Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

ROOFS AND COVERS

Code 367

(No.)

DEFINITION

A rigid, semirigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility, agrichemical handling facility, or an on-farm secondary containment facility.

PURPOSE

Provide a roof or cover to:

- protect clean water from dilution in waste water in an existing or planned animal waste handling or storage area
- improve waste management and utilization to protect nearby surface water quality
- capture biogas emissions from an existing or planned animal waste storage facility to reduce the net effect of greenhouse gas emissions, improve air quality, and reduce odor as a result of:
    - biological treatment with composite cover material
    - combustion by flare
    - combustion by engine generator for energy production
- protect clean water by excluding it from a chemically contaminated area

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where—

- Precipitation should be excluded from contaminated areas, such as animal feeding and management areas, facilities for waste storage, animal mortality, composting, waste transfer or waste treatment, and agrichemical handling.
- Biotreatment of emissions using a porous cover on a wastewater storage facility is needed to improve air quality, limit odors, and moderate the net effect of greenhouse gas emissions.
- A cover is needed to exclude precipitation from a wastewater storage facility. Auxiliary elements of the cover will also capture and manage biogas emissions, improve air quality, limit odors, and reduce the net effect of greenhouse gas emissions.
- Biogas capture for energy production is a component of an existing or planned waste management system. Biogas capture and utilization will also improve air quality, limit odors, and reduce the net effect of greenhouse gas emissions.

This practice does not apply to NRCS Conservation Practice Standard (CPS) Code 325, High Tunnel System.

CRITERIA

General Criteria Applicable to All Purposes

Materials. Select the type, thickness, and material properties of the roof or cover and any supporting members after accounting for all loads and stresses due to operational, environmental, and climatic conditions.

Loads. Include all anticipated loads in the structural design for facility components that serve as part of the foundation or support for a roof or cover. See section below, Additional Criteria for Rigid and Semi-rigid Roofs and Covers, and Flexible Covers.

Design. Refer to NRCS CPS Code 313, Waste Storage Facility, or Code 309, Agrichemical Handling Facility, for structural design criteria of the foundations associated with these respective practices. Account for all items that will influence the performance of the roof or cover, including strength, durability, serviceability, material properties and construction quality in the current editions of the following material references as appropriate:

- Steel.—Manual of Steel Construction, AISC, American Institute of Steel Construction
- Timber.—National Design Specifications for Wood Construction, American Forest and Paper Association
- Concrete nonliquid tight.—Building Code Requirements for Structural Concrete, ACI 318, American Concrete Institute
- HDPE/LLDPE Geomembrane.—HDPE and LLDPE Geomembrane Installation Specification, International Association of Geosynthetic Installers

Access. Provide suitable access for normal operation and maintenance of a facility which is enclosed as the result of a roof or cover.

Venting. For an enclosed roof structure located over animals, manure storage, or petroleum product storage, provide ridge or end vent openings of at least 2 inches per 10-foot-width of building. This prevents buildup of moisture and gases in the attic area.

For enclosed buildings, provide mechanical (exhaust fans) or natural (adequate openings) ventilation in order to maintain a safe working environment when human entry is intended.

Safety. Provide safety features, including fences and warning signs, as appropriate, to prevent undue hazards from biogases and drowning. Refer to American Society of Agricultural and Biological Engineers' (ASABE's) document, *ASAE EP470.1, Manure Storage Safety* for guidance.

Design covers and grating over openings such that livestock or humans cannot accidentally displace them and fall into the facility.

Include provisions in the design to prevent the unintentional conveyance of biogas to any facilities connected to the installed roof or cover.

Additional Criteria for Rigid and Semirigid Roofs and Covers

Design rigid and semirigid roofs and covers 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. Design roofs, covers and associated support systems to resist all applicable loads including wind, snow, and seismic loads as specified in the current version of American

Society of Civil Engineers (ASCE), Standard ASCE 7, *Minimum Design Loads for Buildings and Other Structures*.

Design covers intended for vehicle, equipment and/or livestock traffic to withstand anticipated dead and live loads. The minimum live load design values for covers are contained in ASABE ASAE EP378.4, *Floor and Suspended Loads on Agricultural Structures Due to Use*, and ASAE EP393.3, *Manure Storages*. For tank wagons having more than a 2,000 gallon capacity, use the actual axle load for design.

Design roof structures to prevent waste located under the roof from becoming a pollution problem. Follow criteria outlined in NRCS CPS Code 558, Roof Runoff Structure, for structural practices to collect, control and convey roof runoff away from the contaminated area. Divert any outside surface water from entering the roofed area.

