection.

2. Mechanical and physical hazards.

3. Electrical hazards.

4. Gas and chemical hazards.

B. PREVENTION OF INFECTION

Constant caution is necessary to prevent infection by primary pathogens found in sludge including bacteria, viruses, protozoa and parasites such as helminth worms. Secondary pathogens such as certain fungi can cause aspergillosis in susceptible individuals such as the immunologically suppressed, elderly, and individuals with asthma or other respiratory ailments. Tetanus and skin diseases must also be guarded against. Some basic rules of safety are as follows:

1. Personal cleanliness cannot be stressed too strongly. Sludge on hands contaminates door knobs and fixtures. Dirty clothing or careless washing of hands may spread infection beyond the plant area. Personnel must make a habit of frequently and thoroughly washing with soap and hot water, especially before meals and before leaving the plant.

2. Food should be eaten only in the office and never in the operations areas.

3. Emergency first aid must be promptly given to all minor cuts or injuries.

4. Rubber gloves should be worn when directly handling sludge. Special precautions should be taken to prevent wastewater from coming in contact with open cuts or other injuries. Fingers must be kept out of the nose, mouth and eyes at all times.

5. The use of coveralls or a complete change of work clothes is recommended for working hours.

6. Plant personnel should obtain inoculations against typhoid fever, paratyphoid fever and tetanus as a safeguard against contracting and spreading these diseases. Periodic physical examinations by a physician are advisable.

7. Masks should be worn while working in the composting area to filter out the dust and other airborne matter.

C. PREVENTION OF MECHANICAL AND PHYSICAL ACCIDENTS

1. Care must be taken when repairing or performing maintenance on automatic or remote-controlled equipment to ensure that power is shut off so that equipment cannot be started. Lock -out switches at the equipment

motor should always be locked out and marked with red tags. Power should be locked out at the MCC.

2. Insofar as practicable, lubrication or adjustments should not be made on machinery while in operation. If services must be performed under this condition, a second man must be present and stationed at the stop-start switch.

3. Metal guards for all moving parts of machinery should be provided and properly replaced immediately after any repair work is complete.

4. Floors and stairways must be kept clean, dry and free of grease, oil and ice to prevent slipping.

5. Tools must be picked up and manhole covers or hatch covers kept closed. If it is necessary to have openings uncovered, they should be protected with guards and warning signs.

6. Cleaning fluids with flash points below 100 degrees F. should not be used.

7. Hard hats should be worn when working in areas where tools or other heavy items may be dropped from above.

8. Operators should learn to lift objects with the aid of leg muscles instead of the back to avoid ruptures and back injuries. Hoists or power trucks should be used to lift heavy objects. Adequate personnel should be used for strenuous tasks to avoid injuries.

9. Manhole covers should be removed with a hook lifter rather than a pick. Unless the cover is very heavy, it is safer to have one man pull the cover free of the manhole. A manhole cover or grating should never be left partially over a manhole shaft or opening.

10. Fire prevention is an important part of every safety program. Flammable materials should be kept in approved safety cans.

11. Permanent warning signs should be placed at all hazardous locations and supplemented by temporary signs during emergency operation.

12. Sharp projections or locations of low headroom should be padded and either marked clearly or painted with a contrasting color to identify the hazard.

13. Ample lighting should be used in all work areas. Only grounded explosion-proof portable lamps should be used in hazardous locations.

D. PREVENTION OF ELECTRICAL ACCIDENTS

1. Only electrical tools and lights having 3-wire grounded extension cords should be used.

2. Major electrical maintenance and repairs should be performed only by qualified electrical workers.

3. Care should be taken to avoid wetting panels, motors, etc. during hosing down or clean-up of plant equipment.

4. Operators should make themselves familiar with the types of electrical accidents, how to administer first aid and artificial respiration, and how to rescue a person without also becoming a victim.

5. Rubber mats should be placed on the floors in front of switch gear when working on this equipment.

6. Never underestimate low voltage and low amperage electricity. Extensive studies have shown that five thousandths (0.005) of an ampere will cause loss of muscle control and that a voltage as low as 12 volts may, on good contact, cause injury. Therefore, all voltages above 12 volts are dangerous. The electrical systems at treatment plant is often at voltages from 12 volt to 480 volt. Treat all electricity with respect. Do not guess as to the nature of an electrical circuit.

7. Foreign voltages may be present in instrumentation panels due to the numerous interlocks and interconnections throughout the facility. Proper precautions should be taken.

8. Treat dead circuits as though they were alive. This may prevent an accident resulting from the negligent closure of the circuit by another person.

9. Do not hang clothes on electrical disconnect handles, light switches or control panel knobs.

10. Become thoroughly familiar with switch gear and electrical components of plant equipment. If you don't understand it, don't work on it.

E. PREVENTION OF GAS AND EXPLOSION ACCIDENTS

Normal air contains about 21 percent oxygen by volume. Any atmosphere containing less than 19.5 percent oxygen is dangerous to humans and is termed oxygen deficient. This situation may occur in any confined area, such as the Composting Building, by another gas displacing the oxygen. Oxygen deficiency may also occur in a confined area where organic material may have been spilled.

Refer to the LAWPCA Confined Space policy for proper procedures, hazard identification, mitigation, and emergency protocols.

F. FIRE FIGHTING EQUIPMENT

The sludge composting facility is equipped with hand-held fire extinguishers. All plant personnel should know the exact location of each extinguisher and should be thoroughly familiar with their use. The extinguishers should be checked periodically for operability and charged as recommended.

