

## Roofs and Covers (No.) 367

### DEFINITION

A rigid, semi-rigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility.

### PURPOSES

To provide a roof or cover for:

- Water quality improvement
- Diversion of clean water from animal management areas (i.e. barnyard, feedlot or exercise area) and/or waste storage facilities
- Capture of biogas for energy production
- Reducing net effect of greenhouse gas emissions
- Air quality improvement and odor reduction

### CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Exclusion of precipitation from an outdoor animal management area, waste storage facility or waste treatment facility will improve management of an existing or planned animal waste handling system or eliminate a pollution concern.
- Capture and controlled release of emissions from an existing or planned animal waste management, storage, or treatment system will improve air quality and/or reduce the net effect of greenhouse gas emissions.
- Bio-treatment of emissions from an existing or planned waste storage or treatment facility will improve air quality and/or reduce the net effect of greenhouse gas emissions.
- Biogas production and capture for energy are components of an existing or planned waste management system.

### CRITERIA

#### General Criteria Applicable To All Purposes

**Laws and Regulations.** Roof and covers shall be planned, designed, and installed to meet all federal, state, local, and tribal laws and regulations.

**Service Life.** The roof or cover along with any necessary appurtenances shall be designed to provide a service life of not less than 10 years.

**Materials.** The type, thickness, and material properties of the roof or cover and any supporting members shall account for all loads and stresses due to operational, environmental, and climatic conditions.

The roof or cover manufacture and/or installer shall provide maintenance instructions and certify that the roof or cover is properly installed.

Flexible membrane materials, used for fabrication of inflated and flexible covers, shall be certified by the manufacturer as suitable for the intended application.

The minimum material thickness for flexible or composite geomembrane covers shall be:

- 40 mils for non-reinforced material
- 36 mils for reinforced materials

Any materials exposed to biogas shall be resistant to corrosion. Equipment shall be suitable for use within a potentially explosive environment.

**Loads.** For facility components that serve as part of the foundation or support for a roof or cover, all loads shall be considered in the structural design.

Roofs, covers and associated support systems shall be designed to resist snow and wind loads as specified in the current Michigan Building Code

**Design.** Refer to structural design criteria outlined in NRCS conservation practice standard Waste Storage Facility (313) for the design of foundations associated with animal waste storage facilities. Design roofs and covers according to the criteria in the current editions of the following material references as appropriate:

- Steel: Steel Construction Manual, American Institute of Steel Construction.
- Timber: "National Design Specifications for Wood Construction," American Forest and Paper Association.

- Concrete: “Building Code Requirements for Structural Concrete, ACI 318,” American Concrete Institute.
- Liquid-Tight Concrete Slabs and Walls: “Code Requirements for Environmental Engineering Concrete Structures and Commentary, ACI 350,” American Concrete Institute.
- HDPE/LLDPE Geomembrane: “HDPE and LLDPE Geomembrane Installation Specification,” International Association of Geosynthetic Installers.

The system design shall account for the facility’s seasonal emission rates.

**Treated Wood.** When exposed to waste or elements, use preservative-treated wood that meets the requirements in the applicable American Wood Protection Association (AWPA) Standards or in an evaluation service report prepared by an organization recognized by the International Code Council (ICC). A listing of allowable preservatives includes but is not limited to CCA (Chromated Copper Arsenate), ACQ-C (Alkaline Copper Quat Type C), ACQ-D Carbonate (Alkaline Copper Quat Type D, Carbonate formulation), CuN (Copper Naphthenate), ACZA (Ammoniacal Copper Zinc Arsenate), CBA-A and CA-B (Copper Azole Types A and B). Aluminum fasteners shall not be used in direct contact with treated wood. Use galvanized or stainless steel bolts, washers, nuts, nails, and other hardware which meets ASTM Specifications A153 for fasteners and A653 Class G185 sheet metal for connectors, Type 304 or 316 (stainless) steel, or other type of material or coating as approved by the preservative manufacturer. All fasteners, connectors, and any other metal contacting ACZA, ACQ or CA treated wood shall be stainless steel.

**Access.** Enclosed facilities, as the result of a roof or cover, shall provide suitable access, as necessary, for normal operation and maintenance of the waste facility.