Treated Wood. Use preservative-treated wood when wood members are exposed to animal waste or elements that deteriorate wood. Preservative-treated wood must meet the applicable American Wood Protection Association (AWPA) Standards or have an evaluation service report prepared by an organization recognized by the International Code Council (ICC). Treated wood in contact with animal wastes or as critical components that are difficult to replace, should meet AWPA UC4B or equivalent for heavy-duty ground contact. Allowable preservatives include but are 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), CA-A, CA-B and CA-C (Copper Azole Types A, B and C), MCA (Micronized Copper Azole), µCA-C (Dispersed Copper Azole).

Aluminum fasteners, connectors, or cladding must not be used in direct contact with treated wood unless specifically allowed by the preservative manufacturer. Use hot-dipped galvanized or stainless steel bolts, washers, nuts, nails, and other hardware which meet American Society for Testing and Materials (ASTM) specifications A153 for fasteners and ASTM A653 coating designation G185 for sheet metal connectors, or ASTM A240 for Type 304 or 316 stainless steel, except as noted below. Fasteners and connectors of other materials may be used if specifically allowed by the preservative manufacturer. All fasteners, connectors, and any other metal in contact with ACQ, CA, MCA, or µCA-C treated wood shall be stainless steel if AWPA Use Category UC4B applies or if constant, repetitive, or long periods of wet conditions may occur. All fasteners, connectors, and any other metal in contact with wood treated with ACZA or any other preservative containing ammonia must be stainless steel.

Repair. Use of sectional replacement repair for rigid or semirigid roof and cover material is allowable.

<u>Additional Criteria for Flexible Covers</u>

For fabrication of flexible membrane inflated and floating covers, use only membrane materials which have been certified by the manufacturer as suitable for the intended application.

Design flexible membrane cover systems to resist snow, wind, and wind uplift loads as appropriate.

Design floating covers to fluctuate with rising and falling liquid levels to properly manage the waste storage facility.

Include floatation materials on floating membrane covers as necessary for proper cover performance, and operation and maintenance tasks.

Design impermeable floating covers with a biogas collection, transfer, and control system to provide protection for the cover and convey biogas to a flare, release, or control point.

Design the biogas handling system with the capacity to handle the large range in gas production that can occur as a result of changing ambient temperatures and substrate conditions.

Inflated covers must be—

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

Table 1. Flexible geomembrane cover materials.

Type for	**Minimum Thickness Criteria**	
Purpose	***Contain Biogas***	***Divert Clean Water***
HDPE	40 mil	30 mil
LLDPE	40 mil	30 mil
LLDPE-R	36 mil	24 mil
PVC	40 mil	30 mil
EPDM	45 mil	--
FPP	40 mil	30 mil
FPP-R	36 mil	24 mil
PE-R	NR	24 mil

1 mil = 1/1000 of an inch

HDPE – High Density Polyethylene Geomembrane
LLDPE – Linear Low Density Polyethylene Geomembrane
LLDPE-R – Reinforced Linear Low Density Polyethylene Geomembrane,
PVC – Polyvinyl Chloride Geomembrane
EPDM – Ethylene Propylene Diene Terpolymer Geomembrane
FPP – Flexible Polypropylene Geomembrane
FPP-R – Reinforced Flexible Polypropylene Geomembrane PE-R – Reinforced, Slit –Film, Woven Polyethylene Geomembrane
NR – Not Recommended

Repair. Use only flexible cover material which is readily repairable. Repair may be made by solvent, adhesive, thermoplastic welding, or other methods according to manufacturer's recommendation.

Additional Criteria for Biogas Control/Utilization

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

Bioreduction and Treated Release. Select a cover fabricated of a permeable composite membrane designed to promote biological treatment of gaseous emissions which pass through the membrane for

treated release to the atmosphere. Maintenance of the cover media will be required for the life of the practice to ensure proper biofilter operation.

Contain and Manage Biogas when Excluding Rainfall. Design the cover system for rainfall exclusion on the stored manure and organic wastes with auxiliary elements to manage any biogas produced. For storage cover systems which collect biogas, provide for the safe handling, transfer and combustion of the biogas.

Capture Biogas and Control/Utilization. Design the cover system to capture biogas emissions and transfer biogas to the point of discharge without mixing with air. Equip the point of discharge with a flare or biogas utilization equipment as appropriate.

Equipment and material exposed to biogas must be resistant to corrosion and suitable for use within a potentially explosive environment. Materials, controls, motors and their installation must conform to the National Electrical Code (NEC). Motors must be rated explosion proof and properly sealed.

Design of aboveground pipe for biogas transfer must include pipe with fittings for expansion and contraction effects.

Aboveground biogas transfer pipe intended for pressurized biogas systems must be of steel or plastic materials. Steel pipe must meet the requirements of AWWA Specification C-200 or ASTM A53/A211 for stainless steel. Plastic pipe must be HDPE meeting AWWA Specification C-906 or ASTM D-3350. PVC is only acceptable for aboveground biogas transfer when pipe meets ASTM D2241, is ultraviolet light inhibited and pipe material is modified for high impact strength.