G. ACCIDENT REPORTS

Any injury, however slight, must be reported and should be by means of a standard form. This procedure gives some legal protection to both employees and employer.

After an accident has occurred, an injury investigation (formal or informal) should be undertaken to determine the cause of the injury and to take steps to prevent a recurrence. If plant personnel are allowed to play a role in determining the cause of an injury, a beneficial effect on overall safety consciousness is likely to result. Similarly, copies of accident report forms should be made available to all employees for their review. Hopefully, they will adjust their work habits to avoid similar injuries.

H. LIST OF SAFETY EQUIPMENT

1. The following list contains the safety equipment which should be available to the operations staff:

Item
First Aid Kits
Safety Goggles
HardHat
Pairs Hearing Protectors
Hand-held Emergency Eye Wash Station
Filter Mask
Respirator Filters
Explosion Proof Flashlight
18" Safety Cones
Foul Weather Suit
Pair Safety Knee Boots Size 8
Manhole Cover Hook
Shovel
Sledge Hammer
Oily Waste Can, 6 Gal.

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CHAPTER 10

OPERATING PROBLEMS AND TROUBLESHOOTING

A. INTRODUCTION

This chapter provides a general guide to assist the operator in recognizing, determining the cause of and finding the best solutions to problems which may occur during the operation of the LAWPCA Composting Facility. The contents of this chapter should be continuously revised and/or supplemented as needed based on experience obtained during facility start-up and operation. The operator should use the logical format or sequence presented in this chapter for evaluating all problems.

The problem-solving solutions of this chapter are presented in the form of troubleshooting guides which are set up in tabular form, with each process or system covered separately. The heading on each table is for a particular process, system or piece of equipment. The tables list observations, probable causes, the method by which the operator may check or monitor the cause and suggested solutions to the problem.

The troubleshooting chapter should be used in conjunction with the descriptions presented in both the manufacturer's and this manual's operation and maintenance chapters for the various equipment and unit processes. A solid understanding of the operation and maintenance of the process equipment is essential before this troubleshooting guide can be of real value.

B. OPERATING PROBLEMS WITH INDIVIDUAL SYSTEMS

The facility operator must have the ability to recognize operating problems with each specific process, system or piece of equipment, identify the cause of the problem, and determine the appropriate solution. As an aid to the operator, troubleshooting guides for the following systems or equipment are presented in tabular form at the end of this section:

Many of the manufacturers' Operation and Maintenance Manuals also contain troubleshooting guides (or operation problems sections), which should be consulted in the event of problems occurring.

PROCESS: Agitated Bin Composting

Indicator/Observation	Probable Cause	Check or Monitor	Solution
1. High temperature in compost	Aeration rate is too low.	Temperature set point for blower control	Increase lower temperature limit to require blower to operate longer.
		Throttling valve on blower discharge.	Reduce throttling to increase air flow.
2. Low temperature in compost	Aeration rate is too high.	Temperature set point for blower control	Decrease upper temperature limit to require blower to operate less.
		Throttling valve on blower discharge.	Increase throttling to decrease air flow.
3. Inconsistent appearance of compost, or sludge ball development.	Insufficient mixing.	Time allowed for mixing	Increase mixing time.
	Insufficient percentage of amendment	Amendment to sludge ratio.	Increase amendment to sludge ratio.
4. Excessive amounts of reduced sulfur-type odors.	Compost Temperature above 60°C.	Temperature of compost.	Increase air flow.
	Low pH.	pH level of compost.	Increase pH by increasing amount of wood ash.
	Low porosity.	Moisture content of compost	Increase amendment to sludge ratio.
5. Solids content of compost at end of Zone 4>55%	Too much energy amendment in feed mix.	Feed mix recipe.	Reduce amount of energy amendment and increase recycle.
			Add water to compost in bins prior to turning.
6. Ammonia concentrations in air >25ppm	pH of feed mix too high	Feed mix recipe	Reduce amount of wood ash and increase amount of softwood bark mulch to reduce pH.

	C:N ratio too low	Feed mix recipe	Add more wood shavings as a carbon source.
7. Short circuiting of air along bin walls	Compost feed mix is too wet which can lead to the formation of hard pan in the bin bottom.	Feed mix recipe	Add more recycle compost to lower feed mix water content.
	Hard pan has formed in the bin bottom	Feed mix recipe	Remove hard pan manually with shovel and adjust feed mix to lower water content.

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CHAPTER 11

ELECTRICAL AND INSTRUMENTATION SYSTEMS

A. GENERAL

Generalized procedures necessary to energize and maintain electrical and instrumentation equipment are outlined within this chapter. The discussion of electrical systems includes the incoming electrical and telephone service, power distribution, illumination, control and alarm systems. Operating personnel should become familiar with the electrical and instrumentation systems facility design, shop drawings and various equipment maintenance manuals. These three documents form the set of reference materials that the operator has on hand for these systems.

Major service and maintenance procedures are beyond the scope of this manual, therefore, reference should be made to the instruction manuals of the various equipment manufacturers. Only experienced electricians or instrumentation technicians should be engaged in performing maintenance services beyond simply cleaning, lubricating, replacing of light bulbs, probes, etc. Under no condition should electrical interlocks be bypassed, nor electrical conductors exposed by removing protective covers or insulating material be permitted except by qualified personnel.

Before undertaking any work requiring removal of panels or motors be sure that the electrical power to that panel/station is positively locked off (including the emergency power unit).

WARNING: Instrumentation Panels can contain foreign voltages due to interlocks and other interconnections.

