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Standard Guide for Evaluation and Selection of Alternative Daily Covers (ADCs) for Sanitary Landfills[1]

This standard is issued under the fixed designation D6523; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

~~ε^1 NOTE—Units statement was inserted in Section 1.4 editorially in January 2014.~~

1. Scope

1.1 This guide is intended to assist specifiers and end users in assessing the different options available for sanitary landfill daily cover materials described as alternative (non-soil) daily covers (ADCs). Traditional daily cover consists of at least 6 in. (15 cm) of soil spread over the working faces of sanitary landfills. Alternative systems are attractive to landfill operations in order to conserve landfill disposal space, among other reasons.

1.2 This guide assists in understanding different performance features of broad classifications of ADCs, and determining the extent and degree to which different ADCs are able to "control disease vectors, fires, odors, blowing litter, and scavenging, without presenting a threat to human health and the environment," as intended by United States Environmental Protection Agency (USEPA) regulations.

1.3 This guide is not intended to provide cost information regarding the various ~~ADCs as~~ADCs. As a standard guide, it does not dictate a protocol for the practice and testing of ADCs, but rather provides valuable information, guidance, and recommendations to interested parties concerning the many options available.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 *Exception*—Metric units are used in 6.2.9.2.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4982 Test Methods for Flammability Potential Screening Analysis of Waste

E96/E96M Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

[1] This guide is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.03 on Permeability and Filtration.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *Other ~~Standards~~Standards:*[3]

Solid Waste Disposal Facility Criteria, USEPA, Technical Manual EPA 530-R-93-017, Cover Material Requirements, 40 CFR 258 21, Nov 1993

"The Use of Alternative Materials for Daily Cover at Municipal Solid Waste Landfills" EPA 600/R-93/172 PB ~~92-22719792-~~227197, July 1993

Alternative Daily Cover Regulations, California Environmental Protection Agency, Title 27, Division 2, Subdivision 1, Chapter 3, Subchapter 4, Article 2, Section 20680 CIWMB Daily Cover and Section 20690 CIWMB Alternative Daily Cover

3. Terminology

~~3.1 *alternative daily cover, n*—an alternative to the traditional 6-in. (15-cm) soil cover required by the USEPA for landfill working faces to "control disease vectors, fires, odors, blowing litter, and scavenging, without presenting a threat to human health and the environment."~~

3.1 *Definitions:*

3.1.1 *alternative daily cover, n*—an alternative to the traditional 6 in. (15 cm) soil cover required by the USEPA for landfill working faces to "control disease vectors, fires, odors, blowing litter, and scavenging, without presenting a threat to human health and the environment."

3.1.2 *foam, n*—a synthetic material sprayed and combined with air to form closed-cell air pockets.

3.1.3 *gas emissions, n*—a release of landfill gas generated within the waste mass into the atmosphere through cover materials.

3.1.4 *geosynthetic, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man-made project, structure, or system.

3.1.5 *indigenous, adj*—native to a particular region.

3.1.6 *leachate, n*—contaminated water resulting from the combination of waste with precipitation.

3.1.7 *nonreusable, adj*—in geosynthetics, a fabric or film intended to be placed once and then disposed of, discarded, or left in place.

3.1.8 *reusable, adj*—in geosynthetics, a fabric or membrane material intended to be retrieved and installed more than once to perform the cover function.

3.1.9 *sanitary landfill, n*—a regulated disposal site for the deposition of commercial and household wastes.

3.1.10 *working face, n*—the area of a landfill in which waste is actively being deposited.

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[3] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

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4. Significance and Use

4.1 This guide provides information which the regulator/permit officials, engineers, waste disposal operators, and others will find helpful to (*1*) understand and distinguish between the many choices ~~available;~~available, (*2*) understand the performance feature considerations for living up to EPA regulations for landfill daily covers, and (*3*) understand the various requirements and differences for putting these covers into practice at landfills.

5. Classifications of ADCs

5.1 *Foams*—Foam ADCs are applied to the working face of sanitary landfills using foam generation and application equipment specifically designed for that particular foam. Both hardening and non-hardening foams are currently available. These foam layers are effectively ~~broken-up~~ broken up by the placement of additional wastes on the next operating day, and therefore ~~does~~do not interfere with fluid movement.

5.2 *Spray-On Slurries*—Most slurries are paper-based. The paper-based slurry ADCs are applied to the working face of sanitary landfills using standard hydro-seeding equipment. Certain types of slurries may require some modification of the hydro-seeding equipment. The slurries are allowed to harden to form a crust or shell over the working face. This covering is also ~~broken-up~~ broken up by the placement of additional wastes on the next operating day.