Anchorage. Design the cover anchorage system to withstand internal gas pressures, corrosive environment, wind loads, air tightness (as necessary), and other forces as appropriate to the cover system.

Pressure. Covers associated with biogas production must include provisions for fail-safe pressure relief when interior pressures exceed design operating pressures. Maximum pressure must not exceed manufacturer's recommendations.

Precipitation. Design features to direct precipitation on impermeable covers to collection points for removal by pumping or by controlled release to suitable grassed or otherwise stabilized areas for discharge or infiltration.

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

- Air Exclusion.—Design the cover system and appurtenances, including perimeter soil slopes above the water line, for in-ground liquid waste storage, to exclude the entrance of air under all operating conditions.
- Gas Collection, Control, and Utilization.—The collection, control, and utilization of biogas must meet appropriate criteria in NRCS CPS Code 366, Anaerobic Digester.

Biogas Safety. As a minimum for all roofs and covers that contain or control biogas, post the following warning signs:

- "Warning Flammable Gas"
- "No Smoking"

- When human entry is possible: “Do Not Enter – Hazardous Gases”

Where biogas is captured, design the gas collection, transfer and control/utilization system in accordance with standard engineering practice for safely handling a flammable gas including safety criteria noted in NRCS CPS Code 366, Anaerobic Digester.

CONSIDERATIONS

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

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

Maintain storage capacity and functionality of covered liquid waste storage by minimizing solids accumulation. Consider the use of manure management practices such as solid/liquid separation, NRCS CPS Code 632, Waste Separation.

For organic applications, consider using special construction material such as qualifying lumber as documented by an evaluation service recognized by the International Code Council (ICC). Other application 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 the gas handling system. Energy recovery or production can offset air emissions from fossil fuel combustion.

Consider storage of biogas when installing flexible covers over waste storage facilities or waste treatment lagoons to attenuate gas supply for end use or treated release.

Waste facility covers which capture biogas may reduce nutrient volatilization of the stored manure. Consider the effect this may have on the nutrient management plan.

Waste facility covers which capture biogas may increase the odor nuisance during agitation, pump out, and land application. Consider the effect these activities may have on the surrounding areas and waste management options.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying this practice to meet its intended purpose.

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

- Define the purpose, goals and objectives of the practice installation.
- Include information about the location and sequence of the phases of construction.
- Specify layout and location of agricultural waste storage and handling facility, or agrichemical handling facility.
- Include roof or cover footprint and any waste collection points and all planned access features.
- Grading plan showing excavation and fill. Include appropriate drainage features and revegetation plan as needed.
- Materials and structural details of the roof or cover including all necessary appurtenances as appropriate for the complete system.

- For flexible geomembrane cover systems with biogas combustion, include a listing of associated biogas collection and transfer equipment, and necessary appurtenances.
- Specify that the manufacturer or installer of the geomembrane cover system must certify the installation of the cover. Require the same manufacturer or installer to provide the project owner with maintenance instructions for the cover material.
- Biosecurity measures during installation.
- Warning and safety signage placement.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan and review the plan with the landowner or operator responsible for the application of this practice. Provide specific instructions for proper operation and maintenance of each component of this practice and detail the level of inspection and repairs needed to maintain the effectiveness and useful life of the practice.

- Address biosecurity concerns in all aspects of operation and maintenance.
- For enclosed waste facilities, exercise caution and care during cover removal or access. If opening of the cover is required for facility management, include provisions to prevent exposure of workers to hazardous gases.
- If personnel are or may be required to enter an enclosed waste facility, include safety provisions recommended by the National Institute for Occupational Safety and Health (NIOSH) for working in confined spaces including, but not limited to, using a positive-pressure self-contained breathing apparatus, safety line, and standby personnel.
- Develop an emergency action plan for covered systems associated with biogas production. Include instructions as to limits of cover performance and emergency procedures if control equipment fails. Provide contact(s) and phone numbers of person(s) to contact for the event of an emergency.

REFERENCES

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

American Wood Council. 2012. *National Design Specifications for Wood Construction*. AF&PA, Washington, DC.

American Institute of Steel Construction. *Steel Construction Manual*, 14th Edition. AISC, Chicago, IL.

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.

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.

American Society of Agricultural and Biological Engineers. *Floor and Suspended Loads on Agricultural Structures Due to Use, ASAE EP378.4*. ASABE, St. Joseph, MI.

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

American Society of Agricultural and Biological Engineers. *Manure Storage Safety, ASAE EP470.1*. ASABE, St. Joseph, MI.

American Society of Civil Engineers. *Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-10*. ASCE, Reston, VA.

American Wood Protection Association. 2014. *AWPA Book of Standards.* AWPA, Birmingham, AL

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

International Building Code. 2012. International Code Council (ICC). ICC, Whittier, CA.

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

Natural Ventilating Systems for livestock housing. *Midwest Plan Service, MWPS-33*, *1989.*