The electrical equipment, components and fixtures have different NEMA ratings associated with the various areas around the treatment plant. If modifications to any electrical components are made, the new equipment or work should equal or not degrade the NEMA rating. Table 11-1 lists the NEMA room/area rating

Table 11-1. Room/Area Rating Schedule

General Wet Corrosive Hazardous
Mixing Area
Compost Area
Curing/Storage Area

The following is a description of the NEMA classification requirements for the areas listed in Table 11-1.

1. General Location
    a. Equipment enclosures can be rated NEMA 1 or 12.

2. Wet Locations
    a. Exterior equipment enclosures must be rated NEMA 3R.
    b. Interior equipment enclosures must be NEMA 4.
    c. All conduit connections must be liquid tight.

3. Corrosive Locations
    a. All equipment enclosures must be rated NEMA 4X, stainless steel, aluminum or fiberglass.
    b. All conduit must be PVC coated.
    c. All junction and device boxes must be non-metallic, fiberglass.

4. Hazardous Locations
    a. All equipment enclosures must be rated NEMA 7 (Class I, Div. 1, Group D).
    b. All conduit connections must have conduit seals (Class I, Div. 1, Group D). Seal shall be used on all conduits entering and/or leaving hazardous areas.
    c. All conduit must be heavy wall galvanized rigid steel.
    d. All electrical equipment, devices, motors, J-boxes, fittings, controls, etc. shall be approved for use in Class I, Div. 1, Group D environments.

B. ELECTRICAL AND TELEPHONE SERVICE

Electrical service is provided by Central Maine Power. The primary electrical service is overhead then converts to an underground service starting at Penley Comer Road and ending at a pad mounted transformer. The Authority owns the transformer and is responsible for the underground portion of the primary service connection to the transformer. The transformer reduces the primary voltage to the secondary voltage of *480/277V*, 3 Phase, 4 Wire used by the facility. The electric company should be contacted if any problem occurs to this incoming service. The metering is owned by the electric company. Power service from the secondary side of the power transformer is brought into the building via underground conduits to the Electrical Room.

In addition to the electrical service, the plant telephone service comes underground from the same utility pole as the electrical service. The Telephone company is responsible for the underground telephone wiring from the utility pole to a telephone board located in the Electrical Room.

LAWPCA is responsible for all wiring to all telephones and teledialers within the building. The telephone company should be contacted if any problem occurs to the incoming service.

C. POWER DISTRIBUTION

The record drawings show the one-line diagrams with details of the electrical system at the facility. These drawings schematically illustrate plant power distribution from the motor control center, to individual transformers, panelboards, circuit breakers, and motor circuit protectors.

The overall operation of the plant's power distribution is handled through the motor control center (MCC) in the Electrical Room. The MCC is free standing with the main circuit breaker rated for 1000 amperes. The motor control center is of modular design, consisting of several vertical control sections bolted together to form an integral unit. The vertical sections are equipped with a number of control compartments containing motor starters, circuit breaker switches, etc. These compartments house the circuit breakers and motor starters for controlling the motors and other equipment. The circuit breakers are operated by handles mounted on the outside of the panels. These handles are insulated to prevent exposure to excessive voltage. The compartment doors cannot be opened if the circuit breakers are ON except by turning a "Defeater Screw". All circuit breaker handles have a provision for locking with a padlock and/or lock out device.

Horizontal (main) bus bars, running in a separate compartment at the top of each section, connect to vertical bus bars in the back of each section. An insulated neutral bus also runs through the top of each section, and a ground bus through the bottom. The horizontal bus is rated at 1000 amperes. The vertical bus bars supply power to the circuit breakers, starters and control equipment housed within the sections.

Circuit breaker disconnect switches are of the molded case type providing manual control of the loads served which may be a remote motor starter, a lighting panelboard, etc. The units are activated by handles located external to the control enclosures and are equipped with both a mechanical interlock to prevent opening of the enclosure while the breaker is "ON" and a tab for padlocking the breaker in the "OFF" position. All circuit breaker switches are rated and sized to trip under both a short circuit condition and sustained overloading above the nominal rating of the breaker.

Motor starter units contained within the MCC are of the combination type; i.e., they are equipped with both a circuit breaker disconnect switch and a magnetic contactor. The use of a magnetic contactor in conjunction with a circuit breaker switch permits remote control of an electrical load while retaining the circuit protection of the circuit breaker alone. In addition, overload relays are used primarily with motor loads, providing protection which is more closely matched to the individual motor-characteristics. Overload relay selection is based upon full load amperage and should not be increased due to possible damage to the motor. If a motor starter trips out on occasion due to thermal overload, the motor and its associated drive should be inspected for physical overloading. A qualified electrician should be sought in the event of persistent thermal overload tripping.

In order to properly control the treatment plant, the operator must have an appreciation of the electrical loads imposed by each energized circuit and the current carrying capacity of the systems controlled by circuit breakers and fuses, which in turn protect the wiring. A complete familiarization of the single line diagram is required.

When the main circuit breaker is closed, power is applied to the MCC bus bars. With feeder breakers closed to motor circuits, lighting panelboard, low voltage transformers, etc., the plant is ready to operate. The operator starts up motorized equipment in the prescribed order by depressing START push buttons or turning selector switches. A light in the Main Control Panel provides an illuminated indication of each motor that is running. In addition to MCC push buttons, some equipment has locally installed push buttons or selector switches to allow operators to START or STOP/LOCK OUT selected motors at the motor locations. For this reason, never tag a STOP push-button as a means of securing a maintenance shutdown. ALWAYS lock the motor starter out by padlocking the handle in the OFF position.

