UFC 3-260-17
22 May 2018

UNIFIED FACILITIES CRITERIA (UFC)

O&M MANUAL: STANDARD PRACTICE FOR DUST CONTROL ON ROADS, AIRFIELDS, BASE CAMPS, AND ADJACENT AREAS

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O&M MANUAL: STANDARD PRACTICE FOR DUST CONTROL ON ROADS, AIRFIELDS, BASE CAMPS, AND ADJACENT AREAS

U.S. ARMY CORPS OF ENGINEERS (Preparing Activity)

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER CENTER

Record of Changes (changes are indicated by **\1** ... **/1/**)

Change No.	Date	Location

This UFC supersedes UFC 3-260-17, dated 16 January 2004, and Air Force ETL 09-3, dated 3 March 2009.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD (AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the most stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request. The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://dod.wbdg.org/.

Refer to UFC 1-200-01, *DoD Building Code (General Building Requirements)*, for implementation of new issuances on projects.

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UNIFIED FACILITIES CRITERIA (UFC)
REVISION SUMMARY SHEET

Document: UFC 3-260-17, *O&M Manual: Standard Practice for Dust Control on Roads, Airfields and Adjacent Areas*

Superseding: UFC 3-260-17, *Dust Control for Roads, Airfields and Adjacent Areas*, dated 16 January 2004, and Air Force ETL 09-3, *Chemical Dust Control for Contingency Roads, Base Camps, Helipads, and Airfields*, dated 3 March 2009.

Description: This UFC provides guidance for dust control materials and methods that are used successfully on roads, airfields, base camps, and areas adjacent to these structures to reduce airborne dust. This UFC applies to Army, Navy, and Air Force installations.

Reasons for Document:

The primary reason for the document update was to bring the document in compliance with UFC 1-300-01, *Criteria Format Standard*. A number of editorial changes were also needed to improve readability and correct typographical errors.

Impact:

Cost impact is negligible; improved guidance typically results in improved performance and reduced lifecycle cost.

Unification Issues:

None.

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CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE.

This UFC provides guidance for dust control materials and methods used on roads, airfields, base camps, and areas adjacent to these structures to reduce airborne dust. Dust develops naturally in unpaved, denuded, or sparsely vegetated areas. Dust is created in unsurfaced areas subjected to concentrated foot or vehicular traffic and is a problem on shoulders of surfaced aircraft areas. Dust control improves health, safety, and wellness, limits increased costs associated with damage and maintenance on vehicles and other equipment, and minimizes dust signatures during military operations.

This UFC discusses dust control methods and materials that have proven effective to reduce dust; provides suggestions for rates and methods of application of materials for various soil types and environmental conditions; and discusses factors, such as availability, curing time, durability, logistics, and economics, which are significant in the ultimate choice of material. Agronomic, topical, and admixture methods are discussed; however, the primary focus is on dust palliatives. Appendix B addresses the specific problem of dune sands and how they may be partially controlled.

1-2 APPLICABILITY

This UFC applies to all military Service elements and contractors involved in the planning, design, construction, maintenance, repair, or preservation of DOD pavements worldwide. This UFC provides guidance for dust control materials and methods that are used successfully on roads, airfields, base camps, and areas adjacent to these structures to reduce airborne dust. This UFC outlines standard practices and will result in better oversight of work and help identify problem areas during application of the maintenance and repair (M&R) process.

1-3 REFERENCES.

Appendix A contains a list of references used in this UFC. The publication date of the code or standard is not included in this UFC. In general, the latest available issuance of the reference is used.

1-4 GLOSSARY.

Appendix C contains acronyms, abbreviations, and terms.

1-5 DEFINITION AND CAUSE.

The term “dust” is defined as particles of soil that have become airborne. Dust consists mainly of soil particles finer than 0.003 inch (0.074 millimeter) (i.e., passing the No. 200 sieve as described in ASTM E11). Dust is produced whenever the outside force(s) acting on a soil particle exceeds the force(s) holding it in place. Dust may occur naturally from the force of wind, although the production of dust is accelerated in areas of soil experiencing actual physical abrasion caused by the environment, vehicles, or activity. Dust is reduced by ground covers (such as grass, mulch, and geotextiles) that prevent wind forces from acting on the soil grains. Another mechanism is by adhesion between fine soil grains due to surface tension from liquids (such as water) or a physical bonding agent (such as portland cement). Agglomeration of fines increases the effective particle size, limiting the ability to become airborne. Other terms unique to this UFC are listed and defined in the following paragraphs.

1-5.1 Traffic Areas.

Traffic areas include roadways and vehicle parking areas; walkways; open storage areas; construction sites; runways, taxiways, shoulders, overruns, and parking areas of airfields and heliports; and tank trails.

1-5.2 Non-traffic Areas.

Non-traffic areas include graded construction areas prior to turfing; graded construction areas that remain dormant for an extended period of time; denuded areas around the periphery of completed construction projects; areas bordering all airfield or heliport complexes; protective petroleum, oil, and lubricant (POL) dikes; magazine embankments of ammunition storage barricades; bunkers and revetments; cantonment, warehouse, storage, and housing areas, excluding walkways and roadways; unimproved grounds; and areas experiencing windborne sand (see Appendix B).

1-5.3 Occasional-Traffic Areas.

Occasional-traffic areas include shoulders and overruns of airfields used by propeller or jet aircraft; shoulders, hover lanes, and peripheral areas of heliports and helipads; and non-traffic areas where occasional traffic becomes necessary.

1-5.4 Dust Palliative.

A dust palliative is a material applied to soil to prevent soil particles from becoming airborne. Other terms used to indicate a dust control material include dustproofer, soil stabilizer, soil waterproofer, and dust control agent.

1-5.5 Pre-Wet.

Pre-wetting is the initial application of water on a soil surface prior to applying a liquid surface penetrant. This action primes the soil, improving the penetration and coverage of water-based palliatives.

CHAPTER 2 FACTORS FOR CONSIDERATION

2-1 GENERAL.

A wide selection of dust palliatives for dust control is available to the engineer; however, no one material is singled out as being the most acceptable for all situations. The successful control of dust and erosion in an area depends on several factors, the most important of which are:

- Influencing factors
- Environmental factors
- Expected traffic
- Topography
- Soil type
- Soil surface feature(s)
- Climate

2-2 FACTORS INFLUENCING DUST.

The presence of dust-size particles in a soil does not indicate a dust problem or severity of the dust problem that results in various situations. Many factors contribute to the formation, severity, and endurance of dust, including soil texture and structure, soil moisture content, soil density, presence of salts or organic matter in the soil, smoothness of the ground surface, vegetative cover, wind velocity and direction, and humidity. Depending on these factors, an external force imposed on a ground surface generates volumes of dust of varying density, size, and height above ground which are referred to as dust clouds. Figure 2-1 shows three typical dust clouds rising from military vehicles. Dust clouds are generated by drafts of moving air from windstorms, aircraft engines, or ground vehicles, which not only produce drafts of moving air but also abrade the soil surface.

2-3 ENVIRONMENTAL FACTORS.

For the selection and use of control methods and dust palliatives, consider applicable local safety, health, and environmental requirements. In the United States, material compliance with existing Environmental Protection Agency (EPA) rules and regulations is required.

Figure 2-1 Three Examples of Typical Dust Clouds

2-4 EXPECTED TRAFFIC.

The areas requiring treatment are divided according to the amount of traffic expected: those with no traffic, with occasional traffic, and with channelized traffic (i.e., roadway or taxiway). Where the extent of traffic is predicted or regulated, savings in time and material(s) is realized by adjusting the type and amount of treatment an area receives according to use.

2-4.1 Non-traffic Areas.

These areas require treatment to withstand the effects of airblast due to wind or nearby vehicle operations and are not subjected to actual traffic of any kind. If traffic is applied, the treated area typically is damaged and repairs are required. In the majority of cases, establishing vegetative ground cover is the best solution for long-term dust and erosion control. However, for the short term, intermittent dust control is needed following construction or other activities that disturb the soil.

2-4.2 Occasional Traffic Areas.

Besides resisting wind, helicopter rotor downwash, aircraft propwash, and airblast from jet engines, these areas also are subjected to occasional traffic by vehicles, aircraft, or personnel. Treatment for jet airblast is more involved than that required for helicopter and aircraft propellers; however, treatment for either is adequate to support occasional, non-channelized, vehicular traffic. If traffic conditions change and multiple passes or repeated crossings along the same path occur, the treated area has the potential to be damaged and repairs required. As with non-traffic areas, establishing vegetative ground cover is the best solution for long-term dust and erosion control.

2-4.3 Traffic Areas.

These areas require treatment to withstand regular channelized traffic by vehicles, aircraft, or personnel. Areas treated to withstand regular channelized traffic typically withstand airblast from aircraft and helicopters when applicable.

Perform an economic analysis of the cost to maintain an unsurfaced road versus the costs associated with a paved surface road on a case-by-case basis. Give consideration to the amount of maintenance required, level of traffic, ease of construction, and local costs. Where these areas are considered permanent, treat as specified in existing guidance publications.

2-5 TOPOGRAPHY.

2-5.1 Distinction Between Flat and Hillside Areas.

Consider the overall topography of the area as either flat or hillside. “Flat” is defined as an average ground surface slope of 5 percent or less while “hillside” refers to an average ground surface slope steeper than 5 percent. Place emphasis on the fact that the entire topography of the area to be treated is considered and not specific spot areas. Spot areas are given special attention as needed.

2-5.2 Dust Control for Flat and Hillside Areas.

Dust control depends on the type of traffic expected, etc.; however, the final dust palliative selected is affected by the slope. Liquid dust palliatives flow instead of penetrate on sloped surfaces. Tilling the dust palliatives, either liquid or powder, is recommended on hillside surfaces.

2-6 SOIL TYPE.

The soil type is one of the key features used to determine which method and material is used for dust control. Soils to be treated for dust control have been placed in five general descriptive groupings based on the Unified Soil Classification System (USCS) (see ASTM D2487).

- G = Gravel
- S = Sand
- M = Silt
- C = Clay
- O = Organic

2-6.2 Silts or Clays (High Liquid Limit).

The relatively impervious, plastic, fine-grained soils encompass USCS types CH, OH, and MH.

2-6.3 Silts or Clays (Low Liquid Limit).