5.3 *Geosynthetics:*

5.3.1 *Reusable*—Reusable geosynthetic ADCs consist of various types of fabric or plastic membranes that have either been developed or adapted for use as a daily cover material. Panels fabricated from these materials are placed over the working face at the end of the day, and retrieved prior to the start of the next operating day. Some landfills use special mechanized equipment to facilitate the placement and retrieval of panels.

5.3.2 *Nonreusable*—Nonreusable geosynthetic ADCs consist of less durable disposable films or fabrics, intended to be left in place without retrieval. Special equipment also exists to facilitate the placement and anchoring of these materials to cover the working face of landfills. The cover may contain pro-degradant additives to accelerate degradation within the waste to cease the interception of fluids.

5.4 *Indigenous Materials*—Indigenous ADCs consist of various types of locally available waste products for disposal (for example, sludges, ash, shredded tires, shredded green waste, pulverized construction and demolition debris, automobile recycling fluff, foundry sand, and so forth) placed onto the working face of landfills in a manner similar to soil cover. They often require physical or chemical modification for consistency and workability, and evaluation for the presence of potentially hazardous constituents. Processed indigenous materials such as treated sludges and asphalt-stabilized soils are available from manufacturers who are able to provide such products with consistent properties. Manufacturers should have the necessary supporting data available for review. Unprocessed ADCs can vary significantly with respect to physical and chemical characteristics and composition, depending on the particular source. In addition, suitability and acceptability are dependent on site-specific climatic and operational conditions and regulatory requirements. Because of the wide variety of processed and unprocessed indigenous materials, only key factors and considerations related to the use and performance of these materials can hereby be presented.

6. Features and Considerations (see Table 1)

6.1 *Summary*—See discussion for clarification.

6.2 *Discussion:*

6.2.1 *Methods of Application:*

TABLE 1 Features and Considerations (see Section 6)

Feature/Consideration	Foams	Spray-on Slurries	Reusable Geosynthetics	Nonreusable Geosynthetics	Indigenous Materials
~~Methods of Application~~	~~Self propelled or towed equipment with manifold distribution, or truck mounted with handheld hose.~~	~~Truck mounted or trailer mounted hydro-seeding equipment w/spray tower and nozzle.~~	~~Manually, towed with compactors, or spread w/specialty wide panel deployment equipment.~~	~~Manually, or spread w/specialty unwinder attached to dozer/ compactor and placing ballast soil to anchor.~~	~~Most often spread with dozers as with traditionally daily cover. Varied.~~
Methods of Application	Self propelled or towed equipment with manifold distribution, or truck mounted with handheld hose.	Truck mounted or trailer mounted hydro-seeding equipment w/ spray tower and nozzle.	Manually, towed with compactors, or spread w/ specialty wide panel deployment equipment.	Manually, or spread w/ specialty unwinder attached to dozer/ compactor and placing ballast soil to anchor.	Most often spread with dozers as with traditionally daily cover. Varied.
Post-Application Requirements					
~~a) Equipment Clean-up/ Maintenance~~	~~High~~	~~Low~~	~~Low if placed w/equipment~~	~~Low if placed w/equipment~~	~~Low~~
a) Equipment Clean-up/ Maintenance	High	Low	Low if placed w/ equipment	Low if placed w/ equipment	Low
b) Remove Cover?	No	No	Yes	No	No
~~Application in Different Climates — a) Rain~~	~~Some not recommended for use during rain. Others can withstand drizzle/light rainfall or light to moderate rainfall.~~	~~Can apply in light rain. Once cured, can withstand moderate to heavy rainfall.~~	~~Some have no constraints while others can absorb water, increasing panel weight.~~	~~Rain tends to help anchor cover.~~	~~Generally OK, but sludge and mulch are unsuitably applied in rain due to excessive run-off.~~
Application in Different Climates — a) Rain	Some not recommended for use during rain. Others can withstand drizzle/light rainfall or light to moderate rainfall.	Can apply in light rain. Once cured, can withstand moderate to heavy rainfall.	Some have no constraints while others can absorb water, increasing panel weight.	Rain tends to help anchor cover.	Generally OK, but sludge and mulch are unsuitably applied in rain due to excessive run-off.
b) Wind	Can apply in 20 to 40 mph winds. Adheres to working face.	Can generally apply in winds up to 45 mph.	Depends on ballast mechanism. High winds can pick and destroy.	Increase ballast material. Small panels, disposable nature reduce impact of wind damage.	Most forms OK but yard waste and auto fluff are excessively effected.
~~c) Freezing Temp/Snow~~	~~Can apply under freezing conditions, but equipment must be protected. Some equipment has freeze protection system.~~	~~Can apply in freezing temperatures or snow.~~	~~Some have no constraints. In others, if moisture has been absorbed, panels can freeze, making their placement and retrieval more difficult.~~	~~Shift to different ballast material w/no moisture content (for example, crushed glass instead of sand).~~	~~Generally no Constraints. Sludge and mulch have some difficulty in snow.~~
c) Freezing Temp/Snow	Can apply under freezing conditions, but equipment must be protected. Some equipment has freeze protection system.	Can apply in freezing temperatures or snow.	Some have no constraints. In others, if moisture has been absorbed, panels can freeze, making their placement and retrieval more difficult.	Shift to different ballast material w/ no moisture content (for example, crushed glass instead of sand).	Generally no constraints. Sludge and mulch have some difficulty in snow.
d) Hot Weather	No constraints	No constraints	No constraints	No constraints	Dust generation in many cases (that is, unprocessed materials).
Disease Vector Control? (Access by insects, vermin, pathogen contact.)	Discourages insects and birds from landing; rodents from digging.	If proper thickness, discourages insects and birds from landing; rodents from digging.	Can completely cover waste so as not to attract; Careful for pathogens in human rehandling.	Can completely cover waste so as not to attract.	Must be applied at sufficient thickness.
Fire Control a) Combustible?	a) Most no, some yes.	a) Some no, some yes. Materials should be tested per Test Methods D4982.	a) Yes	a) Yes	a) Some yes, others no.
b) Barrier to air/gas movement?	Low	Medium	High	High	Low to High
Odor and Air Emission Control?	Uniform coverage is key.	Uniform coverage of sufficient thickness is key. Material can be tested by Test Methods E96/E96M permeation.	Trap odors and other emissions while in place; release odors and other emissions when removed; can be tested by Test Methods E96/E96M permeation.	Trap odors and other emissions; can be tested by Test Methods E96/E96M permeation.	Dependent on thickness of application and compaction. Dredged materials can themselves be odorous. Material can be tested by Test Methods E96/E96M permeation.