Before undertaking any work requiring removal of panels or motors, be sure that proper motor starters or controls are locked out and tagged.

D. ILLUMINATION

1. Interior Lights
All interior lights are controlled by ON/OFF switches located in the vicinity of the effected room/area. Light fixtures in the mixing, composting, and curing/storage areas are 277 volt, 60 Hz, single phase high pressure sodium or LED. Light fixtures in the support spaces are 120 volt, 60 Hz, single phase fluorescent. The light circuits are powered from panels DP-l, DP-2, and LP-I located in the Electrical Room.

2. Exterior Lights
Outside light fixtures are 277 volt, 60 Hz, single phase high pressure sodium powered from panel DP-I in the Electrical Room. Outside lights are activated/deactivated by a photocell. A week long timer, located in the electrical room, allows control of the time period that the lights are on.

3. Emergency Lights
Battery powered wall packs are located throughout the facility to facilitate

egress in the case of a power outage.

E. FIRE ALARM SYSTEM

1. General Description

The fire alarm control panel is activated by the following initiating devices:

1. Fixed temperature heat detectors located in the rooms as shown in the record drawings.

2. Photoelectric smoke detectors.

3. Manual pull stations.

Local fire alarm indication is provided by horn/strobe light alarm stations positioned throughout the building.

F. ELECTRICAL MAINTENANCE

1. General Description

This portion of the manual has been prepared as a guide for operating personnel in understanding and performing routine and preventative maintenance tasks which do not require the services of a qualified electrician. It includes only those procedures involving minimum hazard to personnel and requiring only simple safety precautions covered herein. It is recommended that operating personnel establish a routine maintenance schedule which suits the conditions under which the plant is operated and the available manpower. Implementation of such a schedule will assure that the plant is maintained in satisfactory condition at all times, and that most troubles will be detected before they become serious.

No maintenance work, other than that specifically mentioned herein, should be undertaken within a control enclosure of any piece of electrical equipment by any person who is not a qualified electrician. No work should be undertaken on the equipment within a Motor Control Center by any person who is not a qualified electrician. Any work on electrical equipment which requires the use of tools should be performed only with those tools specifically intended for that purpose. All persons working with electrical equipment should be familiar with, and have some training in, artificial respiration. Never work alone around exposed electrical conductors or equipment.

Table 11-4. Summary of Control Panels
Water Supply Mechanical Room
Curing Blowers Control Room
Make-up Air Unit 1 H&V Room
Make-up Air Unit 2 H&V Room
Fire Alarm Control Room

2. Operational Checks

At times consistent with normal operation and at one month intervals, check those controls which are not routinely operated to ensure proper function. Any equipment not operating properly should be immediately repaired or replaced by a qualified electrician.

Check each circuit of the motor control center by starting the equipment. Also, check for proper operation of the following applicable components:

The main circuit breaker.

Motor starters and circuit breakers.

Pumps by pumping down sumps and manually operating them. Check to see if float switches are operating normally.

Indicator lights.

Alarms.

Interlock circuits.

Pushbutton controls.

Control switches (H-O-A, R-O-R, ON/OFF).

Check each lighting panel circuit breaker.

Check safety switches, lockout switches, and manual motor starters and other local controls for each item of equipment.

3. Inspection and Maintenance
The time intervals noted below are suggested frequencies only and may be varied to suit conditions under which the equipment operates and upon maintenance experience acquired over a number of years.

a. Portable Cords and Plugs - Inspect all portable equipment every three months for worn cords and broken or damaged plugs. Immediately replace cords (with same type as original) and plugs which are found to be defective.

b. Grounding - On a semi-annual basis, inspect groundwire connections to water pipe and ground rods to make sure connections are tight. Inspect for tightness of locknuts where conduit enters equipment enclosures. Check tightness of connections between flexible and rigid conduits, and flexible conduits and equipment enclosures. An electrician should measure and record "ground resistance" whenever additions or changes are performed to the ground circuits.

c. Motor Control Center - Annually, check the MCC (panels, connection boxes, etc.) to ensure that all covers and doors are in place, closed and secured. The following should be performed on the motor control center at times consistent with the operation of the stations:

Shut down one circuit at a time by throwing its circuit breaker to the OFF position. This de-energizes the supply to that particular circuit. However. one or more wires in the cubicle may still be energized due to interconnection between circuits. Care should be exercised in not touching any uninsulated parts within the cubicle.

With a cubical circuit breaker in the OFF position, the door to the cubicle may be opened and the units inside inspected and, if necessary, cleaned. Examine the circuit breaker, motor starter, control switch and relay(s) as applicable, for signs of overheating. Coils and wiring which have been seriously overheated will have the characteristic unpleasant odor of burning insulation. When connections which have been overheating are discovered, the services of a qualified electrician should be obtained at once to correct the trouble.

Should any significant accumulation of dirt or dust be discovered within the cubicle, it should be removed by means of a vacuum cleaner.