The moderately permeable, low- to medium-plasticity, fine-grained soils encompass USCS types ML, CL, ML-CL, and OL.

2-6.4 Sands or Gravels (With Fines).

The moderately permeable, coarse-grained soils contain an appreciable amount of fines, encompassing USCS types SM, SC, SM-SC, GM, GC, GM-GC, and GW-GM.

2-6.5 Sands (With Little or No Fines).

The highly permeable sands or gravelly sands contain little or no fines, encompassing USCS types SW-SM, SP, and SW.

2-6.6 Gravels (With Little or No Fines).

The highly permeable gravels or sandy gravels contain little or no fines, encompassing USCS types GP and GW.

2-7 SOIL SURFACE FEATURES.

Soil surface features refer to both the state of compaction and degree of saturation of the soil in the area being considered.

2-7.1 Loose and Dry or Slightly Damp.

The surface consists of a cover, 0.25 to 2 inches (6 to 51 millimeters) thick, of unbound or uncompacted soil overlying a relatively firm subgrade and ranging in moisture content from dry to slightly damp. This surface is acceptable for treatment where no traffic or only occasional traffic is expected.

2-7.2 Loose and Wet or Slurry.

A surface condition consists of a cover, 0.25 to 2 inches (6 to 51 millimeters) thick, of unbound or uncompacted soil overlying a soft to firm subgrade and ranging in moisture content from wet to slurry consistency. Soil in this state cannot be treated until it is dried to the condition defined in either paragraph 2-7.1 or paragraph 2-7.3.

2-7.3 Firm and Dry or Slightly Damp.

The surface condition consists of a less than 0.25-inch (6-millimeter) -thick layer of loose soil, ranging in moisture content from dry to slightly damp, overlying a bound or compacted firm soil subgrade. This surface is acceptable for treatment for dust control regardless of the expected traffic.

2-7.4 Firm and Wet.

This surface condition is similar to that defined in paragraph 2-7.3 but has a wet surface. Soil in this condition cannot be treated until it is dried to the condition defined in paragraph 2-7.3.

2-8 CLIMATE.

2-8.1 Adverse Effects.

The climate in the area where dust control is desired could adversely affect the dust palliative(s) during storage (prior to placement), during placement (the construction and/or cure period), and after placement. The climate at the time of placement and after placement is considered when selecting a palliative. Agronomic methods are initiated at the onset of the growing season, which in some cases is limited to a few weeks.

2-8.2 Weather Extremes.

Weather extremes accelerate the aging and/or deterioration of most materials, and dust palliatives are no exception. Salts become ineffective during extended periods of no rainfall and when the relative humidity falls below 30 percent. Other palliatives (e.g., salts, polysaccharides) may leach from the soil during rain.

2-8.3 Freezing Effects.

Store, place, and permit liquid dust palliatives to cure at temperatures above 40 degrees Fahrenheit (4.4 degrees Celsius). Water-based palliatives (e.g., emulsions) are subject to freezing, which has detrimental effects on the physical properties, performance, and placement equipment. Some dust palliatives become brittle when exposed to extreme cold; therefore, do not traffic (if possible).

2-8.4 Storage of Liquids.

Storage of liquids may result in the settling of some components in the liquid. Mix concentrated liquid stabilizers by recirculating or mechanically stirring the material within the container. At temperatures above 90 degrees Fahrenheit (32.2 degrees Celsius), some bituminous products become tacky. Emulsions stored in containers in the sun can dry to a film in the headspace above the liquid. Once dried, the film does not re-disperse in the liquid. If the film dislodges into the liquid, it clogs spray nozzles, causing significant problems if proper filtering is not employed.

CHAPTER 3 DUST CONTROL METHODS

3-1 GENERAL.

This chapter describes three readily available types of dust control methods and the type of traffic areas where a dust palliative is applicable. Each dust control method is considered in relation to the specific job requirements. The dust control treatment methods commonly used are:

- Agronomic
- Topical application
- Admixtures

The agronomic method requires knowledge of the indigenous vegetation and access to farm-type equipment. Topical applications are the easiest to apply. Topical application requires a material placement procedure (i.e., spreading aggregate or geotextile over the area) or a material-spraying procedure. One of these two methods suffices for the majority of dust control cases. The admixture method requires standard road-building techniques using construction equipment. The agronomic and admixture methods are more complex and require more time and equipment to implement. These methods require specific handling, equipment, and procedures. When using any chemicals, adhere to the manufacturer's precautions for the use of personal protective equipment (e.g., masks, safety glasses, gloves) as required.

3-2 AGRONOMIC METHODS.

This method consists of establishing or extending and preserving vegetative cover, mulch, windbreaks, and rough tillage. It includes tasks such as seeding, sprigging, sodding, adding topsoil, fertilizing, mulching, and disking. Agronomic methods are not prescribed for traffic areas. Large areas are cleared for most construction projects, stripping the project area of the existing vegetation and all topsoil. Keep the extent of stripping to a minimum and the stripped topsoil with vegetative residue stockpiled for later use.

3-2.1 Vegetative Cover.

Vegetative cover is considered the most satisfactory form of dust palliative based on aesthetic aspects, durability, cost, and maintenance. This is the preferred method wherever it can be economically established and maintained. Areas of application are best limited to nontraffic areas. Where vegetative cover is to be ultimately established, select any dust palliative used for immediate surface protection with a view to minimize impairment to subsequent plant growth. While dense vegetation is certainly the most effective cover, more sparse native vegetation typical of semiarid and arid regions is a fully effective dust palliative under natural wind conditions so long as it is not damaged by traffic or other causes.

3-2.2 Mulch.

Use mulch only for non-aircraft applications due to the potential for damage to aircraft. A well-anchored mulch of vegetative material is used to stabilize soil against wind and water erosion in low- or non-traffic areas. Mulch refers to any substance, such as straw, hay, or other vegetative material, which is spread over the ground surface to protect it from the wind. Vegetative mulches are effective for one year and applied during any season.

Hydroseeds and hydromulches/fibrous mulches (blends of water, organic fibers, fertilizer, seed, and adhesive) are common and effective materials used for establishing vegetation. Bonded fiber matrix is a specialized method of hydroseeding that is hydraulically applied. A hydroseeder equipped with a spraying mechanism is used to place hydroseeds and hydromulches.

3-2.3 Windbreaks.

Any barrier of hedges, shrubs, or trees high and dense enough to protect facilities and unsurfaced soil areas is considered to be a windbreak. Windbreaks are placed at right angles to the direction of the prevailing wind. Several parallel windbreaks are required for high wind velocities; the higher the average wind velocity, the closer they are spaced. Their practical applicability solely for dust control is limited. Windbreaks supplement other dust control measures by reducing wind velocity. The use of windbreaks is recommended wherever they do not interfere with intended area activities.

3-2.4 Rough Tillage.

Chisels and turning plows are used to till strips across non-traffic areas that are sources of dust. Several strips are placed in parallel as an emergency measure to control dust in semiarid regions. Ensure the soil is cohesive enough to produce soil clods (lumps of earth with a minimum dimension of 1 inch [25 millimeters] measured in any direction). Strips are tilled at 25- to 100-foot (7.6- to 30.5-meter) intervals at right angles to the prevailing wind. As the strips become smooth through erosion, new strips are plowed adjacent to the earlier ones. The success of this method depends upon the formation of a cloddy, rough surface that breaks up the sweep of soil particles. Tillage of dry soil typical of desert areas is sometimes harmful rather than beneficial to dust control if a cloddy surface is not produced. Rough tillage is considered a temporary control measure to be followed by permanent vegetative cover, but it is sufficient as the only treatment if traffic is excluded from the area and the existing vegetation is capable of regeneration. Disk-type tillage tools are not used for rough tillage as they tend to pulverize the soil (i.e., soil clods are not formed). However, if long, narrow grooves are created, resulting in channelized runoff water, lay out the tillage on horizontal contours to prevent water damage.

3-3 TOPICAL APPLICATIONS.

3-3.1 Surface Penetration.

In the surface penetration method, a liquid dust palliative is applied directly on the soil surface by spraying or sprinkling and allowed to penetrate and/or seal the surface. This is the most common method of dust control due to the lower cost and ease of application compared to the admixture method. This method provides satisfactory—although temporary—dust abatement when significant penetration of the surface is achieved. However, if proper penetration is not achieved, a thin surface crust results, which is easily disturbed by traffic, allowing the underlying material to produce dust. Surface crusts are also more detrimental to aircraft than the dust itself, as larger particles and sheets of material become dislodged under airblast, presenting serious foreign object debris (FOD) potential. This is a concern in sandy and/or unprepared soils. A penetration depth of at least 1 inch (25 millimeters) is recommended for polymer emulsion products to minimize FOD potential. This recommendation is extended to all types of liquid dust palliatives applied topically.

Surface penetration applications are placed with a liquid pressure distributor, by a gravity-flow water distributor, or by hand-held devices. Position the spray apparatus 8 to 14 inches (203 to 355 millimeters) directly above the area being treated to preclude winddrift. Runoff is avoided by decreasing the application rate or applying the dust palliative at one-half the manufacturer's recommended rate and repeating the treatment before curing of the palliative begins.

3-3.1.1 Effectiveness.

The effectiveness of the surface penetration method depends on the depth of penetration, which is a function of the viscosity, surface tension of the liquid, and the permeability of the soil. This is a problem on compacted soils typical of most roads and airfields. Numerous products are designed with low viscosities, surfactants, and other surface-tension-reducing additives to improve penetration. For water-based palliatives, penetration is facilitated by lightly pre-wetting the surface with water before applying the dust palliative. This procedure reduces surface tension, which improves penetration and helps assure uniform coverage. Rapid-setting emulsions are particularly susceptible to forming surface crusts and are more suitable for the admixture method. Humectants require contact with air, having a relative humidity above 30 percent to absorb moisture into the soil; thus, they are well-suited for topical applications.

Surface penetrants require reapplication as they leach during rainfall, penetrate further into the soil over time, age, and wear from traffic. Reapplication rates vary between locations due to soil type, climate, rainfall, and traffic.

Surface penetration is well-suited for non-traffic areas and is temporarily effective for heavy or occasional traffic areas, provided the soil has adequate strength or has been conditioned for the stated use.

3-3.1.2 Types of Materials.