TABLE 1 *Continued*

Feature/Consideration	Foams	Spray-on Slurries	Reusable Geosynthetics	Nonreusable Geosynthetics	Indigenous Materials
Dust Control?	Yes	Yes	Yes	Yes	Many unprocessed materials generate dust.
Blowing Litter Control?	Yes	Yes	Yes	Yes	Auto fluff among others unprocessed materials can generate litter.
Water Infiltration Control (sheds rainwater)	Certain foams can shed water during moderate rains, once cured.	Hardening slurries shed water.	Shed rainwater very effectively when in place; allows infiltration when removed.	Shed rainwater effectively for several layers of cover.	Many processed materials can shed water once compacted. Others are too permeable to shed much water.
Landfill leachate and gas migration interference?	No interference.	No interference.	No interference; unless left or buried in place.	No interference with degradable material (containing a prodegradant); will interfere if non-degradable film.	Ash-based wastes, dredged soils, clayey soils and cementitious foundry products can all create intervening layers.
~~Life expectancy~~	~~Varies according to type of foam. Some last 15 to 20 h while others are from 3 to 7 days.~~	~~Some last up to 14 days.~~	~~Some are 20 to 30 days, while others are 10 to 12 months.~~	~~Varies from days to months depending on additives and conditions.~~	~~Varies. Many processed materials will last indefinitely.~~
Life expectancy	Varies according to type of foam. Some last 15 to 20 h while others are from 3 to 7 days.	Some last up to 14 days.	Some are 20 to 30 days, while others are 10 to 12 months.	Varies from days to months depending on additives and conditions.	Varies. Many processed materials will last indefinitely.

6.2.1.1 Manifold-equipped units apply foam as equipment traverses the working face. Self-propelled units with manifold applicator applies foam as the unit backs down the working face. Handheld hose-equipped units apply foam as the crew walks next to or across the working face, or both.

6.2.1.2 Most slurries use truck-mounted or trailer-mounted standard hydro-seeding equipment with little or no modification. It is applied through the spray tower located on the platform of the hydro-seeding equipment using appropriate nozzles. The use of a ~~hand-held~~handheld hose may be suitable for certain applications. In at least one case, a specially designed storage unit and mobile applicator is required by the manufacturer. Care must be taken to avoid skimping on the thickness of application.

