NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

ROOFS AND COVERS

(No.)

CODE 367

I. DEFINITION

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

II. PURPOSE

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

III. 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.

IV. CRITERIA

Users of this standard should be aware of potentially applicable federal, state, tribal, and local laws, rules, regulations, or permit requirements governing waste facility covers and roof structures. This standard does not contain the text or reference all related requirements, it is incumbent upon the user to ensure all structures are planned, designed, and constructed to meet all applicable laws and regulations.

A. GENERAL CRITERIA APPLICABLE TO ALL PURPOSES

1. 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.

2. 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 manufacturer 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 floating 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.

3. 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.

4. 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.

5. 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 meet 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.

6. 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.

7. 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.

8. 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.

Confined spaces where human entry may occur shall be designed and operated in compliance with the provisions contained in ASABE EP470, Manure Storage Safety.

B. ADDITIONAL CRITERIA FOR RIGID AND SEMI-RIGID ROOFS AND COVERS

1. Roofed Animal Production Facilities

Roofed Animal Production Facilities are defined as roof structures that are used to eliminate precipitation from buildings that house both animals and store manure. In North Dakota, those structures are commonly termed "Bedded Pack Barns".

Roofed Animal Production Facilities are considered to be a Conservation Practice in the following situations only:

- **To replace outdoor feedlots in locations where the seasonal high water table is within 4 feet of the majority of ground surface in the existing lot. A minimum of 75% of the existing open lot shall be abandoned and reclaimed for other purposes in conjunction with this practice.**
- **To replace all, or portions of, outdoor feedlots when an economic analysis supports the roof structure as being the most cost effective alternative to bring the operation into compliance with water quality standards. Approval of the economic analysis by the State Conservation Engineer is required to be considered a conservation practice under this basis.**

The extent of the Roofed Animal Production Facility for the purpose of this standard includes the roof and all of the structural components that support the roof. These components may include piers, columns, footings, pilings, walls, beams, connections, and other items.

Floors of Roofed Animal Production Facilities in locations where the seasonal high water table is within 4 feet of the finished subgrade elevation, must be constructed entirely of concrete.

Design of floors, interior waste stacking walls, and other related facilities will be through the NRCS Waste Storage Facility Practice Standard (313).

A minimum of 270 days storage will be provided for bedding material and the solid portion of manure, within the roofed structure and/or other storage facilities designed under the NRCS Waste Storage Facility Practice Standard (313). The methodology presented in SD NRCS Tech Note SD2011-1, "Beef and Dairy Bedded Pack Barn Planning and Design" will be utilized for computing storage requirements.

2. Design Loads

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. Roofs, covers and associated support systems shall be designed to resist snow and wind loads as specified in the current version of the International Building Code and ASCE 7 Minimum Design Loads for Buildings and Other Structures.

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.

3. Required Appurtenances

Equip openings in covered tanks with grills or secure covers for safety, and for odor and vector control. **Provisions should be taken to make grills and/or covers corrosion resistant.**

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 standard Roof Runoff Structure (558). All outside surface water shall be diverted from the roofed area.

C. ADDITIONAL CRITERIA FOR FLEXIBLE COVERS

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

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

Impermeable floating 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 **(supported by forced air from mechanical means)** covers shall 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.

Flexible membrane cover systems shall be designed to resist snow, wind, and wind uplift loads as appropriate. **A wind speed of 90 mph (3-second gust) shall be used for uplift analysis unless weather data indicates otherwise for a 50-year recurrence interval.**

D. ADDITIONAL CRITERIA FOR BIOGAS CONTROL/UTILIZATION

1. 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.

Perforated pipe and other components under the facility 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.

<u>Capture and Control/Utilization</u>

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.

<u>Bio-reduction and Direct Release</u>

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.

<u>Contain and Release</u>

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

2. 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.

3. 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.

4. 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.

5. 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 for the following:

   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.

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

6. Biogas Safety

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

   - "Warning Flammable Gas"
   - "No Smoking"
   - And when necessary **(i.e. human entry is possible)** "Do Not Enter – Hazardous Gases"

   Where biogas is captured, the gas collection, **transfer,** 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). **Specifically:**

   Appropriate fire protection equipment and biogas leak detection sensors and/or ventilation shall be provided where biogas leakage would enter confined areas intended for human entry.

   Open flares shall be located a minimum distance of 95 feet from the biogas source. Flares shall have a minimum height of 10 feet and shall be grounded or otherwise protected to minimize the chance of lightening strike damage.

   A flame trap assembly (flame arrester and thermal valve) device shall be installed in the biogas line between the cover/structure and sources of ignition or as recommended by the flame arrester manufacturer.

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

V. CONSIDERATIONS

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.

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

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.

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 material such as qualifying lumber as documented by an evaluation service recognized by the 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 additional air emissions from reduced fossil fuel combustion.

Waste facility covers which capture biogas may increase the nutrient content of the manure stored. 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 this may have on the surrounding area and management options.

VI. PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard. Define the purpose, goals and objectives of the practice. Include information about the location and construction sequence.

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

1. Layout and location of waste management facility with roof or cover including waste collection points and planned access.
2. Grading plan showing excavation, fill, and drainage, as appropriate.
3. Materials and structural details of the roof or cover including all necessary appurtenances as appropriate for the complete system.
4. For roof and cover systems with gas collection and control include a listing of material, equipment, and necessary appurtenances.

VII. OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan must be prepared and reviewed with the landowner or operator responsible for the application of this practice. The O&M plan shall provide specific instructions for proper operation and maintenance of each component of this practice and shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice.

Develop an emergency action plan for covered systems associated with biogas production. The plan shall contain instructions as to limits of cover performance and emergency procedures if control equipment fails.

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 NIOSH (National Institute for Occupational Safety and Health) for working in confined spaces including but not limited to using a positive-pressure self-contained breathing apparatus, safety line, and standby personnel.

VIII. REFERENCES

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

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

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

American Institute of Steel Construction. 2005. Steel Construction Manual, 13th Edition. AISC, Chicago, IL. 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.

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.

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.

American Society of Agricultural and Biological Engineers. Manure Storages, ASAE EP393.3.

American Society of Agricultural and Biological Engineers. Manure Storage Safety, ASAE EP470, ASAME, St. Jospeph, MI. www.ASABE.org.

ASABE, St. Joseph, MI. 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.

American Wood Protection Association. AWPA, Birmingham, AL. www.AWPA.com.

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

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

International Code Council Evaluation Service. International Code Council (ICC). ICC, Whittier, CA. www.ICC-ES.org.

USDA, South Dakota NRCS, Design Technical Note SD2011-1, Beef and Dairy Bedded Pack Barn Planning and Design. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/sd/technical/engineering/?cid=nrcs141p2_036576