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UNIFIED FACILITIES CRITERIA (UFC)

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

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UNIFIED FACILITIES CRITERIA (UFC)

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

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

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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

Change No.	Date	Location

This UFC supersedes TM 5-830-3, dated 30 September 1987. The format of this UFC does not conform to UFC 1-300-01; however, the format will be adjusted to conform at the next revision. The body of this UFC is the previous TM 5-830-3, dated 30 September 1987.

FOREWORD

\1\
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 more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

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ARMY TM 5-830-3
AIR FORCE AFM 88-17, CHAP. 3

TECHNICAL MANUAL

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

30 SEPTEMBER 1987

REPRODUCTION AUTHORIZATION/RESTRICTIONS

TECHNICAL MANUAL
No. 5-830-3
AIR FORCE MANUAL
AFM 88-17, CHAPTER 3

HEADQUARTERS
DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, DC, 30 SEPTEMBER 1987

DUST CONTROL FOR ROADS, AIRFIELDS, AND ADJACENT AREAS

*This manual supersedes TM 5-830-3/AFM 88-17, Chap. 3.30 September 1974.

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CHAPTER 1

INTRODUCTION

1-1. Purpose

This manual provides guidance for dust control methods and materials that can be used successfully at airfields and heliports to stop dust from forming naturally or as a result of man's activities and to control dust in areas directly impacted by man's activities. Dust develops naturally in denuded or sparsely vegetated areas and in most unpaved, sparsely vegetated areas occupied by man. (Man's activities may be detrimental to existing vegetation and create a dust problem.) Dust is created in unsurfaced areas subjected to concentrated foot or vehicular traffic, and is usually a problem on shoulders of surfaced airport and heliport traffic areas. Dust control becomes desirable when man needs to occupy land areas adjacent to the dust producing areas or is required to conceal military activities. The control of dust is also an important factor to consider for lengthening the life of vehicles and their engines.

1-2. Scope

This manual discusses dust control methods and materials that have proven effective for treating soil surfaces 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, that may be significant in the ultimate choice of material. Army and Air Force Regulations that implement the requirements for environmental quality are found in appendix A, and economic solutions for dust control of very large areas with little or no vegetation and no direct impact from man are presented in appendix B.

1-3. Definition and cause

The term "dust" can be defined simply as particles of soil that have become airborne. As a general rule, dust consists mainly of soil particles finer than 0.074 millimeter (i.e., passing the No. 200 sieve as described in ASTM E 11). 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 or man's activities. Other terms unique to this manual are listed and defined as follows:

a. Traffic Area. Areas that receive regular channelized traffic by vehicles, aircraft, or personnel. Typical areas include: roadways and vehicle parking areas; walkways; open storage areas; construction sites; runways, taxiways, shoulders, overruns, and parking areas of airfields; runways, taxiways, taxi- hover lanes, and landing and parking pads of heliports.

b. Non Traffic Area. Areas that are not subjected to traffic of any kind. Typical areas include: graded construction areas prior to turfing; partially graded construction areas that will remain dormant for an extended period of time; areas bordering all airfield or heliport complex; protective POL dikes; magazine embankments or ammunition storage barricades; bunkers and revetments; cantonment, warehouse, storage, and housing areas, excluding walkways and roadways; unimproved grounds; and shifting dunes.

c. Occasional Traffic Area. Areas that receive random traffic by vehicles, aircraft, or personnel. Typical areas include: shoulders and overruns of airfields used by propeller or jet air-craft, and shoulders, hover lanes, and peripheral areas of heliports and helipads.

d. Dust Palliative. A material applied to a soil surface to prevent soil particles from becoming airborne. The user should note that many of the references listed use the following additional terms to indicate a dust control material: palliative, dustproofer, spray or soil stabilizer, soil waterproofer, dust control agent, and dust layer.

e. Prewet. A light initial sprinkling of water on a soil surface prior to applying a liquid surface penetrant

f. Pertinent Areas. Soil areas that require a specific dust palliative.

1-4. Factors influencing dust

The presence of dust-size particles in a soil does not necessarily indicate a dust problem or severity of the dust problem that will result in various situations. Some of the factors that contribute to the formation, severity, and endurance of dust include 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 will generate volumes of dust of varying density, size, and height above ground which are referred to as dust clouds. Figure 1-1 shows three typical dust clouds. Dust clouds may be 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.

1-5. Environmental factors

The selection and use of adjust control method and a dust palliative should consider applicable safety, health, and environmental requirements. Material compliance with existing Environmental Protection Agency (EPA) rules and regulations should be required for all peacetime applications.

Figure 1-1. Three examples of typical dust clouds.

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 can be singled out as being the most acceptable for all situations. The successful control of dust and erosion in an area depend on several factors, the most important of which are:

-Intensity of area use.
-Topography.
-Soil type.
-Soil surface feature(s).
-Climate.

2-2. Intensity of area use (expected traffic)

The areas requiring treatment should be 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 can be predicted or regulated, significant savings in time and material(s) may be realized by adjusting the type and amount of treatment an area receives according to use.

a. Nontraffic areas. These areas require treatment to withstand the effects of airblast due to wind or nearby aircraft operations and are not subjected to actual traffic of any kind. If traffic is applied, the treated area may be damaged and repairs required. Typical nontraffic areas include:

-Graded construction areas.'
-Denuded areas around the periphery of completed construction projects.
-Areas .bordering airfield or heliport complexes.
-Protective petroleum, oil and lubricant (PQL) dikes.
-Magazine embankments of ammunition storage barricades.
-Bunkers and revetments.
-Cantonment, warehouse, storage, and housing areas, excluding walkways and roadways.
-Unimproved grounds.
-Areas experiencing windborne sand (see app B).

b. Occasional traffic areas. Besides resisting 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 CH-47 helicopter downwash and C-130 aircraft propwash; however, treatment for either will be 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 may be damaged and repairs required. Typical occasional traffic areas include:

-Shoulders and overruns of airfields.
-Shoulders, hover lanes, and peripheral areas of heliports and helipads.
-Areas mentioned in 2-2a where occasional traffic becomes necessary.

c. Traffic areas. These areas require treatment to withstand regular channelized traffic by vehicles, aircraft, or personnel. Areas properly treated to withstand regular channelized traffic should easily withstand airblasts from aircraft and helicraft. Typical traffic areas include:

-Roadways and vehicle parking areas.
-Walkways.
-Open storage areas.
-Construction sites.
--Runways, taxiways, shoulders.

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*The method(s) and dust palliatives recommended for occasional traffic (table 4-2) are known to be effective for ground surface airblast and temperature of 80 mph and 120°F respectively.

overruns, and parking areas of airfields.

-Runways, taxiways, taxi-hover lanes, and landing and parking pads of heliports.

-Tank trails.

Economic analysis of the cost to maintain an unsurfaced road versus the costs associated with a paved surface road indicates the break-even point occurs at a traffic level of approximately 100 vehicles per day. A durable riding surface such as an asphalt mixture or portland cement concrete should be considered when unpaved roads are trafficked by 100 or more vehicles per day. Where these areas are considered permanent, they should be treated as specified in existing Army and Air Force publications.

2-3. Topography

a. Distinction between flat and hillside areas. The overall topography of the area should be considered 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 6 percent. Emphasis is placed on the fact that the entire topography of the area to be treated must be considered and not specific spot localities. Spot areas can be given special attention as needed.

b. Dust control for flat and hillside areas. Dust control depends on the type of traffic expected, etc.; however, the final dust palliative selected may be affected by the slope. For example, liquid dust control materials may tend to flow instead of penetrate or form a protective cover over the dusty area.

2-4. Soil type

The soil type is one of the key features used to determine which method and material should be used for dust control. Soils to be treated for dust control have been placed into five general descriptive groupings based On the Unified Soil Classification System (USCS), MIL-STD-619B.

a. Silts or clays (high liquid limit). The relatively impervious, plastic, fine-grained soils encompass USCS types CH, OH, and MH.

b. 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.

c. 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. CL 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.

e. Gravels (with little or no fines). The highly permeable gravels or sandy gravels contain little or no fines encompassing USCS types GP and GW.

2-5. Soil surface feature

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

a. Loose and dry or slightly damp. The surface consists of a blanket, 1/4 to 2 inches thick, of unbound or uncompacted soil overlying a relatively firm subgrade and ranging in moisture content from dry to slightly damp.

b. Loose and wet or slurry. A surface condition consists of a blanket, 1/4 to 2 inches 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 above or below.

c. Firm and dry or slightly damp. The surface condition consists of less than 1/4-inch-thick layer of loose soil ranging in moisture content from dry to slightly damp overlying a bound or compacted firm soil subgrade.

d. Firm and wet. This surface condition is similar to that defined in paragraph c but has a wet surface. Soil in this condition cannot be treated until it is dried to the condition defined.

e. Treatment ability. The soil surface feature described in paragraph a is acceptable for treatment for dust control where no traffic or only occasional traffic is expected. The soil surface feature described in paragraph c is acceptable for treatment for dust control regardless of the expected traffic. The soil surface features described in paragraph b and d cannot be treated and do not need treatment for dust control in the stated condition. Normal earth moving methods can be employed in most situations to upgrade dust producing areas to the condition described in paragraph c.

2-6. Climate

a. 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 should be considered by the designer before adjust palliative is selected.

b. Weather extremes accelerate the aging and/or deterioration of most materials and dust palliatives are no exception. Many of the liquid dust palliatives must be stored, placed, and permitted to cure at temperatures above 40 degrees Fahrenheit. Agronomic methods should be initiated at the onset of the growing season which may be limited to a few weeks. Some dust palliatives become brittle when exposed to extreme cold and should not be trafficked during these periods, while others leach from the soil during rain storms. At temperatures above 90 degrees Fahrenheit many bituminous products become tacky. Salts become ineffective during extended periods of no rainfall whenever the humidity falls below approximately 30 percent.

CHAPTER 3

DUST CONTROL METHODS

3-1. General

This chapter describes several types of dust palliatives that are commercially available; special care that must be used with a dust palliative; type of traffic areas where a dust palliative is applicable; and references as to where more details on the proper use and application of the dust palliative can be obtained. Each dust control method should be considered in relation to the specific job requirements. The four general dust control treatment methods commonly used are:

-Agronomic.
-Surface penetrant.
-Admix.
-Surface blanket.