Types of materials used as surface penetrants:

- Humectants (calcium and magnesium salts, organic humectants)
- Petroleum products
- Polymer emulsions
- Synthetic fluids
- Plant resins (binders and natural oils)
- Biopolymers and polysaccharides

3-3.2 Surface Cover.

This method includes the use of aggregates, mats (i.e., AM-2 landing mat), or geotextiles (membranes or meshes) to create a surface cover or membrane for dust control. Geosynthetics/geotextiles and mats require extensive anchoring to be used around aircraft. Standard construction equipment is used effectively to place any of the systems applicable to the surface cover method.

In arid areas where most vegetative covers do not survive because of low rainfall, crushed or uncrushed gravel, slag, or tone aggregate (2 inches [51 millimeters] maximum size) is used as a dust palliative on nontraffic or occasional traffic areas. Aggregate is not recommended in close proximity to aircraft traffic because gravel particles can potentially be picked up and thrown by airblast, with possible damage to aircraft and ground personnel. Spread aggregate in a layer 2 inches (51 millimeters) thick and ensure it contains a minimum 80 percent by weight of particles retained on the 1.25-inch (32-millimeter) screen. Traffic over aggregate-covered areas presses the material into the soil and pulverizes the surface; therefore, this treatment is not recommended where channelized traffic is expected.

3-3.2.1 Effectiveness.

The surface cover method is applicable to nontraffic, occasional traffic, and heavy traffic areas, provided the soil has adequate strength or has been conditioned for the stated use. Aggregate and geotextiles are easy to place and withstand considerable rutting. Once a surface cover treatment is torn or otherwise compromised and the soil exposed, subsequent traffic or airblast increases the damage to the exposed soil. Begin repairs (maintenance) as soon as possible to protect the material in place and keep the dust controlled.

3-4 ADMIXTURE METHOD.

In the admixture method, the dust palliative is blended with the soil to produce a uniform mixture. This method takes more effort, time, and equipment than the penetration and surface cover methods; however, it also increases soil strength and improves performance of the additives. An admixture method is used when it is necessary to improve the soil and provide dust control. Emulsions and powdered additives are well-suited for the admixture method.

For in-place mixing, the surface soil is graded and loosened (if necessary) to a depth 1 to 2 inches (25 to 51 millimeters) greater than the design thickness of the treated layer. The dust palliative is added and blended with the loosened surface soil and the mixture is compacted. Powders may be spread by hand, by bag, or by a mechanical spreader; apply liquids with spray devices. The recommended mixing equipment includes rotary tillers and reclaimer-stabilizers. A grader, when used, is slow and inefficient at blending the additive with the soil. Ensure blending results in a uniform color of soil, both horizontally and vertically. Use compaction equipment and procedures for in-place mixing uses and soil-stabilization procedures (see UFC 3-250-11) for changing soil characteristics and soil strength used in road construction. For dust control on a nontraffic area, compaction is achieved by trafficking the entire surface with a 5-ton dual-wheel truck.

3-4.1 Depth of Treatment.

A minimum treatment of 3 inches (76 millimeters) is satisfactory for all nontraffic areas. To provide a dustproof surface in traffic areas, a minimum treatment depth of 4 inches (102 millimeters) is required. Mixing is accomplished in-place or offsite and is adaptable to a large variety of soil types. (The admixture method is not suitable for areas where a vegetative cover is to be established.)

3-4.2 Offsite Mixing.

Offsite mixing is used where in-place mixing is not desirable and/or soil from another source is needed to meet design requirements. Offsite mixing is accomplished with a stationary mixing plant or by windrow mixing with graders in a central working area. Processing the soil and dust palliative through a central plant produces a more uniform mixture than in-place mixing. The disadvantage in any offsite operation is having to transport and spread the mixed material.

3-4.3 Effectiveness.

The admixture method is effective for dust palliatives that provide increased soil strength, such as portland cement, asphalt and polymer emulsions, natural resins, and synthetic fluids (with binder).

3-4.4 Pertinent Areas.

The admixture method is applicable to nontraffic and occasional-traffic areas but is limited for traffic areas due to costs and manpower associated with construction.

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CHAPTER 4 DUST PALLIATIVES

4-1 GENERAL.

4-1.1 Dust Palliative Categories.

This section describes the different categories of chemical dust palliatives. The objective of a dust palliative is to prevent soil particles from becoming airborne. Dust palliatives are required for controlling dust on nontraffic or traffic areas, or both. For nontraffic areas, a palliative is needed that resists the maximum intensity of air impingement caused by weather or nearby aircraft. For traffic areas, ensure dust palliatives withstand the abrasion of wheels, tracks, or airblast. Although a dust palliative provides resistance against air impingement, it is unsuitable as a wearing surface. An important factor limiting the applicability of a dust palliative in traffic areas is the extent of surface rutting that occurs under traffic. Rutting occurs if the bearing capacity of the soil is such that the soil surface depresses or compacts as a result of vehicle traffic. The effectiveness of a dust palliative treatment is destroyed by rutting and abrasion and any remaining dust palliative is quickly stripped from the ground surface. Some palliatives tolerate deformations better than others, but ruts 1 inch (25 millimeters) or greater result in the destruction of any treatment method.

4-1.2 Hard or Soft Crust.

Dust palliatives either form a hard crust or soft crust on the soil surface. There are advantages and disadvantages to both types of crusts. Hard crust palliatives cause soil particles to form brittle physical bonds, which is stable, but apply the product so there is sufficient penetration (2 to 3 inches [51 to 76 millimeters]) to prevent punctures of the crust during traffic. A soft crust palliative coats the soil particles but does not create a brittle crust, which is advantageous in that punctures caused by traffic do not create loose pieces.

4-1.3 Waterproofing Soils.

Often, a dust palliative also functions to waterproof the soil. When this occurs, the dust palliative not only prevents dust but also helps preserve soil strength during wet weather conditions. Ensure dust palliatives are not harmful to existing vegetation and/or make it difficult to establish vegetation in treated areas.

4-1.4 Materials General Overview.

The descriptions of materials in this chapter are intended to provide an overview of the various categories of products commercially available. There are numerous manufacturers of dust palliatives and some products do not fall clearly into the listed category. The guidelines given for use in this UFC are general for that category. Follow manufacturers’ suggested guidance where there are differences.

4-2 DETAILED DUST PALLIATIVE DESCRIPTION.

4-2.1 Water.

Water sprinkled on the soil surface is a temporary measure for reducing dust. As long as the ground surface remains moist or damp, soil particles resist becoming airborne. Depending on the soil and climate, frequent treatment may be required. Do not apply water to clay soil surfaces in such quantity that puddles form, since a muddy or slippery surface results where the soil remains wet.

4-2.2 Chloride Salts.

Salts (sodium, calcium, and magnesium chloride) are used extensively as dust palliatives due to their low cost. These salts are purchased as a powder, pellet, flake, or water solution. They absorb moisture from the air (deliquescence) or from dew and rainfall (hygroscopic), holding it in the soil. Calcium and magnesium chlorides are used more frequently than sodium chloride and retain soil moisture when the relative humidity is 30 percent or greater. A secondary effect of chlorides is a weak cement action when dry due to crystallization. All chlorides are soluble in water and leach from the soil surface over time, depending on the soil permeability and amount of rainfall; thus, maintenance is eventually required. Continued applications of salt solutions ultimately build up a thin, crusted surface that is hard and free of dust. Do not use chloride salts near aircraft because they are highly corrosive to metal. Calcium chloride and magnesium chloride require relative humidity levels to be a minimum of 30 percent for adequate results. Sodium chloride requires humidity levels greater than 50 percent and is much less frequently used. Ensure the dust palliative selected and the quantity used meets manufacturer’s instructions and does not exceed local environmental protection regulations.

4-2.3 Petroleum Products.

4-2.3.1 Asphalt Emulsions.

Emulsified asphalts are a bituminous product used for dust control. Emulsified asphalts provide dust mitigation by binding surface particles and are used to treat both traffic and nontraffic areas. Bituminous materials impart waterproofing to the treated area that remains effective as long as the treatment remains intact but are sensitive to weather extremes. Do not place emulsions in the rain or when rain is expected.

Asphalt emulsions are a blend of asphalt, water, and an emulsifying agent, and are available either as anionic or cationic emulsions. Ambient temperature, relative humidity, and wind speed affect the rate at which emulsions cure. Do not place emulsions at temperatures below 50 degrees Fahrenheit (10 degrees Celsius). Heating emulsions reduces curing time. Never exceed the upper heating limit of 185 degrees Fahrenheit (85 degrees Celsius) because the asphalt and water separates (breaks), resulting in material damage. Under favorable ground temperature and weather conditions, emulsions are sufficiently cured in eight hours. The slow-setting (SS) anionic emulsions of grades SS-1 and SS-1h are diluted with one to five or more parts water to one part emulsified asphalt by volume prior to use. A three-parts-water-to-one-part-emulsion dilution meets most manufacturers’ recommendations. The cationic slow-setting (CSS) emulsions of grades CSS-1 and CSS-1h are used without dilution. If dilution is required, ensure the water used is free of any impurities, minerals, or salts that might cause separation (breaking) of the emulsion within the distribution equipment.

4-2.3.2 Cutback Asphalts.

Diesel fuel, cutback asphalts, motor oil, and road tars are rarely used due to environmental concerns; however, they may still be in use in some areas of the world that have not implemented strict environmental regulations and where asphalt emulsions are not available.

A cutback asphalt is a blend of an asphalt cement and a petroleum solvent. Cutbacks are classified as rapid curing (RC), medium curing (MC), and slow curing (SC), depending on the type of solvent used and its rate of evaporation. Each cutback is further graded by its viscosity. The RC and SC grades of 70 and 250, respectively, and MC grades of 30, 70, and 250, are generally used. Regardless of classification or grade, the best results are obtained by preheating the cutback. Spraying temperatures range from 120 degrees to 300 degrees Fahrenheit (48.9 to 148.9 degrees Celsius). The actual range for a particular cutback is much narrower; therefore, request the actual range from the supplier at the time of purchase. The user is cautioned that some cutbacks are heated above their flash point for spraying purposes so no smoking or open flames is permitted during application or cure. MC-30 grade is sprayed without being heated if the temperature of the asphalt is 80 degrees Fahrenheit (26.7 degrees Celsius) or above. A moist soil surface assists penetration. Curing time for cutbacks varies with the type. Under favorable ground temperature and weather conditions, RC cures in one hour, MC in three to six hours, and SC in one to three days. In selecting the material for use, consider local environmental protection regulations.