**Repair.** Flexible roof and cover material shall be readily repairable by solvent, adhesive thermoplastic welding, or according to manufacturer’s recommendation. Rigid or semi-rigid roof and cover material shall be repairable by sectional replacement.

**Safety.** Roof and cover systems shall include safety features, including fences and warning signs, as appropriate to prevent undue hazards.

Provisions shall be included to prevent the unintentional conveyance of biogas to connected facilities as a result of the roof or cover placement.

#### **Additional Criteria for Rigid and Semi-rigid Roofs and Covers**

Rigid and semi-rigid roofs and covers shall be designed to withstand all anticipated loads including but not limited to internal and external loads, uplift pressure, concentrated surface and impact loads and load combinations in compliance with this standard.

Covers intended for vehicle, equipment and/or livestock traffic shall be designed to withstand anticipated dead and live loads. The live load values for covers contained in ASAE EP378.3, Floor and Suspended Loads on Agricultural Structures Due to Use, and in ASAE EP393.3, Manure Storages, shall be the minimum used. For tank wagons having more than a 2,000 gallon capacity, the actual axle load shall be used.

Equip openings in covered tank with grills or secured covers for safety, and for odor and vector control.

Roof structures shall be designed to prevent waste located under the roof from becoming a pollution problem. Structural practices for collecting roof runoff shall follow criteria outlined in NRCS conservation practice standard, Roof Runoff Structure (558). All outside surface water shall be diverted from the roofed area.

#### **Additional Criteria For Flexible Covers**

Flexible membrane covers shall be supplemented with floatation materials as necessary for proper function, operation, and maintenance.

Flexible covers shall be designed to fluctuate with the liquid level as necessary to properly manage the storage facility.

Impermeable Flexible covers shall be designed with a biogas collection, transfer, and control system to provide protection for the cover and convey biogas to a flare, release or control point.

Inflated covers shall be:

- Equipped with a warning system to notify operator of blower failure for mechanically forced air systems.
- Provided with a support systems to limit cover collapse.

#### **Additional Criteria For Biogas Control/Utilization**

**Biogas Emissions.** The cover system shall provide for capture and control or utilization of biogas, bio-reduction and direct release of gaseous emissions, or contain and release of gaseous emissions, as appropriate.

Capture and Control/Utilization

The cover system shall be designed to capture biogas emissions and transfer to point of discharge without mixing with air. The point of discharge shall be equipped with a flare or utilization equipment as appropriate.

Bio-reduction and Direct Release

The cover shall be fabricated of a permeable composite membrane designed to promote biological treatment of gaseous emissions which pass through the membrane for direct release to the atmosphere.

Contain and Release

The cover system is designed for rainfall exclusion and not to specifically capture biogas. For systems which generate biogas, designs shall provide for safe handling and transfer of the biogas.

**Anchorage.** The cover anchorage system shall be designed in a manner to resist internal gas pressures, corrosive environment, wind loads, air tightness (as necessary), or other forces as appropriate to the cover system.

**Pressure.** Roofs and covers associated with biogas production shall include provisions for fail safe pressure relief when interior pressures can exceed design operating pressures. Maximum pressure shall not exceed manufacturer's recommendations.

**Precipitation.** Impermeable covers shall direct precipitation to collection points for removal by pumping or by controlled release to suitable grassed or otherwise stabilized areas for discharge or infiltration.

**Biogas Capture.** The cover materials and all appurtenances such as weights and floats shall be designed to capture and convey biogas to the gas collection system. The cover design shall provide the following:

1. Air Exclusion. The cover system and appurtenances, including perimeter soil slopes above the water line for in-ground digesters, shall be designed to exclude the entrance of air under all operating conditions.

2. Gas Collection, Control, and Utilization. The collection, control, and utilization of biogas shall meet appropriate criteria in NRCS conservation practice standard Anaerobic Digester (366).

**Biogas Safety.** As a minimum, all roofs and covers that contain or control biogas, the following warning signs shall be posted:

- "Warning Flammable Gas"
- "No Smoking"
- And when necessary:  
"Do Not Enter – Hazardous Gases"

Where biogas is captured, the gas collection and control/utilization system shall be designed in accordance with standard engineering practice for safely handling a flammable gas including safety criteria noted in NRCS conservation practice standard Anaerobic Digester (366).

