United States Department of Agriculture

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

Use this practice to accomplish one or more of the following purposes–

- Protect clean water by excluding precipitation from potential contaminants.
- Improve waste management and utilization to protect nearby surface water quality.
- Reduce emissions of ammonia, odorous sulfur compounds, greenhouse gases, volatile organic compounds, and particulate matter to improve air quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where—

- Precipitation should be excluded from areas, such as animal feeding and management areas, on-farm secondary containment facilities, and 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 waste 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) High Tunnel System (Code 325).

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations

Plan, design, and construct the roof and covers to meet all Federal, State, Tribal, and local laws and regulations.

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 the sections below, on Additional Criteria for Rigid and Semi-rigid Roofs and Covers, and Additional Criteria for Flexible Covers.

Design
Refer to NRCS CPS Waste Storage Facility (Code 313) or NRCS CPS Agrichemical Handling Facility (Code 309) 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 Wood Council.
- 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. Refer to American Society of Agricultural and Biological Engineers' (ASABE's) document, *ASABE S607, Ventilating Manure Storages to Reduce Entry Risk* for design standards.

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

Design covers and grating over openings such that livestock and 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.

Follow criteria outlined in NRCS CPS Roof Runoff Structure (Code 558) 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 (ESR) 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.

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 Alkaline Copper Quaternary (ACQ), Copper Azole (CA), Micronized Copper Azole (MCA), or Dispersed Copper Azole (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 Ammoniacal Copper Zinc Arsenate (ACZA) or any other preservative containing ammonia must be stainless steel.

Repair

Allow use of sectional replacement repair for rigid or semirigid roof and cover material.

Additional Criteria for Flexible Covers -

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

Design inflated covers to 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.

Use table 1 to select the minimum thickness for flexible geomembrane cover materials.

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	45 mil
FPP	40 mil	30 mil
FPP-R	36 mil	23 mil
PE-R	NR	23 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.

- Permeable Cover for Bio-reduction 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.
- Impermeable Cover for Precipitation Exclusion and Biogas Capture. Design the impermeable cover system on the stored manure and organic wastes with auxiliary elements to manage any biogas produced by capturing biogas emissions and transferring biogas to the point of discharge without mixing with air. For storage cover systems which collect biogas, provide for the safe handling, transfer, and flaring or utilization of the biogas.

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 aboveground pipe for biogas transfer with fittings for expansion and contraction effects.

Use steel or plastic materials for aboveground biogas transfer pipe intended for pressurized biogas systems. Steel pipe must meet the requirements of American Water Works Association (AWWA) Specification C-200, or ASTM A53; or AWWA C-220 or ASTM A312 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. For covers associated with biogas production, include provisions for fail safe pressure relief when interior pressures exceed design operating pressures. Do not exceed manufacturer's recommended maximum pressure.

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. Provide for the following:

1. 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.
2. Gas Collection, Control, and Utilization - The collection, control, and utilization of biogas must meet appropriate criteria in NRCS CPS Anaerobic Digester (Code 366).

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."
- And 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 Anaerobic Digester (Code 366).

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 Waste Separation (Code 632).

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 change 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:

- 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 utilization, 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.

- For covers fabricated of a permeable composite membrane designed to promote biological treatment of gaseous emissions, maintain the cover media for the life of the practice to ensure proper biofilter operation.
- 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.

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