4-2.4 Lignins.

Lignin and lignin derivatives are byproducts of the manufacture of wood pulp. They provide dust control by physically binding soil particles. They are soluble in water and therefore readily penetrate soils. Do not use gray or salt water for dilution. Its solubility also makes it susceptible to leaching from the soil; thus, application is repeated as necessary after rainfall.

4-2.5 Polymer.

Polymer emulsions are excellent products for soil stabilization and dust control. These materials have good adhesive characteristics and provide stiffness, toughness, and water resistance. Do not mix polymer emulsions with gray or salt water for dilution. Soils stabilized with polymer emulsions are similar to those that can be stabilized by bitumen.

Polymer emulsions used for dust control are generally vinyl acetate or acrylic-based copolymers suspended in water by surfactants. They consist of 40 to 60 percent solid particles by weight of emulsion. Once they are applied, the polymer particles begin to coalesce as the water evaporates from the system, leaving a soil-polymer matrix that prevents small dust particles from escaping the surface. The polymers used for dust control typically have excellent tensile and flexural strength, adhesion to soil particles, and resistance to water. Immediately rinse equipment used to apply polymers to prevent damage. Polymer products are limited by a short shelf life (less than two years). Due to some vendors diluting polymer emulsion products in the past, it is recommended that random samples of the bulk product be tested to ensure the bulk product includes at least 40 percent solids according to ASTM D2834.

Polymer products can also be purchased in the form of a water-soluble powder. The polymer undergoes a chemical reaction upon curing and forms a water-resistant film that binds soil grains.

4-2.6 Synthetic Fluids.

Synthetic fluids are hydrocarbon-based liquids that are clear, odorless, non-corrosive, and applied without water dilution. The fluids act by agglomerating soil particles. They are non-curing, re-workable, and are regraded and re-compacted if the road or airfield surface needs smoothing. They are applied with standard spray equipment at a wide range of temperatures, even well below freezing. The re-workable binder is ready for immediate use upon application and maintains effectiveness for several months, depending on traffic level and surface conditions at time of placement. Because synthetic fluids do not harden, they are recommended for expedient helipads due to their minimal curing time and low probability of FOD generation.

4-2.7 Polysaccharides.

Polysaccharides are solutions or suspensions of sugars, starches, and surfactants in water. They may be diluted with water, depending on the intended use. Polysaccharides provide dust abatement by encapsulating soil grains and providing a binding network in the ground. Many polysaccharides are humectant (absorb water from the air) and hygroscopic (hold water after wetting); therefore, they are best used in climates with average relative humidity above 30 percent and with occasional rainfall. They are considered to be biodegradable materials and may leach from the soil with exposure to precipitation.

4-2.8 Cementing Materials.

Cementing type powders (portland cement, hydrated lime, and fly ash) are primarily used to improve the strength of soils (see UFC 3-250-11); however, when they are mixed with soils in relatively small quantities (2 to 5 percent by dry soil weight), the modified soil becomes more resistant to dusting. Portland cement is generally suited for all soil types, provided uniform mixing is achieved, whereas hydrated lime is better suited for soils containing a high percentage of clay. Fly ash may be used in combination with either portland cement or lime. Keep the compacted soil surface moist for a minimum of seven days prior to traffic.

4-2.9 Polyacrylamides.

Polyacrylamides are water-soluble polymers that provide dust control through moisture retention. These materials are used as super-absorbents in baby diapers, chemical spill containment, and other applications. They are generally applied in powder or granular form because polyacrylamides cause very large increases in viscosity when dissolved in water. The solution has the consistency of mayonnaise and is difficult to apply to soil.

Polyacrylamides swell when they come in contact with water and may cause volume changes in the soil. For this reason, they are not recommended for use on roads.

4-2.10 Alternative Materials.

New commercial off-the-shelf products are continually introduced to the market. Some examples of different products are blends including glycerin, vegetable oils, surfactants, or other polymers. Test sections for new products are always recommended before using the products. The glycerin blend and vegetable oil products do not harden on the surface and provide dust control when FOD is of concern.

4-2.11 Vendor Summary and Selection.

4-2.11.1 Potential Vendors.

A list of potential vendors is summarized in Appendix B-2, Table B-1.

4-2.11.2 Logical Considerations.

Make logical considerations, such as duration of effectiveness, equipment required, shipping, storage, and shelf life, when determining which chemicals to use for dust control. In cases where water is not available, either use products that do not require dilution or water should be shipped. Salts cause corrosion to vehicles, which is a reason to select a different, possibly more expensive, product.

4-2.11.3 Emulsified Products.

Emulsified products have limited shelf lives. They consist of finely dispersed hydrophobic particles suspended in water. This dispersion is relatively unstable and results in the settling of solid particles. Normal mixing procedures do not allow these particles to go back into solution, and the product will not perform as designed. Keep emulsions from extreme heat, ultraviolet light, and freezing temperatures. Chloride salts, powdered polymers, and synthetic fluids do not have limitations on shelf life.

4-2.11.4 Choosing a Dust Palliative.

Choosing a dust palliative is ultimately governed by the existing need for dust control. Some products work better for helipads, while others are more effective on roads or airfields. Use soft crust palliatives on helipads to prevent FOD generation. Consider each type of palliative’s benefits and limitations before selecting a product.

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CHAPTER 5 DUST PALLIATIVE APPLICATION

5-1 GENERAL APPLICATION INFORMATION.

The following section describes the primary considerations and methods for applying the recommended dust palliatives.

5-1.1 Soil Type.

The soil type affects the performance of dust palliatives. Fine-grained soils present a larger problem with dust generation and are more difficult to control. These soils require greater quantities of product to treat. Penetration is also hindered by the small pore sizes between soil grains. Multiple applications are required to treat fine-grained soils (silts and clays) to prevent ponding or surface runoff. Coarse-grained soils (sands and gravels) have higher infiltration rates to minimize ponding or runoff. Soil type is classified according to ASTM D2487.

5-1.2 Application Equipment.

Select application equipment based upon the types available and the application method. Projects occurring on or near military installations are more likely to have a broader range of choices for equipment types. Expeditionary missions in active theaters preclude the use of many types of machinery. The ultimate goal is to use equipment that allows the most efficient progress for placing dust palliatives. Larger areas need dispersion systems with large capacities. Liquid discharge is usually not the most time-consuming process. A hydroseeder can be used to spray over 100 gallons per minute. Other systems using a distribution bar spray around 50 gallons per minute. The time required to empty any tank at this rate is relatively small. The process dominating the construction time (for topical applications) is transporting and filling the equipment. For large jobs, it is important to use methods that reduce these steps. For treating small areas, time may not be as critical of a factor.

Rinse all equipment with water after transferring dust palliatives. Additionally, it is important to flush all distribution systems with water after applying dust palliatives. Film-forming products (polymers, lignosulfonates) coagulate within the distribution system and clog equipment. Cleaning the equipment after this occurs typically requires significant disassembly. Organic solvents may also be required to completely remove remaining polymer. It is important to rinse equipment after spraying chloride salts because of their tendency to corrode metal and initiate rust formation. Rinsing may be optional when using synthetic fluids for dust control. They tend to lubricate equipment and have not been found to generate problems. Cleaning is necessary if other types of liquids are to be placed in the equipment for other purposes.

5-1.3 Application Rates.

Choose application rates according to the soil type, the intended use of the treated area, and the necessary duration of use. Target a penetration depth of 1 inch (25 millimeters) for most applications where subjected to traffic. Dust palliatives applied to areas subjected to traffic are applied at a rate of 0.8 to 1.2 gallons per square yard (3.6 to 5.4 liters per square meter) and a lower rate used for nontraffic areas. Synthetic fluids are applied at lower rates because they contain 100 percent active ingredients. Polymeric emulsions require application rates of greater than 1 gallon per square yard (4.5 liters per square meter) in areas of heavy traffic or for helipads. For example, using polymer emulsions on helipads requires an application rate of 1.2 gallons per square yard (5.4 liters per square meter) to produce thicker surface crusts to reduce FOD potential. Note that higher application rates are required if the polymer emulsions/polysaccharides are pre-diluted by the vendor as evidenced by less than 40 percent solids as measured according to ASTM D2834. Trial and error is necessary to achieve proper application rates.

Reapplication of dust palliatives is necessary as product effectiveness diminishes over time. Areas treated with chloride salts or synthetic fluids are rejuvenated by applying more palliative at half the original application rate. Troublesome areas or exposed, untreated soils require site preparatory work before spraying. Existing polymer film, if left undisturbed, typically repels the emulsion and prevents penetration of additional product.

5-1.4 Dilution Ratios.

Some products require dilution with water. These are typically any emulsified products (asphalt and polymer). Diluting the emulsion reduces the viscosity and improves penetration. In general, three parts water is added for each part product. Note that the recommended dilution ratio needs to be reduced if the palliatives have been pre-diluted by the vendor to less than 40 percent solids as measured according to ASTM D2834.

5-1.5 Topical Method.

Topical applications are the most commonly used technique for dust control. Spraying the surface of the soil with a dust palliative temporarily solves most dust problems. Alternative methods are used when the area to be treated is structurally deficient for the anticipated traffic or when greater durability is needed. Do not apply hard crust palliatives topically where heavy traffic is expected; soft crust palliatives can be applied topically on roads with sufficient bearing capacity. Topical applications are accomplished by spraying the dust palliative onto the native or prepared soil surface. It is imperative to maintain uniformity while dispersing the liquid. Application quantities are determined by estimating the area of ground surface to be treated and multiplying that area by the manufacturer’s recommended application rate.

5-1.6 Admixture Method.

Admixture methods are designed to incorporate dust palliatives deeper into the soil and to provide longer-lasting dust abatement. These methods are usually necessary when heavy repetitive loading is introduced to the soil. Roads and airfields (runways, taxiways, or parking aprons) generally require admixture applications to achieve the desired results. Admixture depths for roads are typically a minimum of 3 inches (76 millimeters). The spray/till/compact/spray procedure (Figures 5-1 through 5-4) is recommended for incorporating the dust palliative into the soil.

1. Grade the soil using a motor grader (Figure 5-1).

2. Spray half of the total palliative application rate onto the soil surface.
3. Blend into top 3 inches (76 millimeters) of soil using a rotary mixer (Figure 5-2).
4. Compact using a steel-wheeled vibratory compactor until no significant change in density of the road surface is observed (Figure 5-3).
5. Spray remaining product onto compacted surface (Figure 5-4).