The surface penetrant and surface blanket methods are the easiest to apply. Application of either method requires a material placement procedure (i.e., spreading aggregate or membrane over the area) or a material spraying procedure. One of these two methods will probably suffice for the majority of dust control cases. The other two methods are much more involved and require more time and equipment to implement., The agronomic method requires a knowledge of the indigenous vegetation and access to farm type equipment. The admix method requires standard road building techniques using construction equipment.
Application may require specific handling, equipment, and procedures. The manufacturer's precautions should be adhered to with the use of personnel protective equipment (masks, safety glasses, gloves, etc.) as required.

3-2. Agronomic methods

a. This method consists of establishing or extending and preserving vegetative cover, mulch, shelter belts, and rough-tillage. It includes such items as seeding, sprigging, sodding, topsoiling, fertilizing, mulching, and disking. Agronomic methods are not normally prescribed for traffic areas.

b. Occasionally large areas are cleared for proposed projects, stripping the project area of the native grass and all topsoil. The extent of stripping should be kept to a minimum and the stripped topsoil with vegetative residue stock-piled for later placement around the completed structure(s) and/or use on other denuded areas.

(1) Vegetative cover. Vegetative cover is often considered the most satisfactory form of dust palliative based on aesthetic aspects, durability, cost, and maintenance. Indeed 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, any dust palliative used for immediate surface protection should be selected with a view of minimizing impairment to subsequent plant growth. While dense vegetation is certainly the most effective cover, more sparse native vegetation typical of semiarid and arid regions can be a fully effective dust palliative under natural wind conditions so long as it is not damaged by traffic or other causes.

(2) Mulch. A well-anchored mulch of vegetative material .can be used to stabilize soil against wind and water erosion. Mulch refers to any substance, such as straw, hay, paper, or brushwood, that is spread over the ground surface to protect it from the wind. Vegetative mulches are normally effective for 1 year and can be applied during any season. Mulches are normally spread by either a beater or blower type, spreader. The blower type has the advantage in that it is

normally equipped with an asphalt spraying mechanism for anchoring the mulch. It can place the mulch and asphalt at the same time and at considerable distance from the operating location. Otherwise, anchoring is normally accomplished with either a disk packer or V-tread rolling wheel packer. Rapid curing (RC) cutbacks or rapid setting (RS) asphalt emulsions are normally used for anchoring, since they are more effective than the slower curing materials. In an emergency, vegetative mulch can be anchored by applying a jet of water to bury part of the mulch in the soil. About 2,000 gallons of water per acre is needed to provide maximum anchorage. Mulch is undesirable around airports since it may be ingested into jet engines. Further details on the recommended uses and methods of applying a wide variety of mulches are discussed in TM 5-830-2/AFM 88-17, Chapter 2; TM 5-630/AFM 126-2; and Department of Agriculture Hand- book No. 346.

(3) Shelter belts. Any barrier of hedges, shrubs, or trees high and dense enough to protect facilities and unsurfaced soil areas is considered to be a shelter belt or windbreak. Shelter belts should be placed at right angles to the direction of the prevailing wind. Several parallel shelter belts may be required and usually the higher the average wind velocity the closer the shelter belts should be spaced. While such shelter belts can serve occupied areas, their practical applicability solely for dust control is limited. Trees are slow to become established, and additional soil treatment between tree belts is usually required. Finally, in semiarid regions, where shelter belts or windbreaks are most highly valued, trees often cannot be sustained without irrigation. Notwithstanding the above limitations, shelter belts can supplement other dust-control measures by reducing wind velocity. The use of shelter belts are recommended wherever they do not interfere with the intended area activities.

(4) Rough tillage. Chisels, listers, and turning plows are used to till strips across nontraffic areas that have become sources of dust. Several strips are placed in parallel as an emergency measure to control dust in semiarid regions. The soil should be cohesive enough to produce soil clods (lumps of earth with a minimum dimension of 1 inch measured in any direction). Strips should be tilled at 25- to 100-foot intervals at right angles to the prevailing wind. As the strips become smooth through erosion, new strips should be 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 sometimes may be harmful rather than beneficial to dust control if a cloddy surface is not produced. Rough tillage is normally considered a temporary control measure to be followed by permanent vegetative cover, but it sometimes can be sufficient as the only treatment if traffic is excluded from the area and the native vegetation is capable of regeneration. Disk-type tillage tools generally should not be used for rough tillage as they tend to pulverize the soil too much (i.e., soil clods are not formed). However, if long narrow grooves are created which would channel runoff water, the tillage should be laid out on horizontal contours to prevent water damage.

3-3. Surface penetration method

In the surface penetration method, the dust palliative, a liquid, is applied directly on the soil surface by spraying or sprinkling and allowed to penetrate the surface under its own accord. Surface penetration applications may be accomplished with a liquid pressure distributor, by a gravity-flow water distributor, or by hand-held devices. The spray apparatus should be positioned directly above the area being treated (8-14 inches) to preclude, wind-drift. Runoff should be avoided (if necessary by decreasing the application rate or applying the dust palliative at one-half the recommended rate and repeating the treatment later).

a. Effectiveness. The effectiveness of the surface penetration method depends on the depth of penetration which is a function of the viscosity of the dust palliative and the permeability of the soil. Penetration is facilitated by sprinkling (prewetting) the surface with water prior to applying the dust palliative. This procedure reduces surface tension and helps assure a uniform coverage and maximum penetration.

b. Pertinent areas. A soil penetrant can be used in all nontraffic areas provided the other factors for consideration (chapter 2) are met. This method will also prove effective for occasional traffic areas (with the same "factors limitation" noted above) provided the treated soil is strong enough or has been conditioned for the stated use. Very few dust palliatives used as a penetrant impart any additional strength to the treated soil. A soil that will rut before treatment will surely rut after treatment, a process that will quickly render the treatment ineffective. In planned traffic areas a dust palliative penetrant will only prove effective on prepared areas (e.g., on unsurfaced gravel roads).

c. Types of materials. Dust palliatives that penetrate the soil surface include bitumens, resins, salts, and water.

(1) *Bituminous materials.* Conventional types of bituminous materials that may be used for dust palliatives include cutback asphalts, emulsified asphalts, and road tars. These materials can be used to treat both traffic and nontraffic areas. All bituminous materials do not cure at the same rate. This fact may be of importance when they are being considered' for use in traffic areas. Also, bituminous materials are sensitive to weather extremes. Usually bituminous materials impart some waterproofing to the treated area that remains effective as long as the treatment remains intact (i.e., as placed or as applied). Bituminous materials should not be placed in the rain or when rain is threatening.

(a) Cutback asphalts. A cutback asphalt (cutbacks) is a blend of an asphalt cement and a petroleum solvent. These 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 usually range from 120 to 300 degrees Fahrenheit. The actual range for a particular cutback is much narrower and should be requested from the supplier at the time of purchase. The user is cautioned that some cutbacks must be heated above their flash point for spraying purposes and therefore no smoking or open flames should be permitted during application or cure. MC-30 grade can be sprayed without being heated if the temperature of the asphalt is 80 degrees Fahrenheit or above. A slightly moist soil surface will assist penetration. Curing time for cutbacks varies with the type. Under favorable ground temperature and weather conditions RC cures in 1 hour, MC in 3 to 6 hours, and SC in 1 to 3 days. In selecting the material for use, local environmental protection regulations must be considered.

(b) Emulsified asphalts. Asphalt emulsions (emulsions) are a blend of asphalt, water, and an emulsifying agent and are available either as ionic or cationic emulsions. The application of emulsions at ambient temperatures of 80 degrees Fahrenheit or above gives the best results. Satisfactory results may be obtained below this temperature, especially if application is made in the morning to permit the warming effects of the afternoon sun to aid in curing. Emulsions should not be placed at temperatures below 50 degrees Fahrenheit. Emulsions placed at temperatures below freezing will freeze, producing a substandard product. For best results in a freezing environment, emulsions should be heated to between 75 degrees and 130 degrees Fahrenheit. The temperature of the material should never exceed the upper heating limit of 185 degrees Fahrenheit because the asphalt and water will separate (break), resulting in material damage. Emulsions generally cure in about 8 hours. The slow setting anionic emulsions of grades SS-1 and SS-1h may be diluted

with 1 to 5 or more parts water to one part emulsified asphalt by volume prior to use. As a general rule, a 3 part water to 1 part emulsion dilution is satisfactory for most applications. The slow-setting cationic emulsions of grades CSS-1 and CSS-1h are easiest to use without dilution. If dilution is desired, the water used must be free of any impurities, minerals, or salts that might cause separation (breaking) of the emulsion within the distribution equipment.

(c) Road tars. Road tars (tars) are viscous liquids obtained by distillation of crude tars obtained from coal. Tars derived from other basic materials are also available, but are not normally used as soil treatments. Tars are graded by viscosity and available in grades ranging from 1 to 12. Tars are also available in the cutback (RTCB) form of viscosity grades 5 and 6, and in the emulsified form. Tar emulsions are difficult to prepare and handle. The low viscosity grades RT-1 and RT-2 and the RTCB grades can be applied at temperatures as low as 60 degrees Fahrenheit without heating. The tar cutbacks generally have better penetrating characteristics than asphalts and will normally cure in a few hours. Tars will produce excellent surfaces, but curing proceeds very slowly, and several days or even weeks may be required to obtain a completely cured layer. Tars are susceptible to temperature changes and may soften in hot weather or become brittle in cold weather.

(d) Asphaltic penetrative soil binder (APSB). This commercial product is a special liquid asphalt composed of high penetration grade asphalt and a solvent blend of kerosene and naphtha. It is similar in character to a standard low viscosity, medium curing liquid asphalt, but differs in many specific properties. The APSB is suitable for application to soils that are relatively impervious to conventional liquid asphalts and emulsion systems. Silts and moderately plastic clays (to a plasticity index of 15) can be treated effectively. Curing time for the APSB is 6 to 12 hours under favorable ground temperature and weather conditions. On high plasticity solids (plasticity index greater than 15), the material will remain on the surface as an asphalt film that is tacky at a ground temperature of approximately 100 degrees Fahrenheit and above. The APSB must be heated to a temperature between 130 and 150 degrees Fahrenheit to permit spraying with an asphalt distributor.

(2) *Resinous materials*. These dust palliatives may be used as either surface penetrants or surface blankets as they have a tendency to either penetrate the surface or form a thin surface film depending on the type used, the soil type, and the soil condition. The materials are normally applicable to nontraffic areas and occasional traffic areas where rutting will not occur. They are not recommended for use with silts and clays.

(a) Resin-petroleum-water emulsion. Resin petroleum water emulsions are quite stable and highly resistant to weathering. A feature of this type dust palliative is that the soil remains readily permeable to water after it is treated. This type of product is principally manufactured under the trade name Coherex. Application rates range from 0.33 to 0.5 gallon per square yard. The material may be diluted 4 parts water to 1 part concentrate for spraying. This material is primarily suited for dry sandy soils and has been found to provide unsuitable results when used on silty and clayey soils.