When gas storage is included in the system design, a plan shall be provided to the landowner containing instructions as to the limits of roof or cover ballooning and emergency procedures if control equipment fails

## CONSIDERATIONS

Consider the potential effects of installation and operation of roofs and covers on the cultural, archeological, historic, and economic resources.

Storage of biogas should be considered when installing flexible covers over storage impoundments to attenuate gas supply for end use or controlled release.

When designing the gas handling system, consider the large range in gas production that can occur as a result of changing climate and/or substrate conditions.

To further improve water quality, consider eliminating or reducing feedlot areas when placing livestock under roof.

Screening with vegetative plants, landforms, or other measures may be implemented for aesthetic purposes.

To maintain storage capacity and functionality by minimizing solids accumulation, manure management methods such as solid/liquid separation should be considered.

For organic applications, consider using special construction materials such as qualifying lumber as documented by an evaluation service recognized by the ICC. Other applications considerations may also need to be made to address organic issues.

For areas where energy production is an option, consider adding energy recovery or production to get the gas handling system. Energy recovery or production can offset additional air emissions from reduced fossil fuel combustion.

Roofs and covers which capture biogas may increase the nutrient content of the manure stored. Consider the effects this may have on the nutrient management plan.

Roofs and covers which capture biogas may increase the odor nuisance during agitation, pump out, and land application. Consider the effects this may have on the surrounding area and management options.

#### PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Support data documentation requirements are as follows:

- Inventory and evaluation records
  - Assistance notes or special report
- Survey notes, where applicable
  - Design survey
  - Construction layout survey
  - Construction check survey
- Design records
  - Physical data, functional requirements, and site constraints, where applicable
  - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
  - Location map
  - “Designed by” and “Checked by” names or initials
  - Approval signature
  - Job class designation
  - Initials from preconstruction conference
  - As-built notes
- Construction inspection records
  - Assistance notes or separate inspection records
  - Construction approval signature

- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable

#### OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for this practice. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for the design.

#### REFERENCES

American Concrete Institute. 2008. Building Code Requirements for Structural Concrete, ACI 318-08. ACI Committee 318. ACI, Farmington Hills, MI.

[www.concrete.org](http://www.concrete.org)

American Concrete Institute. Code Requirements for Environmental Engineering Concrete Structures. ACI Committee 530. ACI, Farmington Hills, MI.

[www.concrete.org](http://www.concrete.org)

American Forest and Paper Association. 2005. National Design Specifications for Wood Construction. AF&PA, Washington, DC.

[www.AFANDPA.org](http://www.AFANDPA.org)

American Institute of Steel Construction. 2005. Steel Construction Manual, 13<sup>th</sup> Edition.

AISC, Chicago, IL.

[www.AISC.org](http://www.AISC.org)

American Society for Testing and Materials. Annual Book of ASTM Standards. Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, A 153. ASTM, Philadelphia, PA.

[www.ASTM.org](http://www.ASTM.org)

American Society for Testing and Materials. Annual Book of ASTM Standards. Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, A 653. ASTM, Philadelphia, PA.

[www.ASTM.org](http://www.ASTM.org)

American Society of Agricultural and Biological Engineers. Floor and Suspended Loads on Agricultural Structures Due to Use, ASAE EP378.3. ASABE, St. Joseph, MI.

[www.ASABE.org](http://www.ASABE.org)

American Society of Agricultural and Biological Engineers. Manure Storages, ASAE EP393.3. ASABE, St. Joseph, MI.

[www.ASABE.org](http://www.ASABE.org)

American Society of Civil Engineers, Minimum  
Design Loads for Buildings and Other Structures,  
ASCE/SEI 7-05. ASCE, Reston, VA.

[www.ASCE.org](http://www.ASCE.org)

American Wood Protection Association.  
AWPS, Birmingham, AL.

[www.AWPA.com](http://www.AWPA.com)

International Association of Geosynthetic Installers.  
2007. HDPE and LLDPE Geomembrane Installation  
Specification. IAGI, St. Paul, MN.

[www.IAGI.org](http://www.IAGI.org)

International Building Code. 2009. International  
Code Council (ICC), Whittier, CA

[www.ecodes.biz](http://www.ecodes.biz)

International Code Council Evaluation Service.  
International Code Council (ICC). ICC, Whittier,  
CA.

[www.ICC-ES.org](http://www.ICC-ES.org)