This method provides optimal performance of most palliatives; however, for more in-depth details and information on soil stabilization, consult UFC 3-250-11. Note that some palliatives do not provide any strength increase and may decrease the bearing capacity of the soil, which is important for airfield dust control.

Figure 5-1 Grading Road Surface Prior to Treatment

Figure 5-2 Applying Product with Hydroseeder and Mixing into Road Surface with Rotary Mixer

Figure 5-3 Compacting Road Surface After Mixing

Figure 5-4 Applying Final Spray to Seal Road Surface After Compaction

5-2 DISTRIBUTION EQUIPMENT.

A variety of distribution equipment is used to spray apply the palliatives. Appendix B, Table B-2, lists some manufacturers of spray equipment used for placing a variety of dust palliatives.

5-3 DETAILED APPLICATION GUIDANCE.

This section provides detailed guidance for treating helipads, roads, base camps, and fixed-wing airfield facilities.

5-3.1 Dust Abatement on Helipads.

This paragraph provides guidance for mitigating dust on unsurfaced helipads. A 150-foot by 150-foot (45.7-meter by 45.7-meter) helipad size is recommended for cargo helicopters, and a 100-foot by 100-foot (30.5-meter by 30.5-meter) helipad size is recommended for utility and attack helicopters. The equipment requirements may be modified, depending upon availability and mission requirements. Synthetic fluid is used as an example for the following procedures; however, the general types of equipment and process are similar for other liquid dust palliatives.

5-3.1.1 For dust abatement on helipads, provide and use the following:

- Motor grader for initial grading
- Vehicle(s) to haul the chemical totes, pumps, etc., and tow the distribution equipment

- Hydroseeder or other spray distribution system compatible with the selected chemical
- Dust palliative (synthetic fluid), typically in 275-gallon (1041-liter) totes (two to four required)
- Centrifugal pump and hoses with quick-connect ends to transfer the material from the tote to the distributor if the distributor does not include a pump
- Personnel (three)

5-3.1.2 The following steps will treat an expedient helipad:

1. Survey and visibly establish the area to be treated.
2. Place the synthetic fluid into the hydroseeder/distributor (Figure 5-5).
    - 450 gallons (1703.4 liters) for 100-foot by 100-foot (30.5-meter by 30.5-meter) helipad for smaller rotary-wing aircraft
    - 1000 gallons (3785.4 liters) for 150-foot by 150-foot (45.7-meter by 45.7-meter) helipad for larger rotary-wing aircraft
    - Quantities will be larger for treating with a polymer emulsion as an alternative solution; follow manufacturer’s dilution/application guidance
3. Position the hydroseeder/distributor on the edge of the helipad.
4. Use the tower gun and a long-distance nozzle to spray half of the product on half of the helipad. A hose attachment may also be used (Figure 5-6).
5. Move to the opposite side of the helipad and spray the remaining product.
6. If the distributor does not have standoff spray capability, it may be necessary to traverse the helipad ensuring spray overlap. **Note:** If the helipad ruts significantly under the distributor, smooth and re-treat the ruts by a hand wand to keep the ruts from acting as erosion focal points during aircraft operations.
7. Helicopters can land immediately on areas treated with synthetic fluids; however, best results occur after 24 hours (Figure 5-7). If a polymer emulsion is used as the alternative solution, allow the material to cure for a minimum of 24 hours prior to allowing traffic on the helipad.

Figure 5-5 Filling Hydroseeder from Material Tote

Figure 5-6 Topical Application from Hydroseeder Tower Gun (Top) or Hose (Bottom)

Figure 5-7 UH-1 Rotary-Wing Aircraft Operating on Treated Helipad

5-3.2 Dust Abatement on Roads.

5-3.2.1 Topical Application or Admixture Methods.

Complete dust abatement on roads using a topical application or admixture methods. Performing only a topical application provides dust abatement on aggregate roads with a high load-bearing capacity; however, when applying dust palliatives to unimproved roads, topical applications may not allow for manufacturer-recommended penetration. Thin surface crusts are prone to disintegration with increased traffic, allowing the underlying material to produce dust. Using a rotary mixer or soil stabilizer to incorporate dust palliatives into the soil is recommended. It is not necessary that the road be tilled prior to spraying the product. As long as runoff of the product does not occur, mixing can be performed after spraying onto the existing road surface to minimize construction efforts. Disturb the surface if the product does not readily soak into the road or if working on an inclined or crowned surface.

5-3.2.2 Equipment.

Modify the equipment requirements, depending upon availability and mission requirements. Polymer emulsion is used for the following example at a 3:1 water/emulsion mixing ratio. However, the types of equipment and process are similar for other types of liquid palliatives.

5-3.2.3 Supplies.

Provide and use the following:

- Motor grader for initial grading

- Vehicle(s) to haul the chemical totes, pumps, etc., and tow the distribution equipment
- Hydroseeder or other chemical distributor compatible with products
- Polymer emulsion mixed with water in appropriate amounts
- Rotary mixer
- Steel-wheeled vibratory compactor
- Personnel (three)

5-3.2.4 Application Procedures.

The application procedures using a diluted polymer emulsion are as follows:

1. Determine the length of road that can be treated per tank (hydroseeder/distributor capacity):

$$length\ (yd) = \frac{tank\ capacity\ (gal)}{[application\ rate\ (gsy) \times road\ width\ (yd)]}$$

$$length\ (m) = \frac{tank\ capacity\ (liter)}{[application\ rate\ (lsm) \times road\ width\ (m)]}$$

2. Place 675 gallons (2555 liters) of water into hydroseeder/distributor (minimum 900-gallon [3406-liter] capacity). For smaller distribution equipment, compute quantities to match the manufacturer recommended dilution ratio.
3. Add 225 gallons (852 liters) of polymer emulsion.
4. Mix for five minutes, using mechanical agitation.
5. Apply to the road surface for the determined length using a distribution bar or wide fan nozzle on the tower gun.
6. Immediately till the road surface to a 3-inch (76-millimeter) depth, using a rotary mixer (Figure 5-2).
7. Grade the road to establish grade requirements and correct distresses.
8. Compact the soil until the desired density is achieved (Figure 5-3).
9. Repeat steps 2 through 8, as needed.
10. Spray a light application (0.2 gallon per square yard [0.9 liter per square meter]) over the compacted road surface (Figure 5-4).
11. Repeat steps 1 through 10 for subsequent road lengths to be treated.

5-3.3 Dust Abatement in Base Camps and Other Non-Traffic Areas.

5-3.3.1 This paragraph provides guidance for mitigating dust in general base camp areas and other non-traffic areas. The topical application method is recommended. This method is less robust but cost-effective since the surface is subjected to lower loading requirements; thus, do not use this guidance for areas directly exposed to vehicle traffic. Synthetic fluid is used as an example for the following procedures. Modify the equipment requirements, depending upon availability and mission requirements.

5-3.3.2 Provide and use the following:

- Vehicle(s) to haul the chemical totes, pumps, etc., and tow the distribution equipment
- Hydroseeder or other chemical distributor compatible with products
- Dust palliative (synthetic fluid*)
- Personnel (three)

* Calculate quantities based upon recommended application rate of 0.4 gallon per square yard (1.8 liters per square meter) and the area to be treated.

5-3.3.3 The application procedures are as follows:

1. Determine the area of road that can be treated per tank (hydroseeder/distributor capacity):

$$area\ (yd^2) = \frac{product\ (gal)}{application\ rate\ (gsy)}$$

$$area\ (m^2) = \frac{product\ (liter)}{application\ rate\ (lsm)}$$

2. Fill the distribution equipment with synthetic fluid.
3. Apply to the road surface using a distribution bar, wide fan nozzle on tower gun, or hand wand/hose.
4. Repeat steps 1 through 3, as needed.

5-3.4 Dust Abatement Around Fixed-Wing Airfields.

5-3.4.1 Safety.

Due to safety concerns associated with surface friction requirements, dust palliatives are not recommended for use on any primary operating surface of the airfield. These areas are treated as a soil stabilization issue. Additionally, since the shoulders of unsurfaced airfields are designed to support occasional aircraft loading, it is also not recommended that the products be used on the shoulders of unsurfaced airfields; thus, the use of chemical dust palliatives is limited to the graded areas of unsurfaced airfields. For paved airfields, dust palliatives are used on any unpaved area around the perimeter of the pavement, including unpaved shoulders and graded areas. Due to potential FOD concerns, use synthetic fluids for this application. If a polymer emulsion or hard crust palliative is used, mix the material into the soil to minimize FOD potential. Polymer emulsions or other crust-forming stabilization additives cannot be topically applied around fixed-wing airfields due to the potential to form thin crusts capable of generating

FOD. Modify the equipment requirements, depending upon availability and mission requirements; however, the types of equipment and process are similar to the previous section on dust abatement in base camps and other non-traffic areas.

5-3.4.2 Size Consideration.

Consider the size of the area to be treated around fixed facilities. The width of treatment along the perimeter is not an issue; however, the length of treatment for airfields can range from 1 to 3 miles (1.6 to 4.8 kilometers) per side of the runway. The resulting treatment area accumulates quickly. An analysis of the propeller/jet airblast was performed for the C-130 and C-17, respectively, to develop recommendations for the width of the treated area. The minimum treatment width is based upon the wingspan of the aircraft and the highest intensity plume, while the optimum treatment width is based upon the distance required to reduce the exhaust plume to a maximum velocity of 50 feet per second (15.2 meters per second) or 35 miles per hour (56 kilometers per hour). The treatment widths along each side of the runway and around any turnarounds or aprons are:

- C-130 minimum treatment width: 27 feet (8.2 meters)
- C-130 optimum treatment width: 50 feet (15.2 meters)
- C-17 minimum treatment width: 50 feet (15.2 meters)
- C-17 optimum treatment width: 100 feet (30.5 meters)

For unsurfaced fixed-wing facilities, begin the treatment at the edge of the shoulder and apply outward into the graded area and transition area. For paved fixed-wing facilities, begin the treatment at the edge of the paved surface and extend outward to the recommended width.

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CHAPTER 6 ECONOMICS

6-1 GENERAL.

Dust control is based on many factors and methods. More than one dust palliative is found to meet the needs for the method selected. Consider economics to determine the dust palliative selected for use.