(b) Lignin. Lignin is a by-product of the manufacture of wood pulp. It is soluble in water and therefore readily penetrates the soil. Its solubility also makes it susceptible to leaching from the soil; thus application is repeated as necessary after rainfall. Lignin is readily available in the continental United States and certain other sections of the world, and has utility in areas where dust control is desirable for short periods of time. It is not recommended for use where durability is, an important factor. Application at a rate of 1 gallon per square yard of a resinous solution of 8 percent solid lignin sulphite is recommended.

(c) Concrete curing compounds. Concrete curing compounds can be used to penetrate sands which contain little or no silts or clays. This material should be limited to areas of no traffic. The high cost of this material is partly offset by the low application rate required (0.1 to 0.2 gallon per square yard). Standard asphalt pressure distributors can be used to apply the resin, but the conventional spray nozzles should be replaced with smaller opening spray nozzles to achieve a uniform distribution at the low application rate.

(3) *Brine materials*. Salts in water emulsions have been used with varying success as dust palliatives. Dry calcium chloride is deliquescent and is effective when the relative humidity is about 30 percent or greater. A calcium chloride treated soil will retain more moisture than the untreated soil under comparable drying conditions. Its use is limited to occasional traffic areas. Sodium chloride achieves some dust control by retaining moisture and also by some cementing from salt crystallization. Both calcium chloride and sodium chloride are soluble in water and are readily leached from the soil surface; thus frequent maintenance is required. Continued applications of salt solutions can ultimately build up a thin, crusted surface that will be fairly hard and free of dust. Most salts are corrosive to metal and should not be stored in the vehicle used for application. Magnesium chloride will control dust on gravel roads with tracked vehicle traffic. Best results can be, expected in areas with occasional rainfall or where the humidity is above about 30 percent. The dust palliative selected and the quantity used should not exceed local environmental protection regulations.

(4) *Water.* As a commonly used but very temporary measure for allaying; dust, a soil surface can be sprinkled with water. As long as the ground surface remains moist or damp, soil particles will resist becoming airborne. Depending on the soil and climate, frequent treatment may be required. Water should not be applied to clay soil surfaces in such quantity that puddles form, since a muddy or slippery surface may result where the soil remains-wet.

3-4. Admix method

In the admix 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 blanket methods, however, it also increases soil strength.

a. Depth of treatment. A minimum treatment of 3 inches will be satisfactory for all nontraffic areas. To provide a dustproof surface in traffic areas, a minimum treatment depth of 4 inches is recommended. Admixing can be accomplished in-place or offsite and is adaptable to a large variety of soil types, (The admix method is not particularly suitable for areas where a vegetative cover is to be established.)

b. Types of materials. Two types of admix materials may be used as dust palliatives:

-Powders - Portland cement, hydrated lime

-Liquids - Bituminous materials including cutback asphalt, emulsified asphalt, and road tars.

c. In-place admixing. In-place admixing is the blending of soil and dust palliative on the site. The surface soil is loosened (if necessary) to a depth slightly greater than the desired thick- ness 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 or a mechanical spreader, and liquids should be applied with an asphalt distributor. Mixing equipment that can be used includes rotary tillers, rotary pulverizer-mixers, graders, scarifiers, disk harrows, or plows. Admixing and/or blending should continue until a uniform color of soil and dust palliative mixture, both horizontally and vertically, is achieved. The most effective compaction equipment that can be used are sheepsfoot or rubber-tired rollers. The procedure for in-place admixing closely resembles the soil stabilization procedure for changing soil characteristics and soil strength used in road construction. For dust control on a nontraffic area, adequate compaction can be achieved by trafficking the entire surface with a 5-ton dual wheel truck. For all other traffic situations the procedure should follow TM 5-822-4. This procedure is time consuming and requires the use of more equipment than the other three. Following placement, admixing, and compaction a minimum of 7 days is required for curing.

(1) *Cementing materials*. Two cementing type powders (portland cement and hydrated lime) are primarily used to improve the strength of soils. However, when they are admixed with soils in relatively small quantities (2 to 5 percent by dry soil weight), the modified soil is resistant to dusting. Portland cement is generally suited for all soil types, provided uniform mixing can be achieved; whereas hydrated lime is applicable only to soils containing a high percentage of clay. The compacted soil surface should be kept moist for a minimum of 7 days prior to traffic.

(2) *Bituminous materials.* Bituminous materials are more versatile than cementing materials in providing adequate dust control and waterproofing the soil. Cutbacks, emulsion asphalts, and road tars can all be used successfully. The quantities of residual bituminous material used should range from 2 to 3 percent of dry soil weight for soils having less than 30 percent passing the No. 200 sieve to 6 to 8 percent for soils having more than 30 percent fine-grained passing the No. 200 sieve. The presence of mica in a soil is detrimental to the effectiveness of a soil-bituminous material admixture. There are no simple guides or shortcuts for designing mixtures of soil and bituminous materials. The maximum effectiveness of soil-bituminous material admixtures can usually be achieved if the soil characteristics are within the following limits:

Plasticity Index:	equal to or less than 10
Percent of material passing No. 200 sieve:	equal to or less than 30 percent by weight

These data and additional construction data can be found in TM 5-822-4. Traffic should be detoured around the treated area until the soil-bituminous material admixture has cured.

(a) Cutback asphalt. When admixed into soil to depths of 3 inches or more on a firm subgrade, cutback asphalt will provide a dust free, waterproof surface. More satisfactory results will be obtained if the cutback asphalt is preheated prior to use. Soils should be fairly dry when cutback asphalts are admixed. When using SC or MC types of cutback asphalt, it is necessary to aerate the soil-asphalt mixture to allow the volatiles to evaporate. Also see paragraph 3-3c(1)(a).

(b) Emulsified asphalts. Emulsified asphalts are admixed with a conditioned soil that will allow the emulsion to break prior to compaction. A properly conditioned soil should have a soil moisture content not to exceed 5 percent in soils having less than 30 percent passing the No. 200 sieve. Emulsified asphalts, particularly the cationics, are extremely sensitive. When they (CSS-1 or CSS-1h) are used improperly, the emulsion may break prematurely or after some delay. The slow-setting anionic emulsions of grades are less sensitive.
See also paragraph 3-3c(1)(b).

(c) Road tars. Road tars grade RT and RTCB can be used as admixtures in the same manner as other bituminous materials. Road tar admixtures are susceptible to temperature changes and may soften in hot weather or become brittle in cold weather. See also paragraph 3-3c(1)(c).

d. Offsite admixing. Offsite admixing is generally used where in-place ad- mixing is not desirable and/or soil from another source provides a more satisfactory treated surface. Offsite admixing may be 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 admixing. The major disadvantage in any offsite operation is having to transport and spread the mixed material.

3-5. Surface- blanket method

This method includes the use of aggregates, prefabricated membranes and mesh, bituminous surface treatments, polyvinyl acetates (with and without fiberglass scrim reinforcement), and polypropylene-asphalt membranes to create a surface blanket for dust control. The type of treatment used will dictate the equipment required. However, standard construction equipment in all cases can be used effectively to place any of the systems applicable to the surface blanket method. Mechanized equipment should be used wherever possible to assure uniformity of treatment.

a. Effectiveness. The surface blanket method is applicable to nontraffic, occasional traffic, and traffic areas. Aggregate, prefabricated membrane, and mesh treatments are easy to place and can withstand considerable rutting. The other surface blanket methods will only withstand minimal rutting. Once a surface blanket treatment is torn or otherwise compromised, and the soil exposed, subsequent traffic or airblast will increase the damage to the torn surface blanket while producing dust from the exposed soil. Repairs (maintenance) should begin as soon as possible to protect the material in place and keep the dust controlled. Three types of materials may be used as surface blankets:

-Mineral	aggregates.
-Synthetics	membranes or meshes.
-Liquids	Bituminous or polyvinyl acetate liquids.

b. These materials may be used alone or in the combinations discussed below.

(1) *Aggregates*. In arid areas where most vegetative covers do not survive because of low rainfall, crushed or uncrushed gravel, slag, or tone aggregate (2 inches maximum size) can be used as a dust palliative on non- traffic or occasional traffic areas. Aggregate is not recommended in close proximity to aircraft traffic because gravel particles may be picked up and thrown by airblast with possible damage to aircraft and ground personnel. Aggregate should be spread in a layer about 2 inches thick and should contain at least 80 percent by weight of particles retained on the 1/4-inch screen. Traffic over aggregate blanketed areas tends to press the material into the soil and pulverize the surface; therefore this treatment is not recommended where channelized traffic is expected.

(2) *Prefabricated membrane*. Membrane used to surface an area will control dust and even act as a surface course or riding surface for traffic that does not rut the soil. When subjected to traffic, the membrane can be expected to last approximately 5 years. Minor repairs can be made easily. For optimum anchorage, the membrane should be extended into 2-foot-deep ditches at each edge of the covered area; staked in place and the ditches backfilled. Further details on the use and installation of prefabricated membranes can be obtained from TM 5-330/AFM 86-3, Volume II.

(3) *Prefabricated mesh*. Heavy woven jute mesh such as commonly used in conjunction with grass seed operations can be used for dust control of nontraffic areas. The mesh should be secured to the soil by burying the edges in trenches and by using large U-shaped staples that are driven flush with the soil surface. A minimum overlap of 3 inches should be used in joining rolls of mesh. After being placed, the mesh and covered soil should be sprayed with a bituminous material. Trial applications are recommended at each site and should be adjusted to suit each job situation.

(4) *Bituminous surface treatments*. Single or double bituminous surface treatments can be used to control dust on most soils. A medium-curing liquid asphalt is ordinarily used to prime the soil prior to placement of the surface treatment. Fine-grained soils are generally primed with MC-30, and coarse-grained soils with MC-70. After the prime coat has cured, a bituminous material is uniformly applied and gravel, slag, or stone aggregate spread over the treated area at approximately 25 pounds of aggregate per square yard.

Types of bituminous materials, aggregate gradations, application rates, and methods of placing surface treatments are described in TM 5-822-8/AFM 88-6, Chapter 9. Single or double bituminous surface treatments should not be used where turf is to be established.

