NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

ANAEROBIC DIGESTER – AMBIENT TEMPERATURE

(No.)

CODE 365

DEFINITION

An unheated waste treatment impoundment.

PURPOSE

To biologically treat waste as a component of a waste management system to:

- produce biogas and capture for energy
- improve air quality
- reduce greenhouse gas emissions

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Biogas production and capture are components of a planned animal waste management system. Suitable geographic areas for energy recovery are shown in figure 1.
- Existing waste impoundment(s) can be modified to the requirements of this standard or for new construction.
- The digester is in conjunction with a separate waste storage facility or where the digester and storage are congruent.
- Manure can be collected fresh and delivered to the digester with a total solids (TS) concentration in the influent waste of less than 2 percent.
- The operator has the interest and training to monitor and maintain processes or contracts with a consultant to provide these services.

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations. Waste treatment facilities must be planned, designed, and constructed to meet all Federal, State, and local regulations. This includes the Illinois Livestock Management Act and provisions of Title 35E, State of Illinois Rules and Regulation.

Manure Characteristics. This practice is applicable to manure that is collected fresh, generally less than 7 days old. Manure shall be essentially free of soil, sand, stones, or fibrous bedding material (including clumps of straw), or processed to remove such material.

Ruminant's manure shall be treated with solid separation prior to entry into the digester.

Rainfall Runoff. Rainfall runoff shall be diverted away from the digester.

Anaerobic Digester. The digester shall meet the General Criteria for All Lagoons given in Practice Standard 359, Waste Treatment Lagoon, as appropriate, and the following additional requirements:

1. Minimum Treatment (Design Operating) Volume. The design operating volume shall be based either on the daily volatile solids (VS) loading rate per 1,000 ft^3 or the minimum hydraulic retention time (HRT) adequate for methane production, whichever is greater. The maximum daily VS loading rate shall be selected from the values listed on the map in figure 2. The minimum HRT shall be selected from values listed on the map in figure 3.

2. Required Total Volume. The required total volume of the digester shall be equal to the minimum treatment volume except where waste storage is included in the design, in which case the volume shall meet the additional criteria for Design Storage Volume in Practice Standard 313, Waste Storage Facility, as appropriate.

   The digester storage volume does not need to account for rainfall except for partially covered digesters.

3. A minimum of 2 feet of freeboard above the digester design water surface shall be provided except when rainfall is included in determining the operating volume, where only 1 foot of freeboard is required.

4. Length to Width Ratio. The ratio of length to width of the digester is limited to 4:1 or less.

5. Operating Depth. The operating depth of the digester shall be at least 12 feet over 50 percent or more of the bottom area.

6. Interior Slopes. Interior slopes shall be as steep as permitted by soil properties and construction techniques.

7. Waste Inlet and Outlet. The inlet and outlet devices shall be located as far apart as practical to minimize “short circuiting.”

8. The inlet shall discharge a minimum of 12 inches below the digester water surface.

9. Outlet. The digester shall be equipped with an outflow device that maintains the digester water surface at its operating level. Except where the digester is designed to include storage, the outlet shall release directly to the waste storage facility without release of trapped gas.

10. Digester Cover. The digester cover, materials, anchorage, and all appurtenances, such as weights and floats, shall be designed to capture and convey biogas to the gas collection system. The digester cover and materials shall meet the requirements of Practice Standard 367, Waste Facility Cover.

Separate Waste Storage Facility. Separate waste storage facilities shall meet the requirements of Practice Standard 313, Waste Storage Facility. No storage credit shall be attributed to the digester in meeting the minimum storage requirements in Practice Standard 313 except for sludge volume reduction based on expected total solids (TS) removed or destroyed.

Gas Collection, Transfer, and Control System. The biogas collection, transfer, and control system shall be designed to convey captured gas from under the digester cover to gas utilization equipment or device (flare, boiler, engine, etc.).

Gas Collection and Transfer

1) Perforated pipe and other components under the digester cover shall be designed to exclude floating debris and waste residue and shall have a service life consistent with the expected cover life, but not less than 10 years.

2) Pipe and components under the cover shall be securely anchored to prevent displacement from normal cover forces.

3) The collection and transfer pipe shall be designed for wet biogas. In colder climates, the pipe shall be protected as necessary to prevent frost buildup. In no case shall the pipe size be less than 3-inch diameter.

4) Pipe used for transfer of gas can be buried or installed above ground and must include provisions for drainage of condensate, pressure and vacuum relief, and flame traps.

Gas Control

1) Gas control equipment and components shall be conveniently located and sheltered from the elements. A minimum distance of 30 feet (10 m) shall separate the control facility from the digester.