6-2 ECONOMIC FACTORS.

Economic factors include, but are not limited to, the following items:

- Initial cost of the dust palliative(s) at site
- Equipment and labor costs (by method if applicable)
- Maintenance costs (see paragraph 6-2.3.4)
- Material storage costs (if applicable)
- Shipping costs
- Equipment acquisition/modification costs
- Area preparation (clearing and grubbing is expected at all sites)

6-2.2 Initial Cost.

The initial cost of the dust palliative is typically not the governing factor in making the selection. Consider any suitable dust palliative already on hand, especially when placement equipment is available.

6-2.3 Equipment and Labor Costs.

6-2.3.1 Agronomic Method.

Costs associated with this method closely parallel the local turf seeding or landscape planting operational costs in the area where dust control is desired (UFGS 32 05 33). Landscape contractors or similar firms are a source to provide rough estimates for planning purposes.

6-2.3.2 Surface Penetrant and Surface Cover.

Both of these methods recommend some spray-on dust palliatives, which are placed with an asphalt distributor or hydroseeder. Aggregate and membrane costs are taken from the supplier(s) near the area where dust control is planned. Labor costs associated with these two methods vary according to method type.

6-2.3.3 Admixture Method*.*

This method is probably the most expensive method described but is the most effective long-term. It requires equipment and manpower similar to that associated with soil stabilization techniques. The admixture method requires a rotary tiller mixer or reclaimer/stabilizer mixer to blend the admixture into the soil and other equipment used for pavement construction (e.g., motor grader, compactor). The material cost; cement, lime, or bituminous material is determined from the local supplier(s) nearest the area where dust control is desired (see UFC 3-250-11).

6-2.3.4 Maintenance.

No dust control method or dust palliative provides a maintenance-free solution. When frequent maintenance is required, order enough material for initial application plus an equal amount for 12 months' maintenance. In the case of trafficked areas, maintenance is minimized by prohibiting quick stops and sharp turns for all using vehicles and limiting traffic to essential vehicles only. Tanks and other tracked vehicles will obliterate most dust control methods employed.

6-2.3.5 Material Storage Costs.

Consult the manufacturer prior to purchase for storage information/requirements. Provide theft-proof storage for all dust palliatives until they are applied. Protect the liquid dust palliatives from freezing temperatures. Powders such as lime and cement are typically stored in a dry place with low humidity.

6-2.3.6 Shipping Costs.

Shipping or transportation costs are incurred directly or indirectly with all dust palliatives.

6-2.3.7 Area Preparation.

Most sites require some preparation. As a minimum, remove all large rocks (> 6 inches [152 millimeters]) and all large sticks and stumps.

6-3 FINAL SELECTION.

Some of the economic factors outlined in paragraph 6-2 are difficult to determine with certainty, especially where placement crews have no prior experience with dust palliative placement or the expected traffic use is not known; however, by considering these factors the final selection of a dust palliative is reasonably made.

APPENDIX A REFERENCES

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FHWA-CFL/TD-13-001, *Unpaved Road Dust Management - A Successful Practitioner's Handbook*, https://www.fhwa.dot.gov/innovativeprograms/pdfs/centers/local_aid/UnpavedRoadDustManagementASuccessfulPractitionersHandbook.pdf

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https://www.astm.org/

ASTM E11, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*

ASTM D2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

ASTM D2834, *Standard Test Method for Nonvolatile Matter (Total Solids) in Water-Emulsion Floor Polishes, Solvent-Based Floor Polishes, and Polymer-Emulsion Floor Polishes*

APPENDIX B BEST PRACTICES

B-1 CONTROL OF WINDBORNE SAND.

B-1.1 Introduction.

Many factors, including low rainfall, high evaporation, sparse vegetation, and seasonal winds, contribute to rock weathering and sand movement. Methods for controlling sand movement have met with varying degrees of success. This section summarizes the latest available information on windborne sand control and lists recommended methods for sand movement stoppage and diversion. Marine and river sand movement control are not discussed.

B-1.2 Wind, Wind Direction, Crosswind.

Wind is defined as any natural movement of air, whether of high or low velocity, or great or little force. Most regions have a predominant wind direction, some section of the compass from which the wind blows most often and with the greatest velocity. Crosswinds are winds directed at some angle to the predominant wind direction.

B-1.3 Forms of Dunes.

A dune is defined as a mound or ridge of windblown material, usually sand, formed in arid regions. Local conditions under which dunes are developed vary widely and, consequently, there is a broad range in their shape and size. The shape may assume almost any configuration and the size may vary from an insignificant lone sand pebble to mounds higher than 100 feet (30.5 meters). Some coastal dune formations have reached 1000 feet (304.8 meters) in height. The three general types of sand dunes are described below; only the third type (moving sand dunes) requires control.

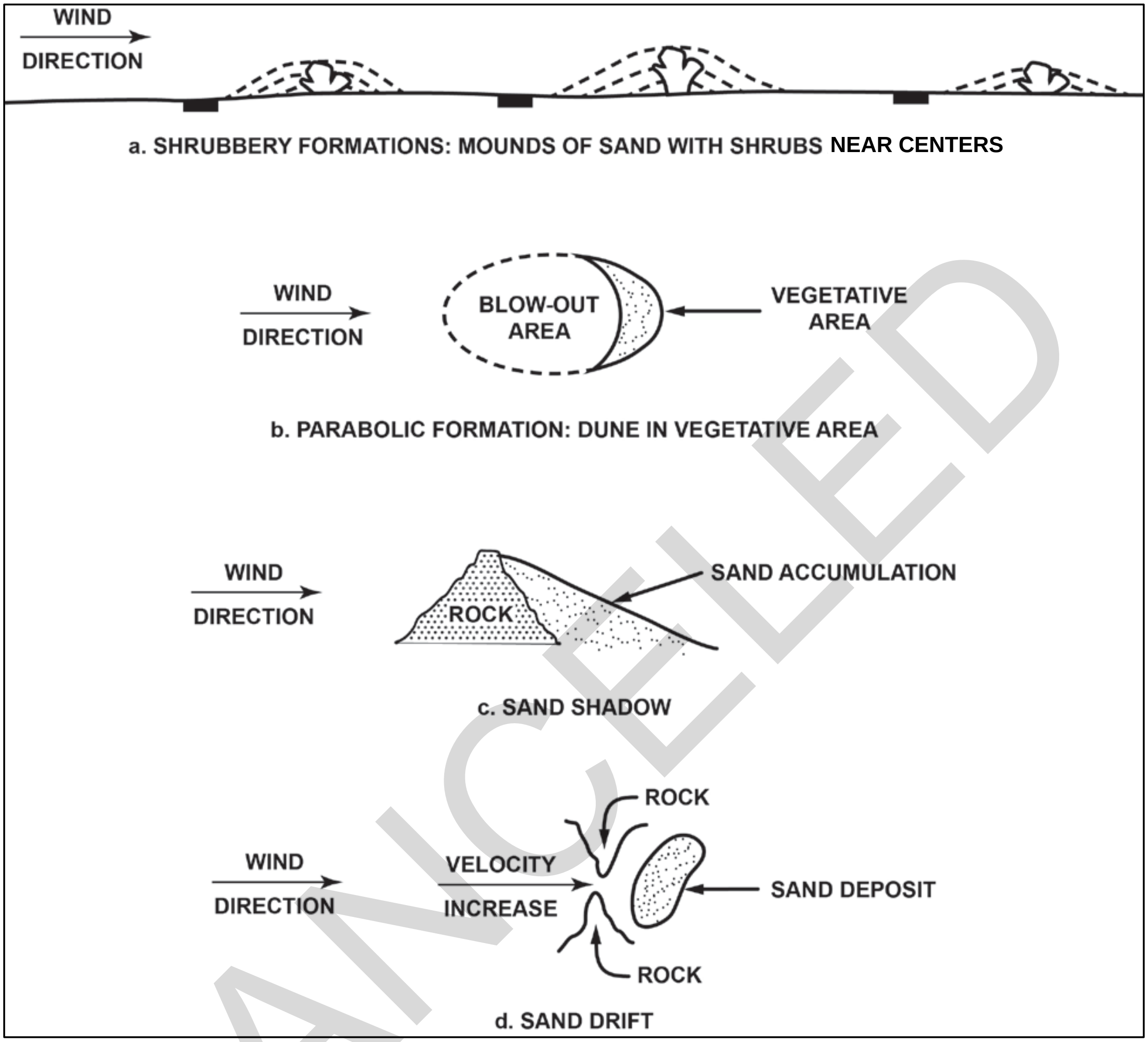
B-1.3.1 Sand Sheets.

These sheets occur in a generally flat, barren area with a predominant wind direction. They present no control problems because the sand does not accumulate.

B-1.3.2 Fixed Sand Dunes.

These dunes result from the accumulation of sand particles adjacent to fixed obstructions such as hills, cliffs, shrubs, and buildings. Fixed sand dunes may range in size from an accumulation around small shrubbery to sand shadows more than 50 feet (15.2 meters) deep. Because the fixed sand dune is immobile, it typically does not present a control problem. Figure B-1 shows types of fixed sand dune formations.