(5) *Polyvinyl acetates (DCA 1295).* DCA 1295 has a slight odor and an appearance similar to latex paint. The material is diluted 3 parts DCA 1295 to 1 part water and cures in 2 to 4 hours under ideal conditions of moderate to high temperature and low relative humidity. A clear, flexible, film forms on the treated surface. DCA 1295 can be sprayed with a conventional asphalt distributor provided modifications are made to the pump to permit external lubrication. The DCA 1295 can be used alone or over fiberglass reinforcement. The addition of fiberglass does not affect the basic application procedures or the curing characteristics of the DCA 1295. This material is suitable for use on nontraffic, occasional traffic, and traffic areas. This material has also been found to be effective when sprayed over grass seed to protect the soil until growth occurs. Uniform soil coverage is enhanced by sprinkling (prewetting) the surface with water.

(6) *Polyvinyl acetate (DCA 1295) with reinforcement*. A fiberglass scrim material is recommended for use with the DCA 1295 when a reinforcement is desired. Fiberglass scrim increases the expected life of the dust-control film by reducing the expansion and con- traction effects of weather extremes. The scrim material should be composed of fiberglass threads having a plain weave pattern of 10 by 10 (ten threads per inch in the warp direction and ten threads per inch in the fill direction), having a greige finish, and should weigh approximately 1.6 ounces per square yard. The use of scrim material does not create any health or safety hazards, and special storage facilities are not required. Scrim materials can be applied under any climatic conditions suitable for dispensing the DCA 1295. (Under special conditions, continuous strands of fiber-glass may be chopped into 1/2-inch-long segments and blow over the area to be protected.) The best method of placement is for the fiberglass scrim material to be placed immediately after the prewet water followed by the DCA 1295 (fig 3-1).

(7) *Polypropylene-asphalt membrane*. The polypropylene-asphalt membrane is recommended for use in all traffic areas. It has considerable durability and will withstand rutting up to approximately 2 inches in depth. This system is a combination of a polypropylene fabric sprayed with an asphalt emulsion. Normally a cationic emulsion is used; however, both cationic and anionic emulsions have been used successfully. Several types of polypropylene fabric are commercially available.

(a) Application. Generally this system is placed in a three-step procedure. The first step consists of placing a layer of asphalt (0.33 to 0.50 gal per sq. yd.) on the ground and covering this with a layer of polypropylene fabric. In most cases this is accomplished in a single operation. Normally, a rolling frame is fabricated, the roll of polypropylene is placed on the axle shaft of the frame and the frame is attached to the rear of a distributor. Figure 3-2 illustrates this assembly. The second step is the placement of 0.33 gal per sq. yd. of asphalt on top of the polypropylene and the third step is the application of a sand blotter course. This system does not require any rolling or further treatment and can be trafficked immediately.

(b) Construction for traffic areas. Care should be taken during construction operations to assure adequate longitudinal and transverse laps where two pieces of polypropylene fabric are joined. Longitudinal joints should be lapped a minimum of 12 inches. On a super-elevated section the lap should be laid so the top lap end is facing downhill to help prevent water intrusion under the membrane. On a transverse joint, the minimum overlap should be at least 24 inches. Additional emulsion should be on the top side of the bottom lap to provide enough emulsion to adhere to and waterproof the top lap. Figure 3-3 illustrates this

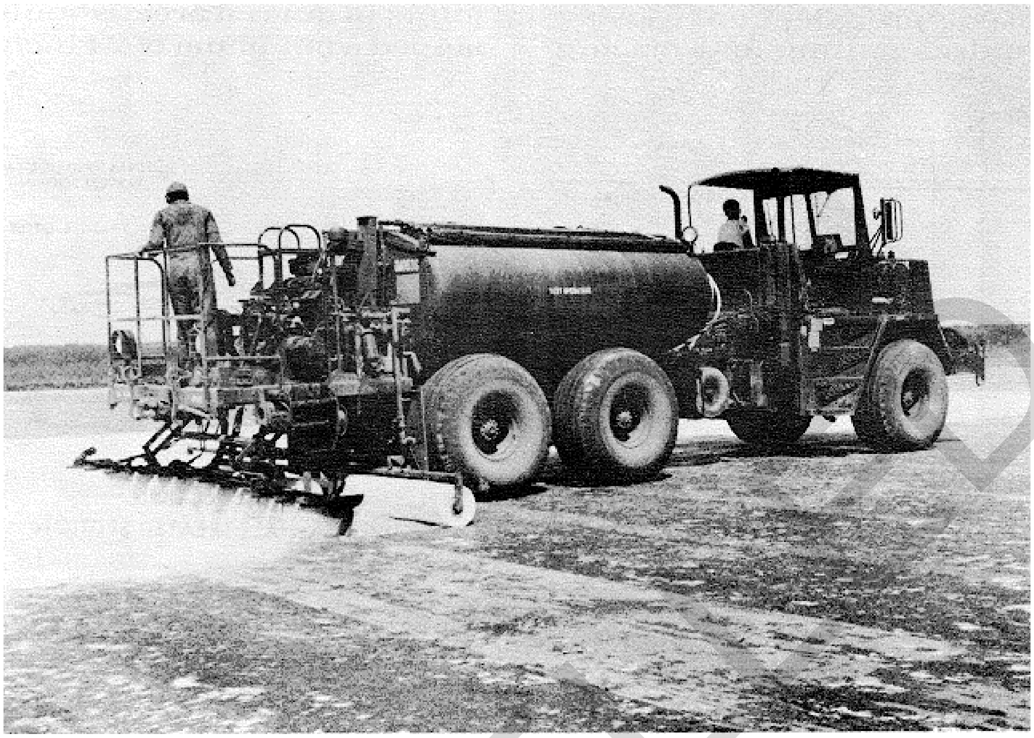


Figure 3-1. Special distributor for the three-step process of applying the DCA 1295.

Figure 3-2. Rolling frame for placing polypropylene fabric over the first coat of asphalt emulsion.

process on tangential sections. Application of polypropylene on roadway curves requires cutting and placing the fabric as shown in figure 3-4. The joints in curved areas should be overlapped a minimum of 24 inches.

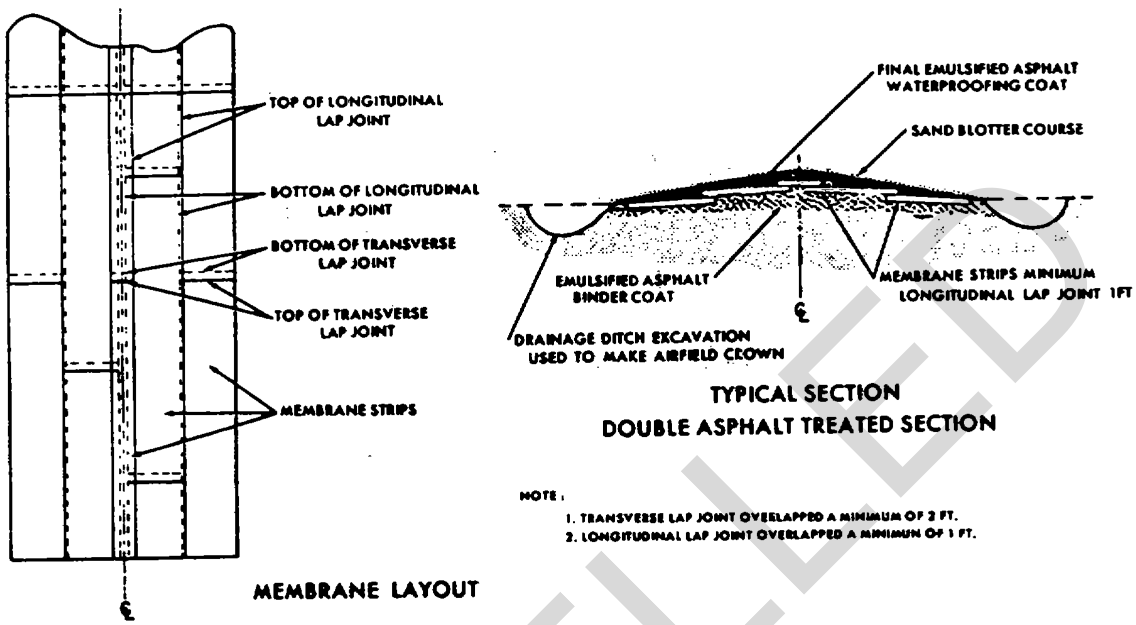


Figure 3-3. Polypropylene membrane layout for tangential sections.

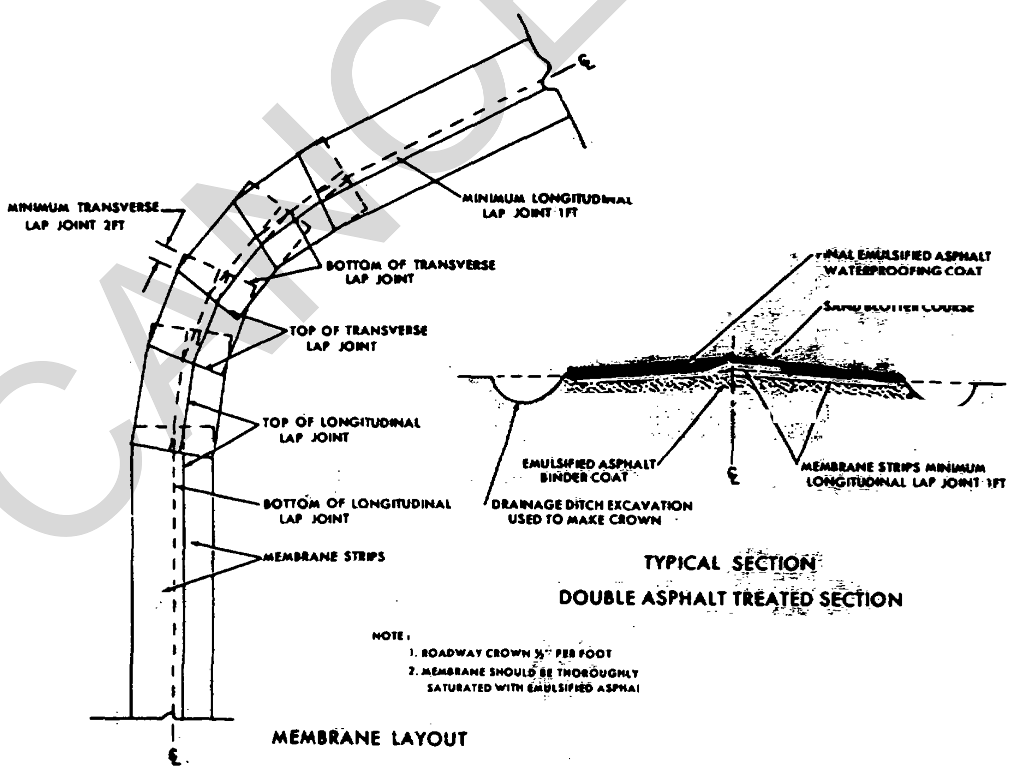


Figure 3-4. Polypropylene membrane layout for curved sections.

