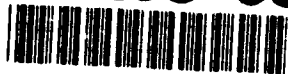
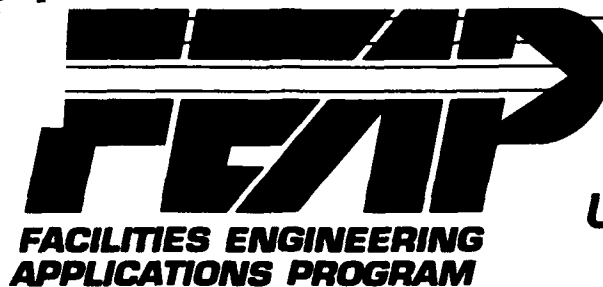


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March 1992

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USER'S GUIDE

USER'S GUIDE: DUSTPROOFING UNSURFACED AREAS

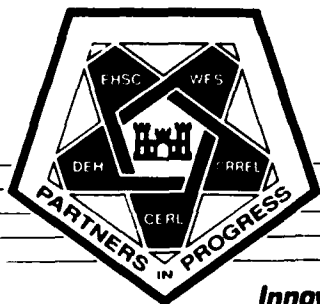
by

Richard H. Grau
US Army Engineer Waterways Experiment Station
Vicksburg, MS 39180-6199

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Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

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13. ABSTRACT (Maximum 200 words) This report documents field demonstrations of magnesium chloride, calcium chloride, and polyvinyl acetate used as dust suppressants on unpaved roadways and airfields. The demonstrations were conducted during FY 84-FY 86, and the sites were located at Fort Stewart, GA, Fort Bliss, TX, Fort Irwin, CA, Fort Chaffee, AR, and Fort Campbell, KY. The description, applicability, benefits, limitations, costs, recommended uses, and location of demonstrations for three dust control technologies are discussed.				
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USER'S GUIDE: DUSTPROOFING UNSURFACED AREAS

PART I: EXECUTIVE SUMMARY

Description

Dust has been a long time enemy of the Army, especially in a tactical scenario. It occurs when military equipment operates over dry, unsurfaced terrain. This dust occurs when the small surface particles of soil are scraped or rubbed away from the traveled surface by vehicle tires and tracks or aircraft landing gear and propeller wash, and then the dust is carried airborne by wind forces. A good structural material for gravel roads and assault airstrips is a coarse aggregate with sufficient sand to fill the voids and adequate fines to bind these materials together. Gradually as vehicles or aircraft pass over an unsurfaced area, sufficient small soil particles are displaced; so the larger soil particles become unstable. Ruts, potholes, and washboard begin to form, and soon maintenance will be required to reduce the severity and extent of deterioration. If sufficient fine soil particles are not replaced to stabilize the larger particles, the time between succeeding maintenance periods will be reduced, and annual maintenance cost will increase. In addition to the negative impacts of dust on the operating surface, it is a safety hazard (reduced visibility) and causes increased wear and tear on engines and rotor blades. A good dust control material resists the abrasion of the small soil particles, and a more stable and safer operating condition is realized over a longer period of time.

Application

Three dust control materials were selected for the demonstrations. The first was a polyvinyl acetate (PVA) liquid emulsion which is effective on most soil types when subjected to foot

or rubber-tired traffic. Before application, the as-received concentrate is diluted three parts concentrate to one part water for spraying purposes. Positive displacement pumps are best for applying this material and should be maintenance free or fitted for external lubrication. The other two materials were brine solutions. One was magnesium chloride ($MgCl_2$) and the other was calcium chloride ($CaCl_2$). The brine solutions are low viscosity hygroscopic materials sprayed directly onto the soil after pre-wetting. These solutions work best on well-graded gravel. Although with a more limited life span, these solutions have been used effectively on clay-type soils. Both brine solutions were applied by a contractor with a 4,000 gal distributor. During three of the demonstrations, $MgCl_2$ was applied with a Government owned asphalt distributor.