2) Gas control equipment and components shall have a service life of not less than 2 years and shall be readily accessible for replacement or repair.

3) The size of equipment and connecting pipe shall be based on head loss, cost of energy, cost of components, and manufacturers’ recommendations.

4) Where electrical service is required at the control facility, the installation and all electrical wire, fixtures and equipment shall

meet the National Electrical Code and local and state requirements.

Gas Utilization. Gas utilization equipment shall be designed and installed in accordance with standard engineering practice and the manufacturer recommendations. As a minimum, the installation will include a flare to burn off collected gas.

1. The flare shall be equipped with automatic ignition and powered by battery/solar or direct connection to electrical service. The flare shall have a minimum capacity equal to the anticipated maximum biogas production.
2. Gas-fired boilers, turbines, and internal combustion engines, when a component of the system, shall be designed for burning biogas directly or shall include equipment for removing H_2S and other contaminants from the biogas.

Monitoring. When the purpose is to produce and capture biogas for energy, equipment needed to properly monitor the digester and gas production shall be installed as part of the system. As a minimum, the following equipment is required:

- A temperature sensor and readout device to measure internal temperature of digester.
- Gas meter suitable for measuring biogas.

Safety. Methane is a flammable gas. The gas collection, control, and utilization system shall be designed to incorporate measures to prevent undue safety hazards. As a minimum, “Warning Flammable Gas” and “No Smoking” signs shall be posted.

Flares shall be located a minimum distance of 95 feet (30 m) from the biogas source and grounded or otherwise protected to minimize the chance of lightening strikes.

A flame trap device shall be provided in the gas line between the digester and points of use (flare, boiler, engine, etc.).

The location of underground gas pipe shall be marked with signs to prevent accidental disturbance or rupture. Mark exposed pipe to indicate whether gas line or other.

CONSIDERATIONS

Location. In determining the location of the waste storage facility, consider elevation and distance from the covered digester to take advantage of gravity flow.

The covered digester should be located as near the source of manure as practicable and as far from neighboring dwellings or public areas (minimum distance of 300 ft (100 m)) as possible. Proper location should consider slope, distance of manure transmission, vehicle access, wind direction, neighboring dwellings, proximity of streams and flood plains, and visibility.

Using available gas to heat the digester can improve total solids destruction and further reduce greenhouse gas emissions. In geographic areas north of the 40th parallel (figure 1), heat is required to maintain year around anaerobic digestion.

The covered digester should be located near a suitable site for energy utilization equipment. Short distances for the transmission of methane through buried pipe are preferable.

Waste Transfer Pipe. The standard practice is to locate a cleanout immediately upstream of the digester. Influent from the waste collection pit discharges below the digester operating level, and depending on the installation, solids tend to build up in the inlet pipe. The cleanout is also a good location for venting any gas that builds up in the transfer pipe.

Visual Screening. Analyze the visual impact of the digester within the overall landscape context or viewshed. Screening with vegetative plantings, landforms, or other measures may be implemented to alleviate a negative impact or enhance the view.

Depth of Digester. Improved digester performance and reduced cover cost (less area for given volume) can be realized with deeper digesters.

Rainfall. Rainfall on the digester cover can result in increased effluent discharge into the storage facility. For normal rainfall events this is probably not a problem. In locations subject to high rainfall events (thunderstorms and hurricanes), a ported riser on the outflow pipe should be considered to provide temporary storage and reduce outflow rate.

Gas Transfer Pipe. Exposed pipe conveying flammable gas is generally painted orange.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and good engineering practice. The plans and specifications shall include all details necessary for construction and completion of the work.

As a minimum, the plans and specifications shall provide the following:

1. Layout of livestock facilities, waste collection points, waste transfer pipe, digester, and storage pond.
2. Location of all digester influent pipes and devices.
3. Details of pipe material, size, and grade.
4. All digester and storage pond dimensions, type of lining material, and other parameters as appropriate.
5. Digester cover material and dimensions of covered surface. Means of rainfall removal or details of drainage.
6. Details of digester cover anchorage (ex: location and width of trench, depth, backfill material, and compaction of fill).
7. Details of the gas collection system, including type of pipe, devices, sizes, location, material, and grades.
8. Details of gas control facility, piping layout, components, electrical service if required, and protection from the elements.
9. Appropriate gas safety equipment or protective measures.