CHAPTER 4

DUST PALLIATIVES

4-1. General

a. The primary objective of a dust palliative is to prevent soil particles from becoming airborne. Dust palliatives may be required for the control of dust on nontraffic or traffic areas, or both. For nontraffic, adjust palliative is needed that is capable of resisting the maximum intensity of airblast impingement caused by weather or (nearby) aircraft. For traffic areas, a dust palliative must withstand the abrasion of wheels (and possibly tracks) in addition to airblast. Although a dust palliative may provide the necessary resistance against air impingement, it may be totally 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 will occur under traffic. (Rutting occurs if the bearing capacity of the soil is such that the soil surface depresses or com- pacts as a result of vehicle traffic.) The effectiveness of a dust palliative treatment is destroyed rapidly by rutting and any remaining dust palliative is quickly stripped from the ground surface. Some palliatives will tolerate deformations better than others, but normally ruts of 1 to 1-1/2 inches will result in the destruction of any treatment method.

b. Many times a dust palliative also functions as a soil water proofer. When this occurs, the dust palliative not only prevents dust but also preserver, the in-place or as-constructed soil strength during wet weather conditions The judicious selection of soil waterproofers is beyond the scope of this manual.

c. Some dust palliatives may be harmful to existing vegetation and/or make it difficult to establish vegetation in areas previously treated. Some dust palliatives trap soil moisture and increase soil temperature thus promoting vegetative growth. The dust palliatives presented herein will not harm adjacent vegetation as long as wind-drift and runoff during placement are prevented.

4-2. Selection

Many materials exist that are suitable as dust palliatives for each of the four major methods given in this manual. The selection of a- dust control procedure limits the number of applicable dust palliatives. For example the use of vegetation would obviously only apply to the agronomic method. However, some dust palliatives will not penetrate a fine grained clay and must act as a surface blanket while the same material readily penetrates coarse grained sand and gravel and consequently acts as a surface penetrant. Tables 4-1 through 4-4 were developed as aids for selecting a material. These tables present dust palliatives and methods proven effective through test and analysis and/or satisfactory service in actual use. The dust palliatives and dust control methods are not listed in any order of priority; the selection is left to the designer. All listed dust palliatives in table 4-4 are available commercially in the continental United States. The application rates and the anticipated service life presented represent the best estimate available. The numbers listed in vertical columns in tables 4-1:through 4-3 represent dust palliatives. The columns are interrupted by horizontal lines to separate each dust control method. Each column appears directly below the particular soil type/soil condition applicable. Where no column of numbers is present, no dust palliative for that particular dust control method is recommended. For

Table 4-1. Dust palliative numbers for dust control in nontraffic area.

SOIL TYPE/OR CONDITION: Nontraffic area → Flat* → Loose and dry (or slightly damp) ← Loose and wet (or slurry); Firm and dry (or slightly damp) ← Firm and wet

DUST CONTROL METHOD	Loose and dry: Silts or clays (high liquid limit)	Loose and dry: Silts or clays (low liquid limit) / Sands or gravels (with fines)	Loose and dry: Sands (with little or no fines)	Firm and dry: Silts or clays (high liquid limit)	Firm and dry: Silts or clays (low liquid limit) / Sands or gravels (with fines)	Gravels (with little or no fines)
Agronomic	1 2 3 4	1 2 3 4		1 2 3 4	1 2 3 4	No treatment necessary
Surface Penetrant	5 8 11 25	5 8 15 20 22 25	5 9 12 16 18 21 22 25		8 12 15 22 25	
Admix	31 37 40	28 34 37 40	30 34 37 40	31 37 40	28 34 37 40	
Surface Blanket	43 46 47 48 51 54 60	43 46 47 48 51 54 60	43 46 47 48 51 54 60	43 46 47 51 54 57	43 46 47 51 51 54 57	

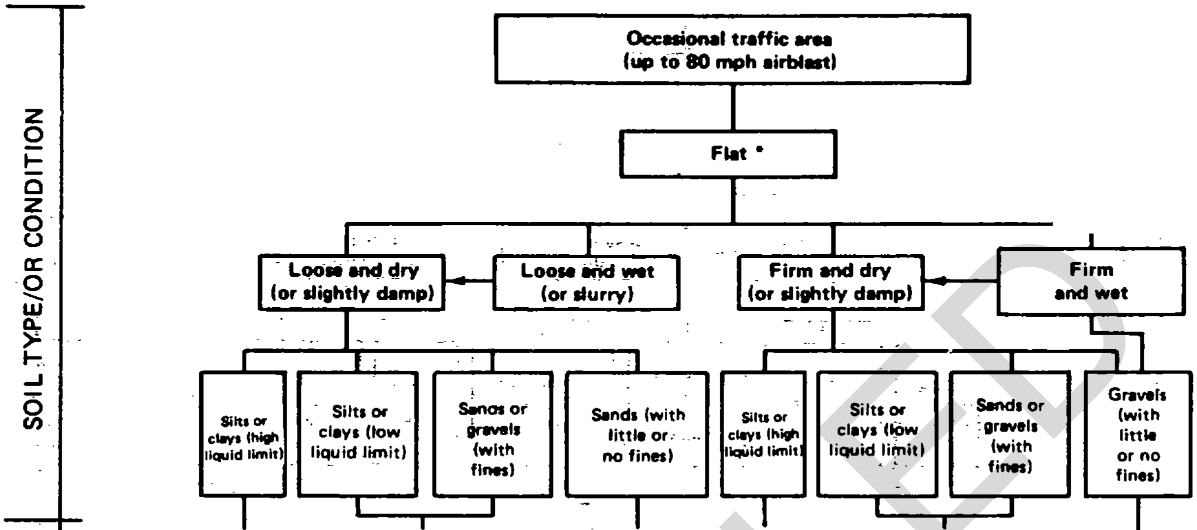
NOTE: Numbers refer to palliative numbers listed in table 4-4
***Hillside (ref para 2-3) applications for liquid dust palliatives should be reduced by half and then repeated if necessary to avoid runoff/waste.**

example, a dust palliative is not recommended for the agronomic method for a loose, sand soil with no binder nor is a dust palliative recommended for the surface penetration of a firm, clay soil (tables 4-1 and 4-2). Also the agronomic method of dust control is not recommended for any traffic area (table 4-3). The column of numbers representing dust palliatives identified in numerical order and separated by dust control method in table 4-4. Included in table 4-4 is the suggested rates of application for each dust palliative; gallon per square yard for liquid spray on applications, gallon per square yard per inch for liquid (or pound per square yard per inch for powders) admix applications.

4-3. Application rates'

The application rates should be considered estimates as stated above. Unfortunately the admix method and

Table 4-2. Dust palliative numbers for dust control in occasional traffic area.



DUST CONTROL METHOD

Method	Loose and dry: Silts or clays (high liquid limit)	Loose and dry: Silts or clays (low liquid limit); Sands or gravels (with fines)	Loose and dry: Sands (with little or no fines)	Firm and dry: Silts or clays (high liquid limit)	Firm and dry: Silts or clays (low liquid limit); Sands or gravels (with fines)	Firm and wet: Gravels (with little or no fines)
Agronomic	1	1		1	1	No treatment necessary
Surface Penetrant	6 10 13 17 26	6 10 13 17 23 26	6 10 13 17 19 26		6 10 13 17 23 26	
Admix	32 35 38 41	29 32 35 38 41	29 35 38 41	32 35 38 41	29 32 35 38 41	
Surface Blanket	43 45 49 52 55 61	43 45 49 52 55 61	43 45 49 52 55 61	43 45 49 52 55 58	43 45 49 52 55 58	

NOTE: Numbers refer to palliative numbers listed in table 4-4
***Hillside (ref para 2-3) applications for liquid dust palliatives should be reduced by half and then repeated if necessary to avoid runoff/waste.**

some surface blanket methods represent, a full commitment. Should failure occur after selection and placement, the, only, recourse is to completely; retreat-the failed area which is a lengthy, involved process. However, should failure occur on a section treated with a, liquid, dust palliative, retreatment of the failed area is relatively simple involving only a distributor and operator. A second application is encouraged as soon as it is determined that the initial application rate is not achieving the desired results.

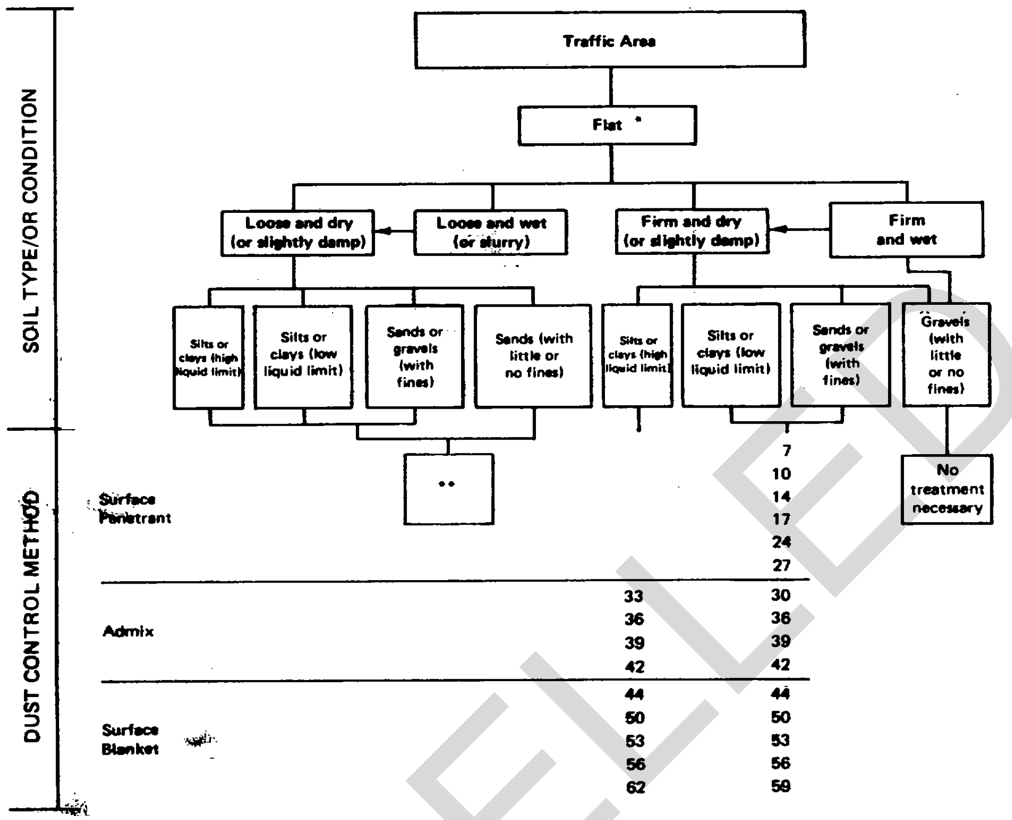
4-4. Placement

No treatment- is suggested for areas containing large dense vegetation and/or large debris. Loose soil in a wet or slurry condition and firm soil that is wet should not be treated (dust problems should not exist in any of-these areas). However, if- these areas are known dust producers when dry, they should be dried or conditioned and then treated.