Benefits

Reduction in the migration of the fine materials in the surface of an unsurfaced pavement (i.e., controlling dust) will reduce the formation of ruts caused when sufficient fines are displaced to render the larger particles unstable. By limiting the instability of the fine material and postponing the formation of ruts, the need for blading and compacting is substantially decreased, resulting in lower maintenance costs. Other tangible benefits from using a dust control program are reduced vehicle operations costs, increased service life for vehicles especially rotary blades of aircraft, improved safety conditions (increased sight distance), and reduced nuisance (personal comfort).

Limitations

PVA provides a film that resembles a viscous white glue (before curing) and covers the surface like a blanket to prevent dust from becoming airborne. Because this surface film may be torn under heavy traffic conditions, it is better suited for non-traffic areas such as the shoulders of helipads and of airfield

runways. The brine solutions are recommended for use on well-graded cohesionless soils (sand and gravel) with moderate traffic. These solutions also provided a high degree of dust suppression on crushed-limestone-surfaced roads. Since the brine solutions are hygroscopic materials, the average relative humidity must be approximately 30 percent or more in order for them to be effective.

Costs

The costs for treating the soils with PVA was \$1.65/sq yd. This is a material cost only and does not include the cost for site preparation, prewetting, or material application. $MgCl_2$ was applied to the demonstration sites located on three of the military installations with a Government owned asphalt distributor. However, at Fort Campbell, both brine solutions were applied to the demonstration sites by a local contractor. The contract included prewetting of the sites before the brine solutions were applied. The cost of the $MgCl_2$ ranged from \$0.20 to 0.36/sq yd and the cost of the $CaCl_2$ was \$0.16/sq yd. The cost of the $MgCl_2$ varied because of transportation costs. Since the product is produced in the far west, it was less expensive when used at Fort Irwin, CA, than when it was used at Fort Campbell, KY. None of these costs include site preparation (grading and compaction) that is normally required prior to application of the dust control material.

Recommendation for Use

PVA can be applied to any type soil where dust control is desired. It will control dust adjacent to touchdown areas of C-130 aircraft, CH-47 helicopters, and all aircraft creating lesser surface wind velocities for a period of approximately 6 months. It can also be used with good effectiveness in areas trafficked by pneumatic-tired vehicles.

MgCl₂ is recommended for dust control of any cohesionless soil subjected to rubber-tired or tracked vehicle traffic. The material is hygroscopic and should remain effective 8 to 14 months in areas where the humidity stays above 30 percent. CaCl₂ can also be applied to any cohesionless soil where dust control is desired. It performs very well on gravel roads subjected to both rubber-tired and tracked vehicles. The material is also hygroscopic and should remain effective for 8 to 14 months on roads where the humidity remains above 30 percent. CaCl₂ has also been used on unsurfaced aircraft landing areas and was effective for approximately 2 months.

Points of Contact

Points of contact regarding this technology are as follows:

Technical:

Director
US Army Engineer Waterways Experiment Station
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Vicksburg, MS 39180-6199
Telephone: (601) 634-2494
Facsimile: (601) 634-3020

US Army Engineering and Housing Support Center:

Commander
US Army Engineering and Housing Support Center
ATTN: CEHSC-FB-P (Mr. Stan Nickell)
Fort Belvoir, VA 22060-5516
Telephone: (703) 355-0040
Facsimile: (703) 780-5935

Demonstration Sites:

Commander
ATTN: AFZP-DE (Mr. T. D. Houston)
Fort Stewart, GA 31314-5000
Telephone: (912) 767-8356

Commander
ATTN: ATZC-DEH (Mr. Enrique Rey)
Fort Bliss, TX 79916-6100
Telephone: (915) 568-6200

Commander
ATTN: AFZJ-EH (Mr. W. Cassidy)
Fort Irwin, CA 92310-5000
Telephone: (619) 386-3433

Commander
ATTN: ATZR-B-FE (Mr. James Lowe)
Fort Chaffee, AK 72905-5000
Telephone: (501) 484-2840