At least once a year, arrangements should be made to have a qualified electrician de-energize the motor control center, tighten all bus bars and wire connections and check the condition of all switch and relay contacts.
Instrumentation control panels should be inspected each year similar to the MCC.

d. Motors - All motors and drives should be checked twice a year for cleanliness. If excessive dirt or dust is found inside any motor ventilation passages, the circuit to that motor should be shut down and the motor carefully cleaned by a vacuum cleaner. If an excessive amount of oily dirt is found on the motor, it should be carefully removed by means of a nonflammable cleaner approved by the motor manufacturer. All internal inspections should only be performed by a qualified person.

e. Daily checks - Daily checks for changes in noise level, vibration, and temperature of motors are recommended. If found, the cause should be determined and corrected as soon as possible. If a motor overheats, the bearings should be checked for adequate lubrication in accordance with the manufacturer's instructions. An electrician should be called for assistance if excessive temperature cannot be readily corrected.
The motor manufacturer's lubrication instructions should be followed explicitly in all cases. Do not over-lubricate.

f. Light Fixtures - Before working on any light fixture, always tum off the power supply and lock out. Working on "live" lighting fixtures can be particularly dangerous when: working on ladders and scaffolds; washing fixtures with water; or performing work on high pressure sodium fixtures where high voltages may be present.

Good lighting maintenance requires regular and frequent: cleaning of lighting fixtures, glass and reflectors; and replacement of light bulbs and tubes after their normal life has been expended, even though actual failure has not taken place. The end of normal life is indicated by excessive blackening of incandescent lamps and at the ends of fluorescent tubes. The end of normal life of high pressure sodium lamps is indicated by continuous cycling ON and OFF of the lamp. Satisfactory cleaning cannot be achieved by merely dry-wiping fixture parts. They must be washed with warm soapy water or other suitable detergent. When reflectors cannot be taken down, use a cleaning agent that removes dirt quickly and thoroughly and requires no rinsing. Wipe off excess moisture with clean dry cloth. In all cases avoid strong alkaline or acid cleaning agents. A thin film of liquid wax will protect surfaces between cleaning.

g. <u>Heating Devices</u> - Materials should not be stored close to heaters and interfere with air circulation or become a fire hazard. Heating elements should be cleaned as frequently as necessary to prevent the accumulation of dust and dirt. Grills and guards essential for the safety of personnel must be kept in place and securely fastened. Fan bearings should be oiled or greased in accordance with the manufacturer's instructions.

h. <u>Miscellaneous Equipment</u> - All additional electrical devices, not specifically itemized in the preceding sections, should also be inspected periodically to assure that there are no damaging collections of dirt and that the devices are adequately lubricated, properly cooled and function as intended. Electrical repairs should be made only by a qualified electrician.

H. EQUIPMENT FAILURE AND TROUBLESHOOTING

1. General Description

A complete shutdown of all electrical equipment at the plant is generally caused by failure of the normal source of power. All equipment and lights will be extinguished under such a condition. Operation of the main circuit breaker at the MCC will give the same result and should be checked to see that it is closed. If the trouble is not due to loss of normal power, call a qualified electrician at once to determine and correct the cause.

An individual motor which fails to start may be caused by failure of the motor control circuit fuse. Turn the cubicle circuit breaker handle to OFF position, open the cubicle door in the motor control center, and check for a blown fuse. If a fuse is blown, try to determine the cause before replacing. If the replacement fuse blows, call an electrician to correct the trouble. An individual motor which shuts down after it has been in operation for some time may be caused by an overload of the motor circuit. Depress the "motor reset" button to reset a shut down due to motor overload. If the motor starts, turn the circuit breaker off and try to determine the cause of overload before operating the equipment. If the motor does not start check the unit circuit breaker for a "trip" condition or

if the overload device trips out again, call an electrician to correct the trouble. If other equipment fails to operate, the general procedures outlined above should be followed (i.e., resetting circuit breakers, checking fuses and resetting overload devices as applicable). Check for causes and contact an electrician if trouble persists. Fixtures with burned out lamps should be relamped as soon as the outage is noted. Do not wait until the next cleaning period. When a fixture needs to be rewired or otherwise repaired, a qualified electrician should be retained to perform the work.

2. Fluorescent Lamp Fixtures

If the relative humidity exceeds 65 percent, some difficulty may be experienced in starting fluorescent lamps. This effect increases rapidly as the humidity approaches 100 percent. All of the fluorescent lighting fixtures are of the "rapid start" type. Replacement lamps must also be of the "rapid start" type, for use without starters.

If a lamp consistently flashes and will not start, determine whether the trouble is in the lamp or in the ballast. This can easily be done by removing the affected lamp and testing with a lamp that is known to be good. Replace defective lamps. If the ballast is defective, it should be replaced by a qualified electrician.

3. High Pressure Sodium (HPS) Lamp Fixtures

All high pressure sodium lighting fixtures require a ballast to regulate lamp current and voltage as well as a starter. Therefore, starting of light fixtures is not immediate but within 4 to 7 minutes maximum output should be achieved. Similar to fluorescent lamp fixtures the ambient air temperature and relative humidity effect the starting time of the lamp.

If a lamp will not start, determine whether the lamp, ballast or starter must be replaced. Because HPS lamps have long life, 24,000 hrs., the trouble usually will be with the ballast or starter.

I. GENERAL PRECAUTIONS

All personnel should be alert to the hazards of working with electrical equipment and exercise extreme care.

Do not work on any piece of electrical equipment until it has been determined that the power source is either disconnected or turned off. If a circuit is controlled from the motor control center, padlock the circuit breaker in the OFF position and tag the breaker to indicate that it is not to be turned on. Check locally at the equipment to be sure that the power is off and leave the local switch in the OFF position. Always treat electrical equipment as though it were live, and do not touch uninsulated electrical parts of any electrical device.

Instrumentation panels can contain stray or foreign voltages due to interlocks and other interconnections.