6.2.1.3 At some sites, ancillary equipment (for example, tow bar, lifting bar, reel, or rollers) are used to facilitate placement of geosynthetic panels (both reusable and nonreusable) and reduce wear and tear. Tires, sandbags, or ballast soil are placed along the edges to anchor the panels.

6.2.1.4 The preparation of the working face prior to placement of a geosynthetic panel and the care taken in placement of the panel can have a significant impact on the effective life of a panel. Consequently, operators should ensure that the working face is properly compacted to provide a smooth surface, and that protruding objects which could damage panels are eliminated. In addition, during placement of panels, measures should be taken to prevent unnecessary stress on the material and minimize snagging while dragging the panel across the working face.

6.2.1.5 Most indigenous materials may be spread and compacted in the same manner as traditional sands and gravels. Dozers and front-end loaders are usually used to spread the material. Compaction can be accomplished with single-drum rollers, dozer tracks, or loader tires, or combination thereof.

6.2.2 *Post-Application Requirements:*

6.2.2.1 When equipment is used to apply ADCs there is ~~clean-up~~cleanup and maintenance. Cleanup often takes place by hosing with water or compressed air, or both.

6.2.2.2 Many ADCs have no other post-application requirements but are simply broken up by the placement of wastes on subsequent days.

6.2.2.3 Reusable geosynthetic panels are normally removed from the working face prior to the start of the next operating day.

Hence, the necessary personnel and equipment have to be available, and sufficient time allowed, for this activity to be performed prior to the arrival and disposal of waste at the working face. This may require modification of the work schedule for site personnel. Furthermore, depending on the season of the year and operating hours at the site, panel retrieval may have to be performed while it is still dark, requiring extra precaution against accidents or injury.

6.2.2.4 Retrieval of geosynthetic panels is accomplished by reversal of the procedures used to place them. Anchoring materials are first removed and stockpiled near the working face. If soil was used to secure the edges, particular care must be taken not to tear the panel upon retrieval. Panels are then removed, either manually or using landfill equipment, by pulling them back over themselves to minimize snagging. They are then stored near the working face for subsequent use. If skid-mounted rollers were used, the panel is rolled back to the skid which is then dragged to an area adjacent to the working face.

6.2.3 *Average Duration of ADC*—Duration of the cover is dependent upon cover type and climatic conditions, particularly rain, and should be taken into consideration if cover is expected to last indefinitely. Some shrinkage or hardening of foam can occur after several days.

6.2.4 *Rain:*

6.2.4.1 If moderate to heavy rain is anticipated, foams should not be applied. Given time to cure, certain foams absorb and shed water during rain events. Application during a rain event should be avoided in order to prevent possible dilution before curing.

6.2.4.2 Most slurry ADCs can be applied in light rain or drizzle. Once cured, most can stand moderate to heavy rainfall.

6.2.4.3 For reusable geosynthetics, increased panel weight makes placement and retrieval more difficult and increases the risk of damage to the panel.

6.2.4.4 Indigenous materials are generally more difficult to transport and apply, if material has a high moisture content. However, many processed materials are provided with consistent moisture contents, suitable for easy application. Application of all indigenous materials should be avoided during periods of significant precipitation. Also, contaminants present in unprocessed materials can be leached by infiltrating rainwater, possibly affecting the composition and disposition of leachate. As with any engineered facility, proper installation is important for adequate performance.

6.2.5 *Wind:*

6.2.5.1 Impact of wind during application of foams is primarily dependent upon the proximity of the discharge nozzle to the working face. Additional touch-up may be required if the material is blown away. Insufficient information is available on the ability of foams to sustain high winds during their effective life.

6.2.5.2 Many slurry ADCs can be applied in winds up to ~~45 mph.~~ 45 mph. Once applied, high winds have little or no effect on the slurry ADC.

6.2.5.3 The impact of wind on the placement of geosynthetic panels onto the working face is primarily dependent upon the weight of the material and the size of the panel. For example, a large, lightweight panel will be more difficult to place under windy conditions than a smaller or heavier panel, or both. The method used to place a panel, whether manually, towed or deployed with landfill equipment or rolled onto the working face, also influences the potential impact of wind during placement.

6.2.5.4 Indigenous materials, when dry, except processed materials such as shredded tires and asphalt-stabilized soil, are prone to dust generation. Some processed materials can actually be used to suppress dust from landfills. Lighter components of green waste/compost can become wind-blown.