4-5. Dilution

Several dilution ratios are mentioned for some liquid dust palliatives. The ratios are presented as volume of

Table 4-3. Dust palliative numbers for dust control in traffic area.



NOTE: Numbers refer to palliative numbers listed in table 4-4.
*** Hillside (ref para 2-3) applications for liquid dust palliatives should be reduced by half and then repeated if necessary to avoid runoff/waste.**
**** Upgrade to a firm condition.**

concentrate to volume of water and should be viewed as a necessary procedure before a particular liquid can be sprayed. The water is a necessary vehicle to get the dust palliative on the ground. *The stated application rate is for the dust palliative* (only). When high dilution ratios are required to spray adjust palliative, extra care should be taken to prevent the mixture flowing into adjacent areas where, treatment may be unnecessary and/or into drainage ditches. Two or more applications may be necessary to achieve the desired application rate. Considerable time can be saved by first determining the minimum dilution that permits a dust palliative to be sprayed.

4-6. Prewet

All liquid dust palliatives present a better finished product when they are sprayed over an area that has been prewet with water. The actual amount of prewet water varies but usually ranges from 0.03 to 0.15 gallons per square yard. The prewet water should not-be allowed to pond on the surface and all exposed soil should be completely dampened. The performance of brine materials is enhanced by increasing the amount of prewet water two to three times the usual recommendation. However the water should not be allowed to pond, and the fine sized particles should not be washed away.

Table 4-4. Dust palliative electives.

Palliative Number	Material[a]	Rate of Application [b]	Estimated[c] Service Life
		AGRONOMIC METHOD	
1	Vegetative	See TM 5-830-2/AFM 88-17, Chap 2 and AR 420-74	5 yr to permanent
2	Mulch	See TM 5-830-2/AFM 88-17, Chap 2 and AR 420-74	6-12
3	Shelter belt	As determined by trial	3-5 yr to permanent
4	Rough tillage	Each 25 to 100 ft	1-4
		SURFACE PENETRANT METHOD	
	Bituminous Materials		
	Cutback asphalt		
5	SC, YC, RC; grades 30-250	0.33	4-6
6	SC, MC, RC; grades 30-250	0.50	1-3
7	SC, MC, RC; grades 30-250	0.50	1
	Emulsified asphalt		
8	SS or CSS	0.33	4-6
9	SS or CSS	0.50	1-3
10	SS or CSS	0.50	1
	Road tar and road tar cutback		
11	RT grades 1-6, RTCB grades 5-6	0.33	2-4
12	↓	0.50	5-7
13	↓	0.50	2-4
14	↓	0.50	1-2
15	Asphalt penetrative soil binder (APSB)	0.33	5-8
16	APSB	0.50	5-8
17	APSE	0.50	1-4
Resinous Materials			
18	Resin in water emulsion	0.50	3-9
19	Resin in water emulsion	0.50	1-3
20	Lignin (8X solids)	0.50	1-3
21	Concrete curing compound	0.33	1-3
Brine Materials			
22	Salt in water emulsion	0.33	10-14
23	Salt in water emulsion	0.50	8-12

(Continued)

[a]Users must insure that materials comply with existing EPA regulations for the intended use.
[b]Rate of application in gallons per square yard unless otherwise noted.
[c]Estimated service life in months unless otherwise noted.

(Sheet 1 of 3)

Table 4-4. Dust palliative electives - (continued).

Palliative Number	Material[a]	Rate of Application [b]	Estimated[c] Service Life
	SURFACE PENETRANT METHOD (Continued)		
24	Salt in water emulsion	0.67	6-12
25	Water	0.25	1 hr
26	Water	0.33	1 hr
27	Water	0.50	1 hr
	ADMIX METHOD*		
	<u>Cementing Materials</u>		
28	Portland cement	1.5 lb per sq yd per in.	4-6
29	Portland cement	2.5 lb per sq yd per in.	4-6
30	Portland cement	4.0 lb per sq yd per in.	4-6
31	Hydrated lime	1.5 lb per sq yd per in.	4-6
32	Hydrated lime	2.5 lb per sq yd per in.	4-6
33	Hydrated lime	4.0 lb per sq yd per in.	4-6
	<u>Bituminous Materials</u>		
	Cutback asphalt		
34	SC, MC, RC; grades 70-250	0.15 gal per sq yd per in.	4-6
35	SC, MC, RC; grades 70-250	0.25 gal per sq yd per in.	4-6
36	SC, MC, RC; grades 70-250	0.40 gal per sq yd per in.	4-6
	Emulsified asphalt		
37	SS-or CSS	0.10 gal per sq yd per in.	4-6
38	SS or CSS	0.30 gal per sq yd per in.	4-6
39	SS or CSS	0.50 gal per sq yd per in.	4-6
	Road tar and road tar cutback		
40	RT grades 1-6; RTCB grades 5-6	0.15 gal per sq yd per in.	4-6
41	RT grades 1-6; RTCB grades 5-6	0.25 gal per sq yd per in,	4-6
42	RT grades 1-6; RTCB grades 5-6	0.40 gal per sq yd per in.	4-6
	SURFACE BLANKET METHOD		
43	Aggregates	2 in. thick	2-3 yr
44	Prefabricated membrane	1 layer	3-6
45	Prefabricated membrane	1 layer	6-9
46	Prefabricated membrane	1 layer	4-5 yr
47	Fabricated mesh	1 layer	9-12
48	Bituminous surface treatment	0.15 prime; 0.25-0.35 cover	1-2 yr

(Continued)

*Suggested minimum thickness, 4 inches. See TM 5-331A and TM 5-822-4.

(Sheet 2 of 3)

Table 4-4. Dust palliative electives - (continued).

Table 4-4. (Concluded)

Palliative Number	Material[a]	Rate of Application [b]	Estimated[c] Service Life
	SURFACE BLANKET METHOD (Continued)		
49	Bituminous surface treatment	0.25 prime; 0.25-0.35 cover	4-6
50	Bituminous surface treatment	0.40 prime; 0.25-0.35 cover	4-6
51	Polyvinyl Acetate (DCA 1295) diluted 3 parts concentrate to 1 part water	0.33	8-12
52	DCA 1295 diluted 3 parts concentrate to 1 part water	0.50	4-8
53	DCA 1295 diluted 3 parts concentrate to 1 part water	0.67	3-4
54	DCA 1295 diluted 3 parts concentrate to 1 part water with fiberglass reinforcing	0.33	8-16
55	DCA 1295 diluted 3 parts concentrate to 1 part water with fiberglass reinforcing	0.50	4-12
56	DCA 1295 diluted 3 parts concentrate to 1 part water with fiberglass reinforcing	0.67	3-6
57	Polypropylene-Asphalt Membrane	0.67	4-6
58	Polypropylene-Asphalt Membrane	0.67	8-12
59	Polypropylene-Asphalt Membrane	0.67	1-2 yr
60	Polypropylene-Asphalt Membrane	0.83	4-6
61	Polypropylene-Asphalt Membrane	0.83	8-12
62	Polypropylene-Asphalt Membrane	0.83	1-2 yr

(Sheet 3 of 3)

4-7. Cure

Most liquid dust palliatives require a cure period. DCA 1295 dries on the soil surface to form a clear film. The cure time varies depending on the weather at the time of placement but averages around 4 hours. Cure is complete when the in-place material becomes dry to the touch. Brine materials do not require a cure period and traffic can begin immediately following placement. Some bituminous materials are ready for traffic as soon as the material temperature drops to the ambient temperature. Traffic can begin immediately on the resinous material Coherex; when it dries (in several months) its effectiveness is lessened considerably.

CHAPTER 5

ECONOMICS

5-1. General

Dust control is based on many factors and methods. More than one dust palliative is normally found to be satisfactory for the method selected. Economic considerations should determine the dust palliative selected for use.

5-2. Economic factors

Economic factors should include, but 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 5-2c).

-Material storage costs (if applicable).

-Shipping costs, equipment acquisition/modification costs.

-Area preparation (clearing and grubbing should be expected at all sites).

From these factors, the most economical dust palliative can be determined.

a. Initial cost. The initial cost of the dust palliative should not be the governing factor in making the selection. Any suitable dust palliative already on hand should be given every consideration, especially when placement equipment is available.

b. Equipment and labor costs.

(1) *Agronomic method.* Costs associated with this method should closely parallel the local turf seeding or landscape planting operational costs in the area where dust control is desired. Landscape contractors or similar firms can provide rough estimates for planning purposes.

(2) *Surface penetrant and surface blanket.* Both of these methods recommend some spray on dust palliatives which can be placed with a common asphalt distributor. Bituminous materials lubricate the asphalt distributor pump when they pass through (this is an inherent feature of bituminous materials). In order to spray other types of dust palliatives (polyvinyl acetate, salts, etc.), the asphalt distributor pump should be altered for external lubrication of the pump shaft brushings as shown in figure 5-1. The alteration is estimated to cost less than $400 (1985). Aggregate and membrane costs are best taken from the supplier(s) near the area where dust control is planned. This is especially true for membrane costs. Labor costs associated with these two methods vary according to the size crew employed. The minimum size crew for spraying a dust palliative is one foreman and/or civil engineering technician, one distributor operator, and one laborer. It is possible to contract the application of dust palliatives. Many membrane suppliers will also contract to place their own materials.

(3) *Admix method.* This method is probably the most expensive method described. It requires equipment and man power similar to that associated with common road building techniques. The admix method requires a rotary tiller mixer, a motor grader, a rubber tired roller, and a water truck. The labor force requires a foreman, operators for the equipment, and two to four laborers. The number of laborers is determined by the method selected for distributing the admix material. The material cost; cement, lime, or bituminous material is best acquired from the supplier(s) nearest the area where dust control is desired. (See TM 5-822-4)

c . Maintenance. No dust-control method or dust palliative provides a maintenance-free solution. Indeed, frequent maintenance is usually required.