Commander
ATTN: AFZB-DEH (Mr. R. Stevens)
Fort Campbell, KY 42223-5000
Telephone: (502) 798-8980

PART II: PREACQUISITION

Description of Technology

Dust generated by vehicles or aircraft can hamper operations, decrease safety, and cause premature equipment failure. To remedy these problems, the use of three dust control materials were demonstrated at selected sites. A surface blanket method using a PVA emulsion diluted with water was one of the solutions demonstrated. PVA provides a film that resembles a viscous white glue (before curing) and covers the soil surface like a blanket to prevent dust from becoming airborne. Because this surface film may be torn under heavy traffic conditions, it is better suited for nontraffic areas such as the shoulders of helipads or airstrips. This material is also effective on areas subjected to foot traffic or rubber-tired traffic if the strength of the soil is adequate to support the loads. The second method demonstrated was the surface penetration method using two brine solutions. These solutions, $MgCl_2$ and $CaCl_2$, were applied directly onto the soil surface as received (no dilution required). These solutions work best on well-graded gravel, but have been used effectively on clay-type soils for shorter periods of time. The brine solutions draw moisture from the atmosphere causing the smaller dust particles to bind to coarser material. The effective life of these solutions is greatly enhanced when compaction equipment is used after application and prior to use. Gravel roads may be traversed immediately after application, but fine-grained soils may require some cure time. This dustproofing method is best for highly traveled areas.

Application

The area to be treated should be bladed, compacted, and prewet prior to the application of a dust palliative. Blading with a motor grader is required to remove all loose material, ruts, potholes, and washboard. Dust control materials do not

impart any additional strength to the soil. Therefore, time spent compacting loose material prior to treatment enhances the effectiveness of the dust control system. Prewetting with water is recommended to reduce surface tension, allow maximum penetration of the dust control material, and ensure uniform application of the dust control material over the applied area. The amount of water required for the prewetting operation ranges between 0.03 and 0.30 gal/sq yd, and is dependent upon surface conditions, soil type, and prevailing weather conditions. The manufacturers of PVA and $MgCl_2$ strongly recommend prewetting of any soil type prior to application of their product. The manufacturer of $CaCl_2$ states that prewetting is not necessary because of its inherent penetrating capabilities. If prewetting is performed, any water that has ponded should be broomed or swept away before application of the dust control material.

PVA is a proprietary product consisting of a PVA emulsion modified with plasticizers, surfactants, and other inorganic elements. Before application, the as-received concentrate is diluted three parts concentrate to one part water for spraying purposes. This material closely resembles white latex paint. It dries in approximately 4 hr depending on the ambient weather conditions. The cured material forms a clear durable film over the treated area. The recommended application rate varies from 1/3 to 2/3 gal/sq yd depending on the treated areas predicted use as stated in TM 5-830-3/AFM 88-17, Chap. 3 (Headquarters, Departments of the Army and Air Force 1987). Both the concentrate and the cured forms of this material are harmless with basic hygiene practices.

$MgCl_2$ is a commercial by-product of a mining operation. The amber liquid brine is composed mainly of $MgCl_2$ which is the primary dust control ingredient. The liquid is applied as received with no dilution necessary at a rate of 0.5 gal/sq yd. The liquid is moderately corrosive but harmless with basic hygiene practices.

$CaCl_2$ is a clear liquid brine used to provide dust control on cohesionless soils. This liquid is applied as received at an

application rate of 0.3 gal/sq yd. CaCl_2 is also moderately corrosive but harmless with basic hygiene practices.

Limitations/Disadvantages

The primary objective of these dust control materials is to prevent soil particles from becoming airborne; they are not soil stabilizers that increase the bearing strength of the trafficked area. Therefore, an important factor limiting the applicability of these dust palliatives in traffic areas is the extent of surface rutting that will occur under traffic. The effectiveness of the treatment is destroyed rapidly by rutting and any remaining dust palliative is quickly stripped from the ground surface.