Warranties. The cover manufacturer and/or installer shall warrant the cover for the intended use and design life, provide maintenance instructions, and certify that the cover is properly installed.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed and reviewed with the owner prior to construction. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design. The plan shall list operation and maintenance requirements including but not limited to:

1. Proper loading rate of the digester and total solids content of influent.
2. Proper operating level of the digester.
3. Estimates of biogas production, methane content, and potential energy recovery.
4. A description of the planned startup procedures, normal operation, safety issues, and normal maintenance items.
5. Alternative operation procedures in the event of equipment failure.
6. Instructions for safe use and/or flaring of biogas.
7. Cover and gas collection system maintenance.
8. Daily inspection of the following:

   - Cover material – check for cracks, tears, or points of distress around perimeter.

   - Check for excessive ballooning of cover or presence of odor.

   - Check for excess rainwater on cover.

   - Check gas control panel, regulators, pressure gages, electrical power, flowmeter, flare igniter, and flare operation.
9. Frequency of measuring and recording digester inflow, operating temperatures, biogas yield, and/or other information as appropriate.

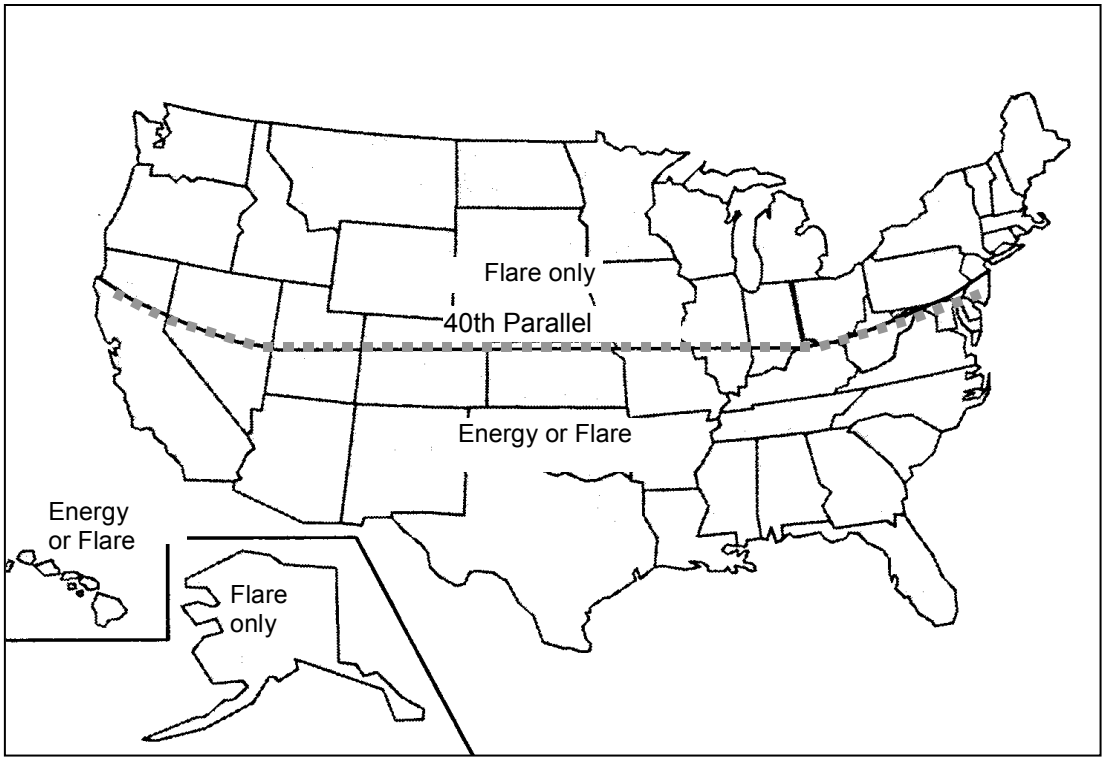

Figure 1. Ambient temperature digester. Locations suitable for energy production generally fall below the 40th parallel.