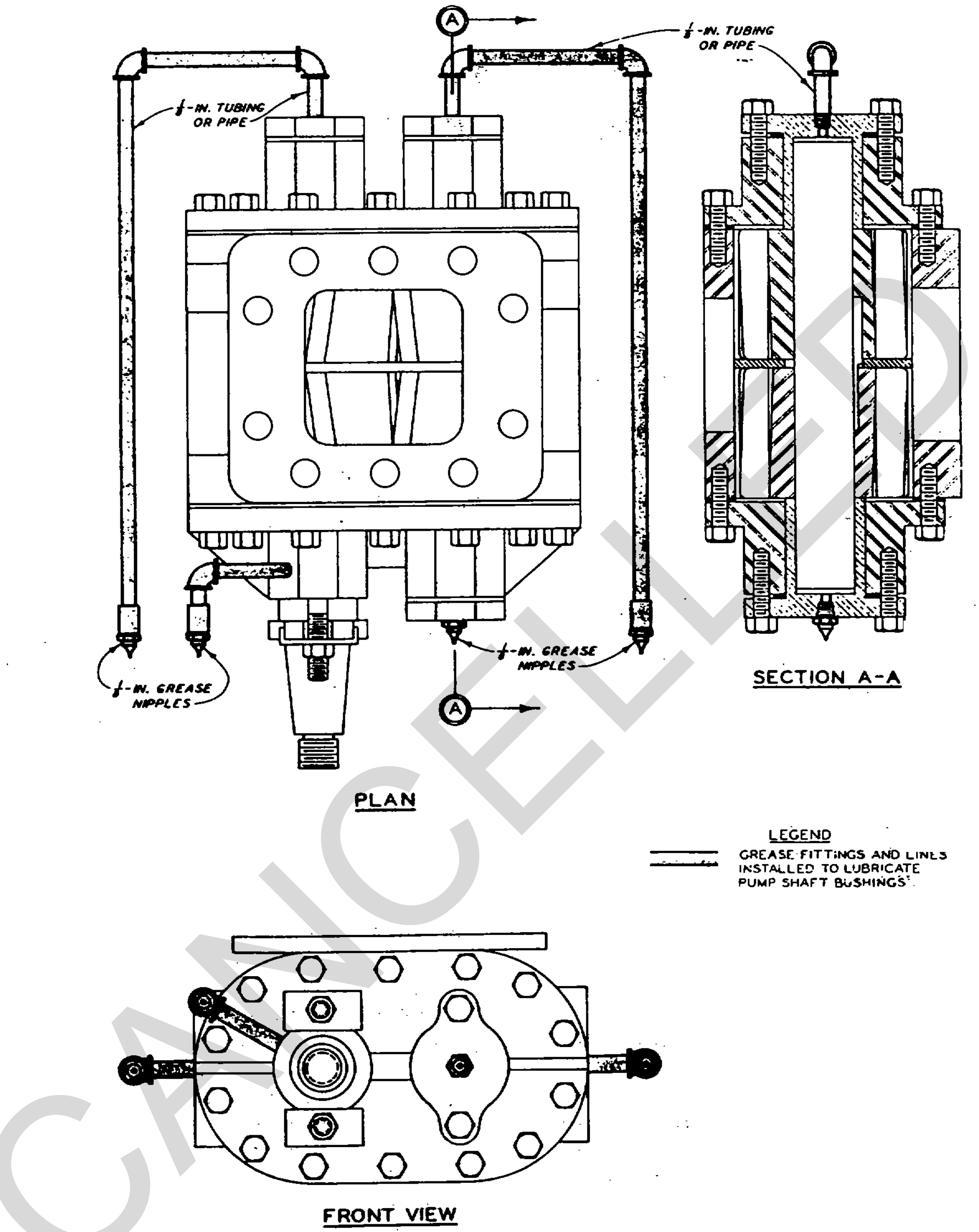


Figure 5-1. Typical pump modifications for conventional asphalt distributor.

Considerable thought should be directed toward ordering enough material for initial application plus an equal amount for 12 months maintenance. In the case of trafficked areas, maintenance can-be 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.

d. Material storage costs. Theft proof storage should be provided for all dust palliatives purchased until they can be applied. Some of the liquid dust palliatives must be protected from freezing temperatures. The manufacture should be consulted prior to purchase for storage information/ requirements. Powders such as lime and cement should be stored in a dry place with low humidity.

e. Shipping costs. Shipping or transportation costs will be incurred directly or indirectly with all dust palliatives.

f. Area preparation. Most sites will require some preparation. As a minimum expect to remove all large rocks 6 in. minimum measure and larger and all large sticks and stumps. If possible the area to be treated should be rolled with a rubber tired roller prior to prewetting to compact the soil and help prolong the dust control treatment.

5-3. Final selection

Some of the economic factors outlined in paragraph 5-2 will be 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 should be easier.

APPENDIX A

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E 11-81 — Wire Cloth Sieves for Testing Purposes

APPENDIX B

CONTROL OF WINDBORNE SAND

SECTION I
DESCRIPTION, DEFINITIONS, FORMATION, AND-CONTROL OF DUNES

B-1. Introduction

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

B-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-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. Some coastal dune formations have reached 1,000 feet in height. The three general types of sand dunes are described below; only the third type requires control.

a. 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. 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 deep. Because the fixed sand dune is immobile, it normally does not present a control problem. Figure B-1 -shows the more common types of fixed sand dune formations.

c. 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 (fig B-2). Longitudinal dunes are distinct ridges elongated in the direction of the predominant wind (fig B-2a). A combination of predominant and cross winds will produce a regular succession of of dunes (fig B-2b). Transverse; dunes are formed by wind 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 (fig. B-2c), and stronger

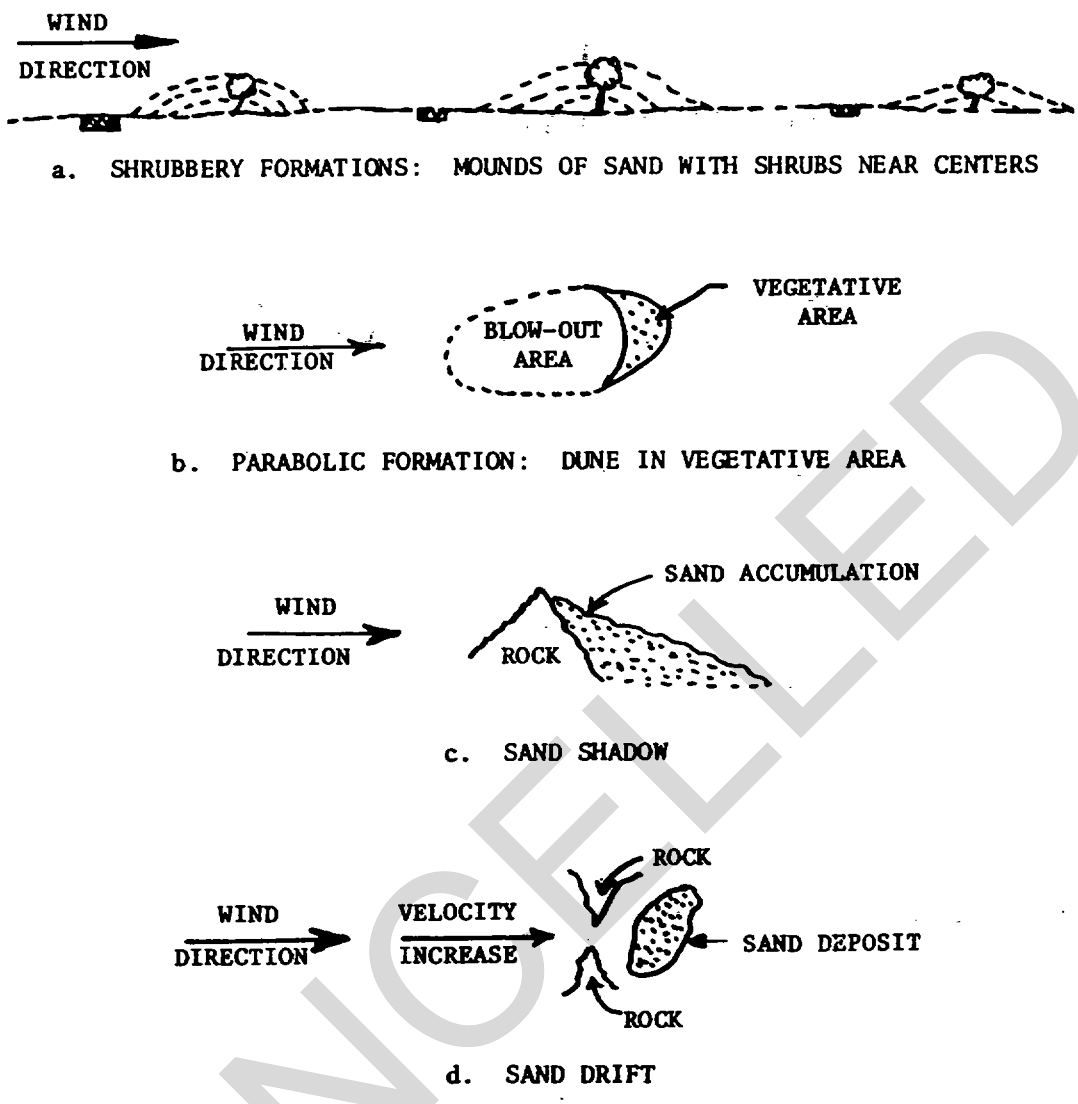

Figure B-1. Types of fixed sand dunes

winds form the more typical crescent-shaped or barchan transverse dune (fig B-2d).

B-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. Along the Bay of Biscay on the west coast of France, duties travel at-fates up to more than 100 feet per year.