Prewetting of the areas to be treated with the dust palliatives is recommended. The amount of water required during the prewetting operation ranges between 0.03 and 0.30 gal/sq yd, but the amount is dependent upon surface conditions, soil type, and prevailing weather conditions. Therefore, a convenient water point should be located and a large capacity (4,000 to 5,000 gal) water distributor is recommended. If a stream or pond is used for the water point, a pump will be required to fill the distributor.

When PVA is used, it must be transported, stored, and permitted to cure at a minimum temperature of 40°F. If allowed to freeze, this material crystallizes, which is an irreversible process. Distributors equipped with positive displacement pumps are best for applying this material and should be maintenance free or fitted for external lubrication. PVA should not be applied to areas that will be trafficked with tracked vehicles.

Since the brine solutions are hygroscopic, they are not effective when the relative humidity is less than 30 percent. As with the PVA, the brine solutions should be applied with distributors equipped with positive displacement pumps. The solutions are considered corrosive and could affect exposed metal on vehicles and/or aircraft that traffic treated areas. It is

recommended that these vehicles and aircraft be thoroughly washed in the after operations preventative maintenance period.

FEAP Demonstrations/Implementation Sites

In 1984 demonstrations were conducted at Fort Stewart, GA and Fort Bliss, TX. The PVA demonstration site at Fort Stewart was a 200 ft by 90 ft unsurfaced loading/unloading area located adjacent to a warehouse. The site was bladed smooth with a motor grader, prewet, and treated with PVA that was diluted at a rate of three parts PVA to one part water. The PVA was applied with an asphalt distributor at a rate of 0.50 gal/sq yd. The pump on the distributor was modified so it could be externally lubricated. Traffic was maliciously applied to the demonstration site before the PVA had cured and caused tears in the surface film. The damaged treatment could not be repaired; therefore the demonstration was terminated.

The $MgCl_2$ demonstration site at Fort Stewart was a 30 ft by 4,860 ft unsurfaced road used primarily by military tracked and wheeled vehicles. The soil was classified by the Unified Soil Classification System (USCS) as a brown silty sand (SP-SM). After the road was bladed with a motor grader and prewetted, $MgCl_2$ was applied at a rate of 0.50 gal/sq yd with an asphalt distributor. During the 4 day demonstration period, 2 in. of rain fell on the treated section, but no reduction in performance was noticed.

The PVA demonstration site at Fort Bliss was a nontraffic area measuring 110 ft by 180 ft. The surface material was a brown gravelly silt classified as a SP-SM soil. After the area was graded with a motor grader, it was prewetted and then the diluted PVA was applied at a rate of 0.44 gal/sq yd with an asphalt distributor. Small depressions and ruts (caused by the distributor tires) were filled with PVA during the application process. These ponded areas cured much more slowly than the nonrutted areas, but did not impair the dust control integrity of the treat area.

Nine thousand gallons of $MgCl_2$ were placed on a Fort Bliss tank trail that was adjacent to the Southern Pacific Railroad Line. All types of wheeled vehicles (both military and civilian) used the road in addition to the tracked vehicles. The treated area was 24 ft wide by 6,750 ft long. The road material was classified by the USCS as a brown gravelly clayey sand (SM-SC). After the roadway was bladed and prewet, the asphalt distributor was used to apply the $MgCl_2$ at a rate of 0.5 gal/sq yd. The asphalt distributor was loaded directly from the railroad car used to ship the $MgCl_2$. No cure time was required for the treated roadway.

Seven areas were selected as demonstration sites at Fort Irwin, CA. All of these areas were treated with $MgCl_2$ in 1985. Three of the areas were tank trials and the others were maintenance, marshaling, or bivouac area. A total of 104,816 sq yd were treated with 48,900 gal of $MgCl_2$ for an overall application rate of 0.47 gal/sq yd. The areas were prepared for treatment first by blading the surface with a motor grader to remove ruts, potholes, and loose surface material. The blading exposed a fairly hard surface. So it was decided that compaction of the areas was not required. A 5,000-gal commercial water truck was used to prewet the areas at a rate of approximately 0.30 gal/sq yd. A 900-gal asphalt distributor was used to apply the $MgCl_2$ to the area at a rate of approximately 0.50 gal/sq yd. Rolling of the treated areas was not necessary because traffic was anticipated the following day.