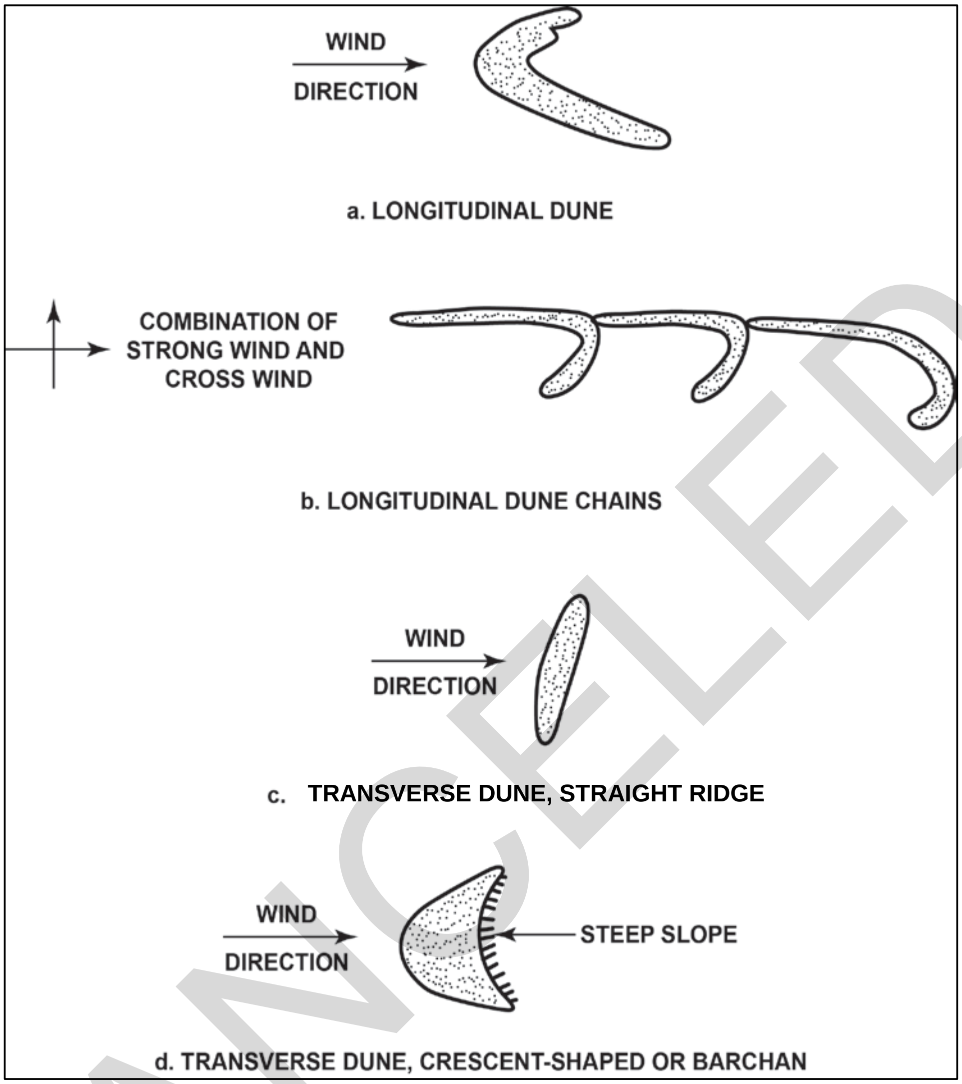
Figure B-1 Types of Fixed Sand Dunes



B-1.3.3 Moving Sand Dunes.

This type of sand mass exists independent of fixed surface features and may move from place to place, maintaining its initial form. Moving sand dunes are common in vast areas of sand with little or no vegetation. The control methods described below are applicable for this type of dune. With relation to predominant winds, moving sand dunes are classified either as longitudinal or transverse (Figure B-2). Longitudinal dunes are distinct ridges elongated in the direction of the predominant wind. A combination of predominant winds and crosswinds will produce a regular succession of dunes (longitudinal dune chains). Transverse dunes are formed by winds of steady direction blowing across an extensive source of loose sand, such as a sandy beach, and building ridges transverse to the wind direction. Low-velocity winds form straight parallel ridges and stronger winds form the more typical crescent-shaped or barchan transverse dune.

Figure B-2 Types of Moving Sand Dunes



B-1.4 Migration of Dunes.

After a dune is formed, the predominant wind may blow sand over the crest to the leeward slope. By this migration of particles, the dune then moves forward at a rate depending on wind velocity, topography, size of dune, and other factors. For example, along the Bay of Biscay on the west coast of France, dunes travel at rates up to more than 100 feet (30.5 meters) per year.

B-1.5 Sand Control.

There are many methods of sand control, with certain advantages and disadvantages in each method. The methods described below for the stabilization and/or destruction of windborne sand dunes are the most effective. These methods may be used alone or in combination.

B-1.5.1 Fencing.

This method of control employs flexible, portable, inexpensive fences to destroy the symmetry of a dune formation. The fence need not be a solid surface and may even have 50 percent openings, as in snow fencing. Any material such as wood slats, slender poles, stalks, or perforated plastic sheets bound together in any manner and attached to vertical or horizontal supports will be adequate. Rolled bundles that can be transported easily are practical. Prefabricated fencing is desirable because it can be erected quickly and economically. Because the wind tends to underscour and undermine the base of any obstacle in its flow path, the fence should be installed 1 foot (0.3 meter) above ground level. To maintain the effectiveness of the fencing system, a second fence should be installed on top of the first fence on the crest of the sand accumulation. The entire windward surface of the dune should be stabilized with dust-control materials, such as bituminous material, prior to erecting the first fence. The old fences should not be removed during or after the addition of new fences. Figure B-3 shows a cross-section of a stabilized dune with porous fencing. As long as the fences are in place, the sand will remain trapped. If the fences are removed, the sand will soon move downwind, forming an advancing dune. The proper spacing and number of fences required to protect a specific area can only be determined by trial and observation. Figure B-4 illustrates a three-fence method of control. If the supply of new sand to the dune is eliminated, migration is accelerated and dune volume decreases. As the dune migrates, it may move great distances downwind before it completely dissipates. An upwind fence may be installed to cut off new sand supply if the object to be protected is far downwind of the dune. This distance usually should be at least four times the width of the dune.

Figure B-3 Cross-Section of Dune Showing Initial and Subsequent Fences

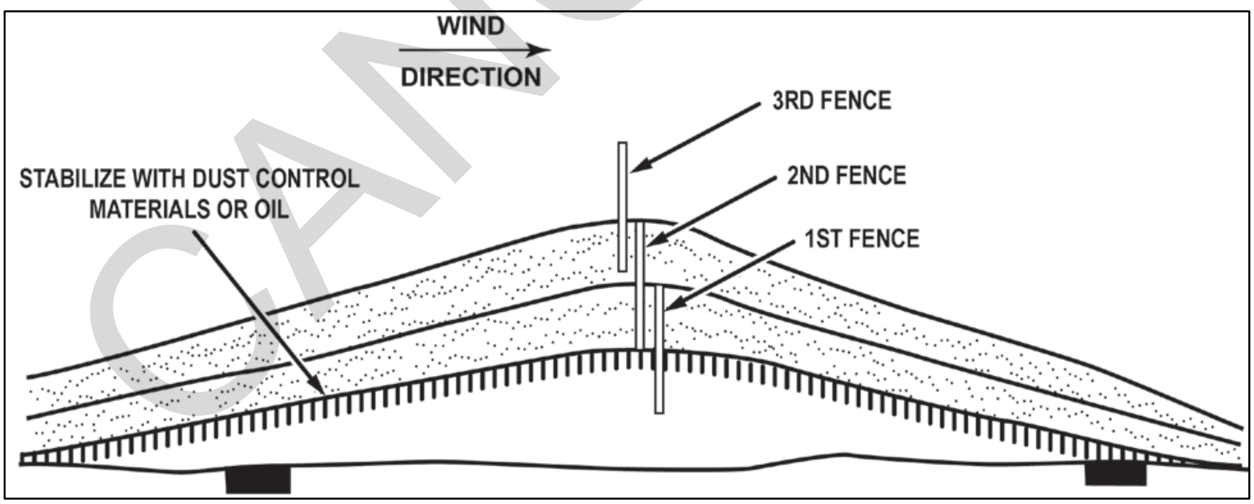
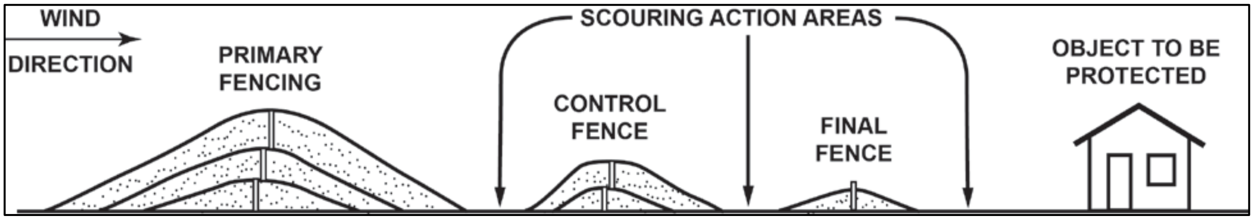


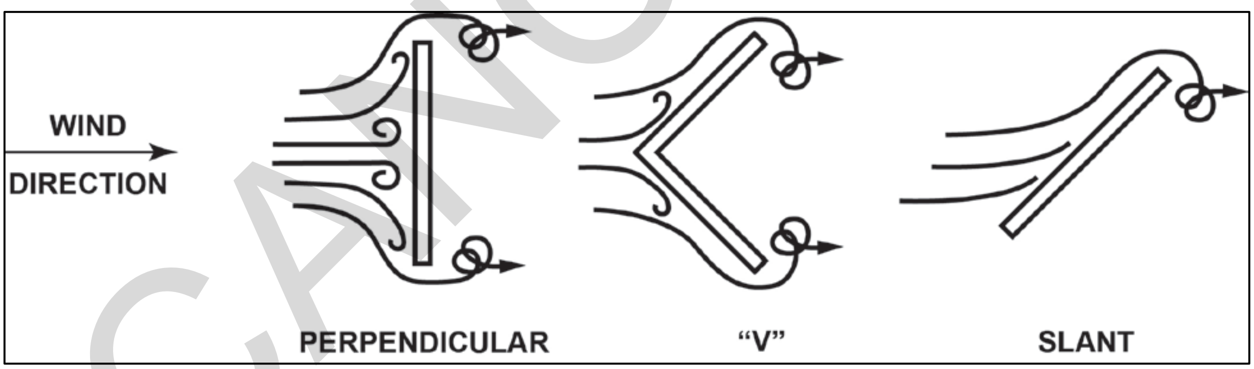
Figure B-4 Three Fences Installed to Control Dune Formation



B-1.5.2 Paneling.

Solid barrier fences of metal, wood, plastic, or masonry can be used to stop or divert sand movement. To stop sand, the barriers should be constructed perpendicular to the wind direction. To divert sand, the panels should be placed obliquely or nearly parallel to the wind. They may be single slant or “V” in pattern (Figure B-5). When first erected, paneling appears to give excellent protection; however, panels are not self-cleaning. Promptly remove the initial accumulations by mechanical means. If the accumulation is not removed, sand will begin to flow over and around the barrier and soon submerge the object to be protected. Mechanical removal is costly and endless. This method of control is unsatisfactory because of inefficiency and expense and should be employed only in conjunction with a more permanent control, such as planting, fencing, or using dust palliatives. Equally good protection at less cost is achieved by the fencing method.