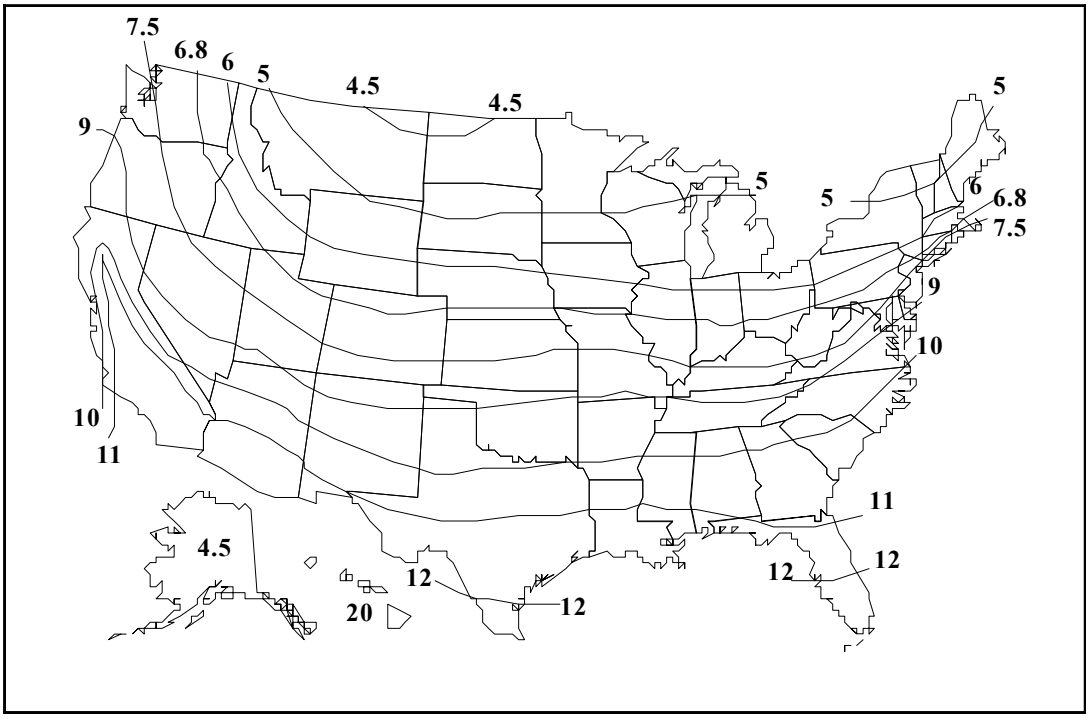

Figure 2. Covered anaerobic digester maximum loading rate (lb VS/1,000 ft^3/day)

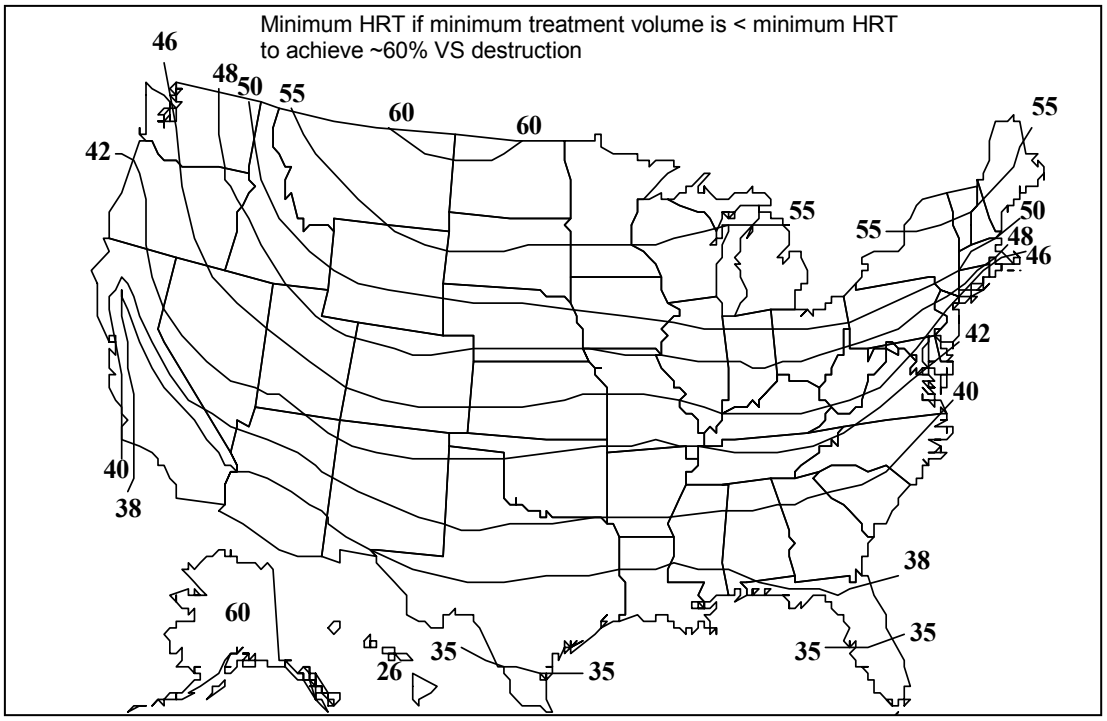

Figure 3. Covered anaerobic digester minimum hydraulic retention times (MINHRT) in days