6.2.6 *Freezing Temperature/Snow:*

6.2.6.1 Foam constituents must generally be protected from freezing. With certain exceptions, application equipment requires inside storage when not in use.

6.2.6.2 Most slurry ADCs can be applied in freezing temperatures and during or after a snow, or both. The hydro-seeding equipment contains agitators that maintain the slurry in the cold conditions.

6.2.6.3 Geosynthetic panels can be damaged if removal is necessary and attempted when frozen to the working face. In order to

prevent damage or possible loss, reusable geosynthetic panels are usually not used when snow is predicted. Snow can bury the panel, necessitating removal of the snow before the panel can be retrieved from the working face. This will not only require additional time and labor, but greatly increases the likelihood of tearing and destroying the panel due to the additional weight imparted by the snow. With a heavy snowfall, removal of snow may be impractical. This can result in the loss of the panel or necessitate the use of an alternative working face until the snow thaws. If an alternative working face is not available, the buried panel may be lost for further use and may act as an internal barrier to gas and leachate movement unless destroyed.

6.2.6.4 If indigenous material has a ~~high-moisture~~ high moisture content, it can freeze similar to wet soils, and be difficult to excavate and apply.

6.2.7 *Disease Vector Control (Access by Insects, Vermin, and so forth):*

6.2.7.1 Non-hardening foams discourage insects and birds from landing and animals from digging. Hardening foams and slurries can form a crust or shell which controls disease vectors when sprayed on with proper thickness.

6.2.7.2 When properly placed over the working face, geosynthetic panels completely cover the waste and block out disease vectors, unlike soil where bulky items may still protrude from the working face and attract disease vectors. Handling requirements for reusable geosynthetics during retrieval may, however, bring personnel into contact with disease-causing bacteria.

6.2.7.3 Indigenous material must be applied at sufficient thickness to completely cover wastes.

6.2.8 *Fire Control:*

6.2.8.1 Foams generally do not sustain a flame nor release heat in calorimeter tests, and can be classified as noncombustible.

6.2.8.2 Some spray-on slurries are also noncombustible in accordance with Test Methods D4982. This should be established by independent laboratory testing of a representative sample of the slurry material after curing.

6.2.8.3 Many other ADCs release more or less heat in calorimeter tests, but may or may not provide other fire suppression behavior. Geosynthetics, for example, offer substantially improved barrier properties to gas and air migration, reducing the transfer and mixing of atmospheric oxygen with landfill fuel gases, an important element in the spread of landfill fires.

6.2.8.4 Indigenous materials vary widely in their performance for fire control. Permeability to air and gas migration, in particular, is variable, and a number of them provide significant combustibility. With green waste/compost, risk of fire increases in hot weather. Some components of automobile recycling fluff are combustible. Others, such as asphalt-stabilized soil are impermeable to air and gas as well as noncombustible.

6.2.8.5 Laboratory testing uniform to all the different candidate ADC's is difficult to specify due to the many different materials and variables affecting ultimate fire control performance at a landfill.

~~(1) Other Considerations for Fire Control:~~

(1) Other Considerations for Fire Control:

(a) Daily cover soil's perceived role in reducing and controlling the fires at landfills was based on casual observation, not on scientific research. While cover soil is in most instances itself noncombustible, its efficacy for fire control also depends on the uniform barrier it provides to the flow of oxygen and landfill gas. As the standard for fire control, though soil is strong in the area of noncombustibility, it is much less so in the area of preventing gas and air exchanges.

(b) Breaks and settlement in the working face of a landfill disrupt the uniformity of soil cover, the uniformity of barrier to fuel and oxygen, and therefore compromise the daily cover's ability to control fires. In the past, soil daily covers were thought to provide barriers within the landfill to the spread of underground fires deep beneath the surface. However, this has been shown not to be the case. Because landfills settle in a differential manner, daily soil cover does not maintain a continuous barrier. Consideration of fire control behavior in candidate ADCs should therefore consider both the function of combustibility and the barrier provided to gas and air exchange.

(c) No ADC should be used which would promote a fire in a landfill.

(2) In modern landfill practice there are other mitigating factors for landfill fires, which may or may not lend themselves to consideration of ADC fire control capability. A significant modern-day decline in the number of landfill fires can be attributed to the following factors:

(a) The municipal solid waste stream has changed over the years. Materials that caused many of the fires at landfills have been eliminated (for example, ashes from coal-burning furnaces and boilers).