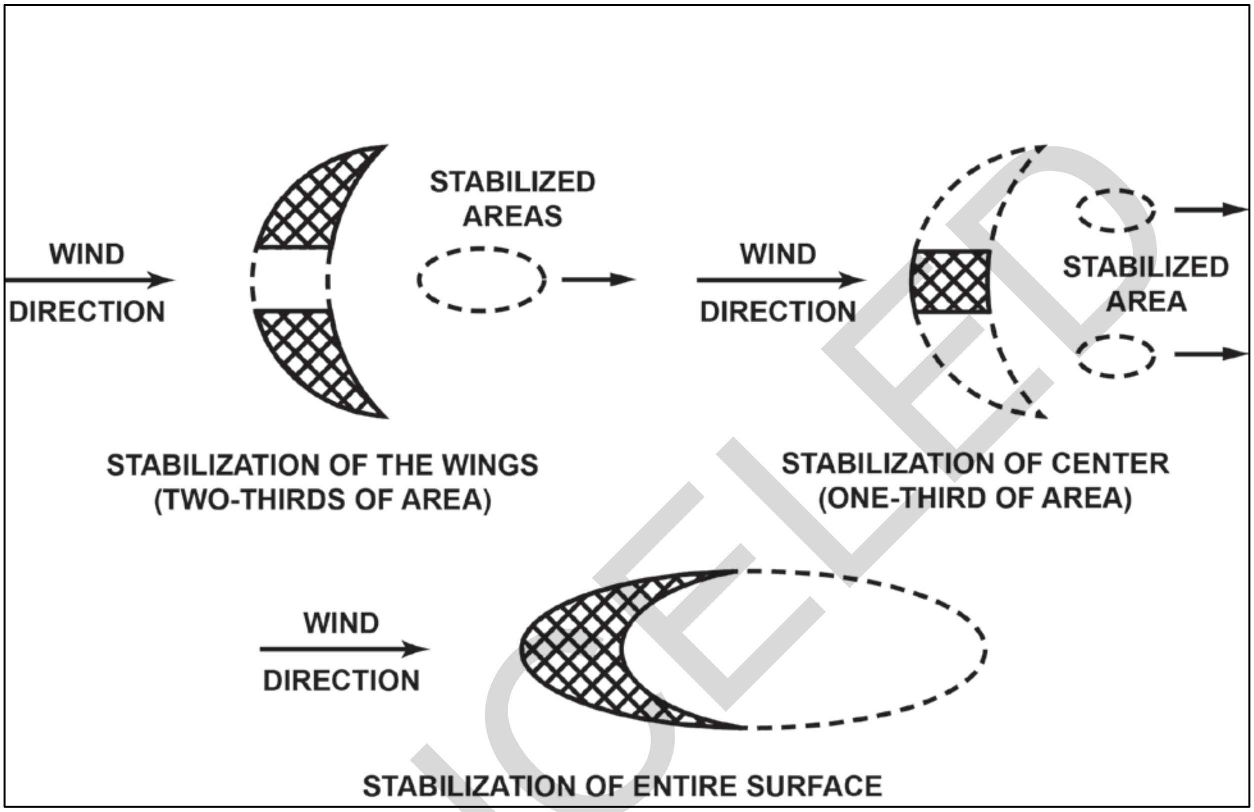
Figure B-5 Three Types of Solid Fencing or Paneling for Control of Dune Formation



B-1.5.3 Bituminous Materials.

Destruction of dune symmetry by spraying bituminous materials at either the center or the ends of the dune is an inexpensive and practical method of sand control. Petroleum resin emulsion and asphalt emulsions have been found to be effective. The desired stickiness of the sand is obtained by diluting one part petroleum resin emulsion with four parts water and spraying at the rate of 0.5 gallon per square yard (2.3 liters per square meter). Generally, the object to be protected should be downwind a distance of at least twice the tip-to-tip width of the dune. The center portion of a barchan dune can be left untreated or can be treated and the unstabilized portions allowed to reduce in size by wasting. Figure B-6 shows destruction of a typical barchan dune and stabilization, depending on the area treated.

Figure B-6 Schematic of Dune Destruction or Stabilization by Selective Treatment



B-1.5.4 Vegetative Treatment.

Vegetative cover is an excellent method of sand stabilization. Ensure vegetation to be established is drought-resistant and adapted to the climate and soil. Most vegetative treatments are effective only if the supply of new sand is cut off. On the upwind side, water, fertilizers, and mulch are liberally used. To prevent the engulfment of the vegetation, the upwind boundaries are protected by fences or dikes and the seed may be protected by mulch sprayed with a bituminous material. Seed on slopes may be anchored by mulch or matting. Oats and other cereal grasses may be planted as a fast-growing companion crop to provide protection while slower-growing perennial vegetation becomes established. Typically, the procedure is to plant clonal plantings, followed by shrubs used as an intermediate step, followed by the planting of long-lived trees. There are numerous suitable vegetative treatments for use in different environments. The actual type of vegetation selected should be chosen by qualified individuals familiar with the type of vegetation that thrives in the affected area. Stabilization by planting has the advantages of permanence and environmental enhancement wherever water can be provided for growth.

B-1.5.5 Mechanical Removal.

In small areas, sand may be removed by heavy equipment, but conveyor belts and power-driven wind machines are not recommended because of their complexity and expense. Mechanical removal may be employed only after some other method has been used to prevent the accumulation of more deposits. Except for its use in conjunction with another method of control, the mechanical removal of sand is not practical or economical.

B-1.5.6 Trenching.

A trench may be cut either transversely or longitudinally across a dune to destroy its symmetry. If the trench is maintained, the dune will be destroyed by wastage. This method has been used successfully in the (Yuma Desert) Arizona highway program, but it is expensive and requires constant inspection and maintenance.

B-1.5.7 Water.

Water may be applied to sand surfaces to prevent sand movement. It is widely used and an excellent temporary treatment. Water is required for establishing vegetative covers. The need for frequent reapplication and an adequate and convenient source constitute two major disadvantages of this method.

B-1.5.8 Surface Covers.

Any material that forms a (semi) permanent cover and is immovable by the wind will serve to control dust. Solid covers, though expensive, are excellent protection and can be used over small areas. This method of sand control accommodates pedestrian traffic as well as a minimum amount of vehicular traffic. Surface covers may be made from bituminous or concrete pavements, prefabricated landing mat, membrane, aggregate, seashells, and saltwater solutions. After placement of any of the above-listed materials, a spray application of bituminous material may be required to prevent cover decomposition and subsequent dust.

B-1.5.9 Salt Solutions.

Water saturated with sodium chloride or other salts can be applied to sand dunes to control dust. Rainfall will leach salts from the soil in time. During periods of no rainfall and low humidity (below 30 percent), artificial moisture in the form of water may have to be added to the treated area at a rate of 0.1 to 0.2 gallon per square yard (0.5 to 0.9 liter per square meter) to activate the salt solution.

B-2 POTENTIAL VENDORS AND DISTRIBUTION EQUIPMENT.

B-2.1 Potential Vendors.

A list of potential vendors is summarized in Table B-1 to assist in the procurement of products. It is not intended to be a complete listing of vendors as there are numerous large and small companies that provide a wide range of materials for dust abatement. Inclusion on this list does not represent endorsement of any kind. The list is provided to assist the Soldiers, Sailors, Marines, and Airmen working in the field. Complete a small test section prior to using each product to evaluate the effectiveness and determine the placement details.

Table B-1 Product and Vendor Information for Dust Palliatives

Vendor	Products	Website
American Distributing	calcium ligosulfonate	http://www.americandistributing.com/
C-Gear	geotextile	http://www.cgear-outdoor.com.au/multimat.html
Deschamps Mat Systems	geotextile	http://www.mobi-mat.com/deschamps/
Dirt Glue	polymer emulsions	https://www.dirtglue.com/
Enviroflo Engineering	surfactants, humectants, organic binders, foams	http://www.envirofloeng.com/
Enviroseal	polymer emulsions	www.enviroseal.com
Envirotac	polymer emulsions	http://envirotac.com/
Envirotech Services, Inc.	polymer emulsions, humectants	www.envirotechservices.com
General Electric	polymer emulsions, surfactants, humectants	http://www.gewater.com/dust-control.html
Midwest Industrial Supply	polymer emulsion, synthetic fluids, glycerin blends, humectants	http://midwestind.com/
Landlock	polymer emulsions	http://www.landlocknaturalpaving.com/polymer-military-road-construction
PennzSuppress	paraffin resin	https://www.pennzsuppress.com/
PolyPavement	polymer emulsion	http://www.polypavement.com
Propex	geotextile	http://www.propexglobal.com/
Soilworks	polymer emulsion, synthetic fluids, vegetable oil, and glycerin blends	www.soilworks.com
USG, Inc.	bonded fiber matrix	www.usg.com

B-2.2 Distribution Equipment.

A variety of distribution equipment is used to apply the palliatives. Table B-2 lists some manufacturers of spray equipment used for placing a variety of dust palliatives. It is not intended to be a complete listing of vendors as there are numerous large and small companies that provide a wide range of equipment for dust abatement. Inclusion on this list does not represent endorsement of any kind. The list is provided to assist the Soldiers, Sailors, Marines, and Airmen working in the field.

Table B-2 Product and Vendor Information for Equipment

Vendor	Products	Website
Finn Corporation	Hydroseeder	www.finncorp.com
TurfMaker	Hydroseeder	www.turfmaker.com
Epic Manufacturing	Hydroseeder	www.epicmanufacturing.com/
SealMaster	Emulsion sprayers	www.sealmaster.net/
Caterpillar	Water distributor (613C-II)	www.cat.com/en_US

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APPENDIX C GLOSSARY

C-1 ACRONYMS

AFJPAM	Air Force Joint Pamphlet
CSS	Cationic Slow Setting
ERDC/GSL	Army Engineer Research and Development Center, Geotechnical and Structures Laboratory
ETL	Engineering Technical letter
FHWA-CFL	Federal Highway Administration - Central Federal Lands Highway Division
FM	Field Manual
FOD	Foreign Object Debris
gsy	Gallons per Square Yard
MC	Medium Curing
RC	Rapid Curing
SC	Slow Curing
SS	Slow Setting
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
USCS	Unified Soil Classification System