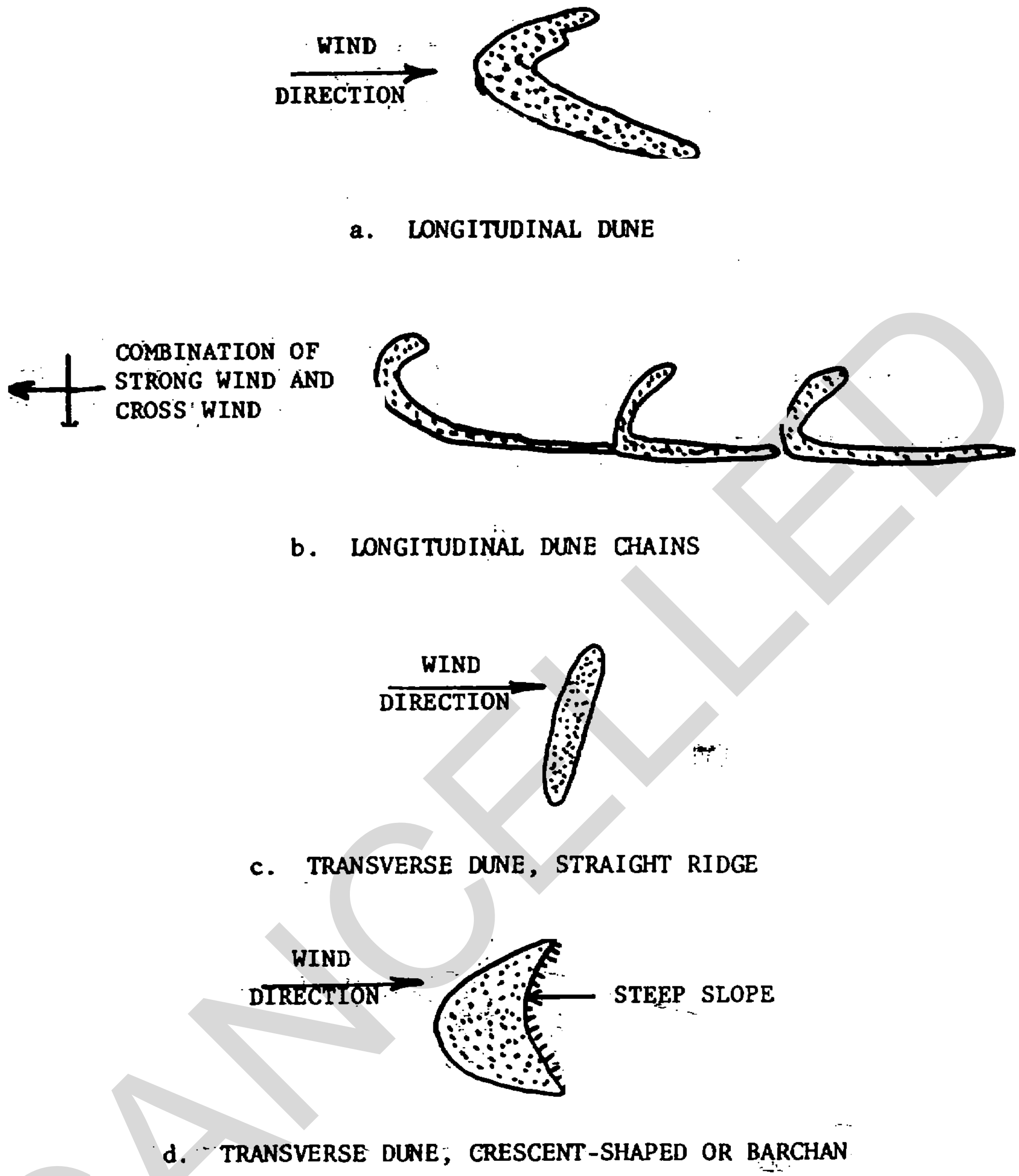

Figure B-2. Types of moving sand dunes

SECTION II CONTROL METHODS

B-5. Introduction

There are-many methods of sand control, with pertain advantages and disadvantage 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 singularly or in combination.

B- 6 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 about 1 foot 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

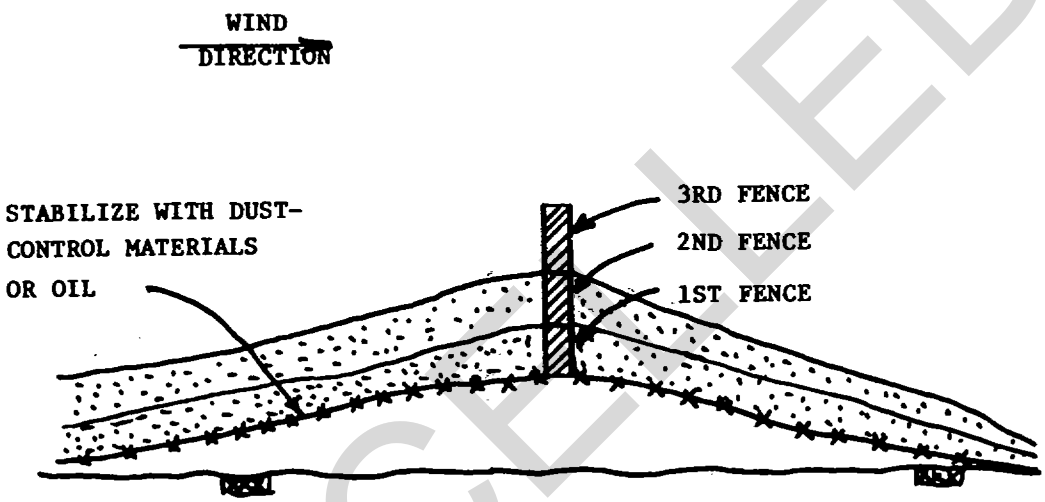

Figure B-3. Cross section of dune showing initial and subsequent fences.

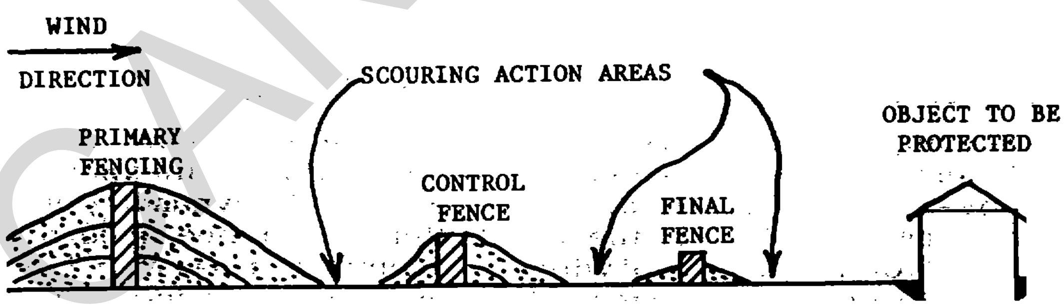

Figure B-4. Three fences installed to control dune formation usually should be at least four times the width of the dune.

B-7. 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 (fig B-5). When first erected, paneling appears to give excellent protection. However, panels are not self-cleaning, and the initial accumulations must be promptly removed 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 the 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.

B-8. 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 1 part petroleum resin emulsion with 4 parts water and spraying at the rate of 1/2 gallon per square yard. 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.

B-9. Vegetative treatment

Vegetative cover is an excellent method of sand stabilization. The vegetation to be established must often be drought resistant and adapted to the climate and soil. Most vegetative treatments are effective only if the supply of new sand is cut off. Upwind and water, fertilizers, and mulch are used liberally. 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. Usually 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

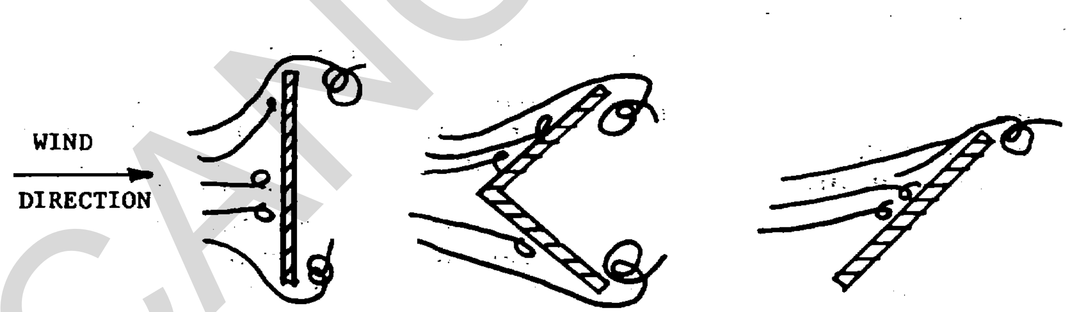

Figure B-5. Three types of solid fencing or paneling for control of dune formation

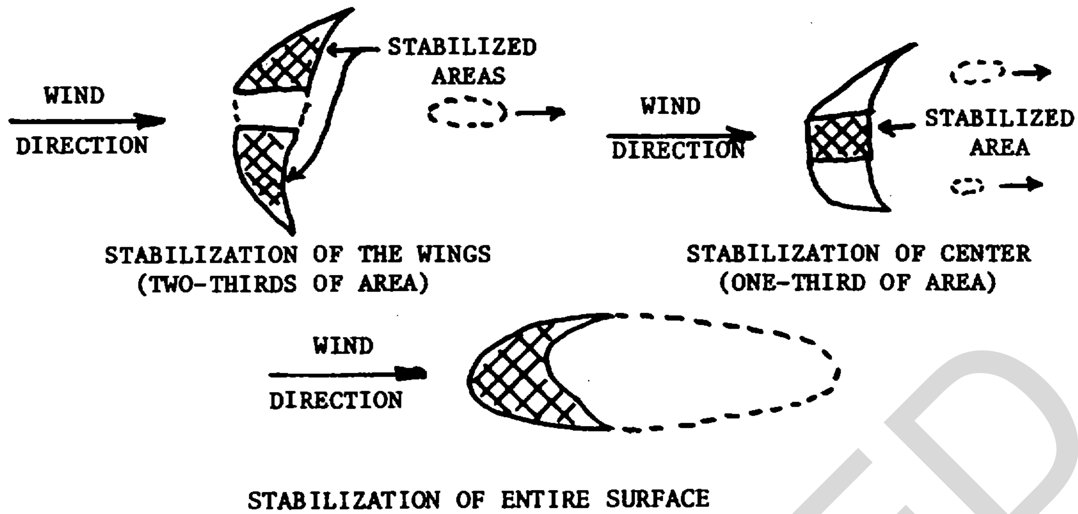

Figure B-6. Schematic of dune destruction or stabilization by selective treatment

advantages of permanence and environmental enhancement wherever water can be provided for growth.

B-10. 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 1. 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-12. Water

Water may be applied to sand surfaces to prevent sand movement. It is widely used and 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-13. Blanket 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. Blanket 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 blanket decomposition and subsequent dust.

B-14. 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 approximately 30 percent) artificial moisture in the form of water may have to be added to the treated area at a rate of 0.10-0.20 gallons per square yard to activate the salt solution.

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