Use only an insulated nozzle on vacuum cleaner hose when cleaning electrical equipment. Be careful not to drive dirt into equipment.

Do not use flammable or toxic cleaning fluids on, or in the vicinity of, electrical equipment. Use only cleaning fluids recommended by the equipment manufacturer.

Never use steel wool, emery paper or cloth in cleaning electrical equipment.

Do not drill or cut into the enclosure of any piece of electrical equipment except under the supervision of a qualified electrician.

Remove or replace lamps only when the source of power is turned OFF. Ballasts should be replaced only by a qualified electrician. Always wear gloves and eye protection when replacing lamps. Should fluorescent lamps be broken, pick up pieces while wearing gloves and be very careful to avoid cuts.

Remove or replace fuses only when the source of power is turned OFF, and then only by means of a suitable fuse pulled. Never use tools made of a conducting material for removing or replacing fuses. Never replace a fuse with one of a higher rating or of a different type. Endeavor to determine the cause of a blown fuse before replacing it with a new one. If fuses blow repeatedly, have the circuit checked by a qualified electrician.

REPEAT: NEVER WORK ALONE AROUND EXPOSED ELECTRICAL CONDUCTORS. Instruct any helper on de-energizing the power with the main circuit breaker and disabling the standby power generator, and be sure he knows how to revive electrocution victims.

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CHAPTER 12

MECHANICAL AND PLUMBING SYSTEMS

A. HEATING SYSTEM

1. Fuel Gas Supply System

The fuel gas system is designed for propane. The system consists of three (3) 1000 gallon liquefied propane gas (LPG) tanks set on a concrete pad. These tanks feed liquid propane to a vaporizer which in turn vaporizes the propane for distribution to the various heating devices in the building. Shut-off valves are located at the tanks, the vaporizer at the entrance to the building and at each gas-fired device. Proper pressure is maintained in the various parts of the gas system by pressure regulators in the vapor line from the vaporizer and at each point of usage.

2. Vaporizer

The vaporizer is the only gas fired device at the Compost Facility that has a standing pilot. All other devices are provided with electric igniters as part of their control systems. The pilot should be checked on a weekly basis and after any storms which included high winds. Refer to the Manufacturer's O & M literature for complete operating and maintenance instructions. It is recommended that the pilot remain lighted continuously even during the summer since night time temperatures can easily reach the automatic changeover point to cool weather operation which will require the makeup air units to startup. If the vaporizer is not operational, the makeup air units will not have enough gas and will trip out on low gas pressure causing an alarm.

3. Makeup Air Units

These units are two identical 15,000 CFM units provide make-up air to the Mixing Area during winter mode operation. Each unit is capable of a 1,760,000 BTU/ HR input at maximum firing rate. The units are equipped with a hand mode based on the temperature in the mixing area.

Both units are equipped with electronic pilot igniters and do not have standing pilots. The units should be checked frequently during periods of cool weather for proper operation. Refer to the manufacturer's 0 & M literature for detailed description of the operation and maintenance needs of the units.

4. Gas Fired Unit Heaters

The H & V room and the Mechanical Room are heated with gas fired unit heaters. All unit heaters are equipped with electronic ignition and have no standing pilots. Each unit heater also draws all combustion air directly from the outside and exhausts flue gas directly to the outside. The unit heaters within a room are controlled by a single wall mounted thermostat which when sensing room temperature below set-point (initially 65^o F) energizes each heater control circuit. Refer to the manufacturer's 0 & M literature for detailed operating and maintenance information.

5. Gas Fired Wall Heater

The Control Room is heated with a direct vented counterflow wall furnace. As with the unit heaters this unit does not have a standing pilot rather it is ignited when heat is called for by the thermostat. A circulating fan is included in this unit to draw room air in at the top, force it over the heat exchanger and discharge it to the room. Note that a high temperature limit switch is included to deactivate the heater if the air duct becomes blocked for any reason. Refer to the manufacturer's 0 & M literature for operational and maintenance details.

6. Electric Heaters

The Corridor, Electric, Locker, and Lab rooms are each heated with an electric convection heater controlled by a remote wall mounted thermostat. Heat loads in all of these rooms are too small to warrant gas heaters. The thermostat cycles the convection unit on and off in response to room temperature changes. Refer to the manufacturer's 0 & M literature for details of operational and maintenance needs for these units.

B. AIR CONDITIONING

1. Control Room

The Control Room is equipped with a through wall type of air conditioner mounted over the outside entry door. Temperature and fan controls are mounted on the unit itself and changing the controls will require the use of a step-ladder. Once the controls have been set for a comfortable temperature and fan speed the unit can be started and stopped by the wall mounted on-off switch. Refer to manufacturer's data for details on operation and maintenance of the unit.

C. VENTILATION SYSTEMS

1. General

The ventilation systems for the Compost Building serves five primary functions.

a) Provides fresh air to the various areas of the building requiring ventilation.

b) Establishes and maintains pressure differentials between clean, dry, non-odor producing areas (i.e. administration areas) toward areas of increasing amounts of odor and moisture production.
c) Collects moist and mal-odorous air within the building in order to pass through odor control system before releasing exhaust air to the atmosphere.
d) Removes excess heat and moisture from all parts of the building.
e) Prevents the buildup of gases to hazardous levels.

Ventilation fans used for this building consists of in-line centrifugal fans, ceiling cabinet fans, roof exhaust fans, roof supply fans and aluminum centrifugal exhaust fans.

All of the belt driven fans should have their drive belts checked for alignment and tension periodically. Replace belts that show signs of wear. Observation of excessive vibration by any of the fans could cause equipment damage and is a potential safety hazard. This should be investigated as soon as it is observed. The majority of the fan motors have pre-lubricated bearings and do not require any further maintenance for ten years under normal conditions.

2. Mechanical Room Ventilation

Ventilation of the Mechanical Room is accomplished by a roof mounted supply fan delivering air to the room and a motor operated damper (MOD) between the Mechanical Room and the Compost Area to relieve the ventilation air forced into the room. This ventilation air is primarily to remove the heat generated by the three variable frequency drives and the fan motors located in this room and to maintain positive pressure with respect to the Compost Area. The fan and MOD are controlled by a wall mounted cooling thermostat. When the room temperature rises above the set point, the MOD is opened and the fan is activated.

It is very important that the MOD be inspected periodically when it is closed and adjusted when necessary to maintain a tight closure when the supply fan is not running.

3. <u>H & V Room Ventilation</u>
Ventilation of this room is identical to the Mechanical Room Ventilation except that the relief MOD connects with the exterior of the building.
It is very important that the MOD be inspected periodically when it is closed and adjusted when necessary to maintain a tight closure when the supply fan is not running.

4. <u>Electrical Room Ventilation</u>
Supply and exhaust air is provided to dissipate excess heat from the electrical room. A cooling only thermostat starts the roof mounted supply fan and opens the outdoor air dampers on temperature rise above set point. Opposite action occurs on temperature drop

5. <u>Lavatory/Locker Room Ventilation</u>
The exhaust fan is controlled by the light switch such that the fan runs whenever the lights are turned on.

6. <u>Lab Ventilation</u>
The exhaust fan is controlled by the light switch such that the fan runs whenever the lights are turned on.

7. <u>Corridor Ventilation</u>
Positive pressure is maintained in the corridor by a roof mounted supply fan. This positive pressure maintains a buffer between the odors and moisture of the Mixing and Compost Areas and the "clean areas" such as the Electric Room and the Control Room. It is intended that this fan run continuously whenever the building is occupied. A wall mounted 7 -day time clock starts and stops the fan. This time clock should be set to start the fan at least one hour before the first person arrives at the plant and to

keep it running for at least one hour after the last person leaves

D. PLUMBING SYSTEMS

1. Plant Water System

Plant water is produced by one on-site well containing a submersible pump. A second well has been drilled, cased as necessary and capped for future use. The well pump pumps water to an atmospheric tank in the Mechanical Room. The level is controlled in the 1500 gallon atmospheric tank by a tank mounted level control that starts and stops the well pump to maintain the level between the set points. A second pump mounted in the Mechanical Room takes suction from the 1500 gallon tank and pressurizes the plant system and is controlled by pressure.

Reduced pressure zone backflow preventers are provided to protect the well and the potable water piping.

2. Hot Water System

Domestic hot water for the Facility is provided by a forty (40) gallon capacity electric water heater. Hot water is provided to the fixtures in the Lab and the Locker Room.

Every year the water heater should be drained and flushed out to eliminate sediment build up in the tank. Care should be taken that the power and water supplies are off before draining the tank. Once the tank is clean, refill and vent all air out of the tank.

3. Fire Extinguishers

Fire extinguishers are provided throughout the plant. They are dry chemical rated for Class A, B and C fires, i.e. all type fires except metal fires. All units are provided with a gauge to show proper pressure, safety pins and seals. A weight check to assure full charge and proper gauge operation should be done at least annually by a qualified professional fire equipment supplier. The seals should be checked monthly for broken seals.

If any extinguisher is discharged it should be recharged and resealed by a professional equipment supplier.

The plant fire protection system consists of 30,000 gallons of stored water contained in six-5000 gallon concrete tanks.

5. Drains

All floor drains in both the Mixing and the Compost Areas are piped to the catch basins in the Mixing Area floor. These three catch basins are in turn piped together and then to the 5,000-gallon holding tank through an 8 inch pipe. The catch basins must be cleaned out periodically to prevent buildup of debris and carry over of solids into the holding tank. Initially, the catch basins should be inspected monthly and cleaned when appropriate. As operating experience is gained, the inspection and cleaning intervals should be adjusted accordingly.

6. Compressed Air System

The compressed air system consists of a receiver mounted electric motor driven air compressor and convenience air drops throughout the plant. Compressed air is not critical to the operation of the plant but is necessary for general maintenance of the plant.

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CHAPTER 13

PERSONNEL

A. GENERAL

The purpose of this section is to list the duties of each position and establish desired qualifications of personnel for the LAWPCA Composting Facility including training, experience and demonstrated skills. Please note that the positions established and the listed qualifications are minimum recommendations.

The LAWPCA Sludge Composting Facility represents a significant investment and its proper operation is the direct responsibility of plant personnel.

The facility is expected to be staffed 8 hours per day, 5 days per week, 52 weeks per year. The facility is capable of continued "operation" without human oversight in that the composting process will proceed naturally and the aeration operations are computer controlled. It is expected that three (3) employees will be primarily responsible for all operations at the composting facility. These will include 2 compost technicians and a facility supervisor. These positions are described below. It should be emphasized, however, that the position descriptions have considerable overlap. That is, both positions must be capable of performing the basic duties of the other. In addition to the three primary employees, projects of a larger scale may occasionally involve other employees of the Authority.

The standard work schedule for both workers will be 6:30 a.m. to 2:30 p.m. for five continuous days

B. FACILITY SUPERVISOR

The Facility Supervisor is in overall charge of the composting facility and will be under the supervision of the Authority's Superintendent
and the Assistant Superintendent. He (or she) is responsible for maintaining all records, insuring compliance with all permits (incl. Federal, State and Local) and performing or arranging for the performance of all laboratory tests on the sludge, amendments, and compost. As opposed to the Technician, the Supervisor's responsibilities will be more oriented toward controlling the composting process itself and maintaining the facility operating records. He will be capable of operating all equipment and process systems on site and be able to perform all tasks required to properly operate and maintain the composting operation including but not limited to the following:

Primary Functions:
• Operate computerized process recording system.
• Operate the compost turning machines and aeration blowers.
• Make up suitable compost/amendment mixes.
• Formulate adjusted compost/amendment mixes.
• Investigate alternative amendment materials.
• Observe the composting process and troubleshoot problems.
• Interpret meter and gauge readings for their effect on the composting process and equipment.
• Operate valves, gates and blowers to maintain optimum conditions for composting.
• Extract representative samples of compost and amendments for analysis (in cooperation with Technician).
• Insure prompt delivery of time cards and invoices to the Authority's Lincoln St. offices.
•Provide first interface with public and support the Superintendent in any problem resolution with public.
• Support the Superintendent in marketing compost product(s).
• Clean up all areas of the facility and keep them in presentable shape for the public.
• Paint and maintain all surfaces as necessary.
• Log and respond to minor complaints by residents. Major complaints will also be recorded but will be forwarded to the Superintendent.

Support Functions:

• Operate front end loader, tractor and mixer.
• Load compost mixture into composting bins.
• Remove compost from drop point and build curing piles.
• Keep inventory of compost batches by time and amendment material used and segregate different batches.
• Maintain sludge and amendment materials in neat order.
• Load finished compost, and assist in the unloading of sludge and amendment materials.
• Take steps necessary to assure that adequate amendment materials are delivered and available to meet sludge processing needs.
• Inspect equipment and perform routine maintenance as required.
• Perform preventive maintenance and general repairs on all operating equipment as able.
• Schedule repairs to equipment with outside companies when needed.
• Update log of equipment maintenance, use and problems.
• Perform general maintenance on building structures.
• Perform general yard maintenance including lawn care, and snow removal

Qualifications: In general, a high school diploma and some post high school training (technical schooling or continuing education) is required. The Supervisor must have effective written communication skills, mathematical ability and a basic knowledge of wastewater treatment issues, including basic laboratory and sampling procedures. In addition, the Supervisor shall have the ability to work cooperatively with others, and perform all required duties without close supervision. The Supervisor must also possess both the ability and all required licenses to operate all machinery and vehicles at the composting facility. An ability to solve problems in a cooperative and positive manner is required.

C. COMPOST TECHNICIAN

The Compost Technicians must work well with the Facility Supervisor as a team to operate and maintain the facility. While the Facility Supervisor is in overall charge of the facility and is ultimately responsible for the facility's operation and compost product, the Technician is expected to take the lead in ensuring the facility is maintained properly, materials are stored neatly, and the grounds are well maintained. He (or she) must be able to work with and maintain all the equipment in the facility and must also be capable of filling in for the Facility Supervisor when Facility Supervisor is unavailable. Thus communication skills, including computer literacy is required. Without limitation, the Technician will be expected to perform the following:

Primary Functions:

- Operate front end loader, tractor and mixer
- Load compost mixture into composting bays
- Remove compost from drop point and build curing piles.
- Keep inventory of compost batches by time and amendment material used and segregate different batches.
- Keep sludge and amendment materials being stored in a neat order.
- Load compost and assist in the unloading of sludge and amendment materials.
- Advise Facility Supervisor as to need to order additional amendment materials to meet sludge processing needs.
- Inspect equipment and perform routine maintenance as required.
- Perform preventive maintenance and general repairs on all operating equipment as able.
- Schedule repairs to equipment with outside companies when needed.
- Update log of equipment maintenance, use and problems.
- Perform general maintenance on building structures.
- Perform general yard maintenance including lawn care, snow removal, and biofilter repairs.
- Work with compost demonstration plots.
- Clean up all areas of the facility and keep them in presentable shape for the public.
- Paint and maintain all surfaces as necessary.

Support Functions:

• Operate computerized process recording system.
• Operate ventilation system.
• Operate the compost turning machines and aeration blowers.
• Make up suitable compost/amendment mixes.
• Formulate adjusted compost/amendment mixes.
• Investigate alternative amendment materials.
• Observe the composting process and troubleshoot problems.
• Interpret meter and gauge readings for their effect on the composting process and equipment.
• Operate valves, gates and blowers to maintain optimum conditions for composting.
• Maintain facility records as directed by the Superintendent.
• Extract representative samples of compost and amendments for analysis
• Insure prompt delivery of time cards and invoices to the Authority's Lincoln St. offices.
• Provide first interface with public and support the Superintendent in any problem resolution with public.
• Support the Superintendent in marketing compost product(s).
• Log and respond to minor complaints by residents. Major complaints will also be recorded but will be forwarded to the Superintendent.

Qualifications: In general, a high school diploma or equivalent is required. A demonstrated mechanical ability, good communication skills, and a basic knowledge of wastewater treatment is needed. A desire to work with the compost material in demonstrating its effectiveness for horticultural applications is helpful. The technician must be proficient in the use of a front end loader, and be able to work with minimal supervision. An ability to work cooperatively with others and a positive approach to problem solving are essential.