Fort Chaffee, AK, was also a 1985 demonstration site. The site consisted of a 4,500 ft long by 110 ft wide C-130 aircraft assault runway. The soil on the runway was classified as a gravelly, sandy, red clay. The area was prepared by blading it smooth with motor graders and then prewetting the surface with a 1,000-gal water distributor at an application rate of approximately 0.75 gal/sq yd. This high rate was used because the wind and heat conditions caused a fast evaporation rate of the water. An asphalt distributor was used to apply the $MgCl_2$ at a rate of 0.43 gal/sq yd. Because of the clayey material in the soil,

24 hr were required for the brine solution to cure. Following the cure period, a pneumatic rubber-tired roller made six passes over the treated section to compact the fine material and the gravelly material together, and then a steel-wheel roller made two passes for the final compaction.

During the final compaction phase, a heavy rain occurred with a total accumulation of approximately 2 in. in a 24-hr period. This rain caused the compacted surface to swell. After allowing the surface to dry, an additional two passes of the rubber-tired roller and one pass of the steel-wheel roller were performed to ensure compaction treated surface was accomplished. The final product was a smooth, well-compacted surface.

Of special note during this project was the effect of overnight humidity on the $MgCl_2$ treated surface of the assault airstrip. The clayey material on the runway would absorb moisture from the cool, night air causing the surface to slightly swell and become sticky. As the sun and wind evaporated the excess moisture, the surface material would shrink and crack. Passing over the area with the steel-wheel roller one time tightened this surface. The best overall surface occurred in areas where gravel complemented the clayey fines.

In 1986, demonstration sites at Fort Campbell, KY, were selected for treatment with $CaCl_2$ or $MgCl_2$. A contractor was funded to prewet and apply the brine solutions to the areas. $CaCl_2$ was applied to 15 miles of crushed limestone surfaced roads that ranged in width from 18 to 24 ft. A 3,900-ft-long by 100-ft wide sandy clay assault runway and a 350-ft by 150 ft taxiway were also treated with $CaCl_2$. $MgCl_2$ was used to treat 5.6 miles of a crushed limestone surfaced roadway. Both military and civilian vehicles trafficked on all of the roadways.

All of the roadway sites were graded during a 1-day period. Prewetting of the roadway sites was not necessary because rain fell intermittently during the two days when the brine solutions were applied. The solutions were applied with 4,000 gal commercial spreader trucks. Average application rates for the $CaCl_2$ and $MgCl_2$ were 0.30 and 0.50 gal/sq yd, respectively. None of

the roadway sites were compacted after treatment. Wheeled vehicular traffic was allowed on the sites immediately after the materials were applied. Very little dust was noticed on any of the treated areas.

Prior to applying CaCl_2 to the runway and taxiway, the areas were bladed with a motor grader and compacted with a pneumatic-tired and steel-wheel roller. The following day, the areas were prewet at a rate of 0.20 to 0.25 gal/sq yd followed by a single pass with an 18-ft-long spray bar applying CaCl_2 at a rate of 0.35 gal/sq yd. Heavy rains forced the cancellation of C-130 sorties that were scheduled after the CaCl_2 was applied. Six weeks later, C-130 aircraft conducted sorties on the runway. Less dust (approximately 50 percent) was generated on the treated runway than on the nontreated runway, but the volume of dust still left an easily recognizable signature of military operations. The performance is attributed to the rainfall immediately after the area was treated and the type soil used to construct the runway.

Life-Cycle Costs

Based on the demonstration projects, the cost of MgCl_2 including the application cost ranged from \$0.20 to 0.36/sq yd. The costs varied because of transportation cost. Since the product is produced in the far west, it was less expensive when used at Fort Irwin, CA, than when it was used at Fort Campbell, KY. The combined material and application costs of CaCl_2 demonstrated at Fort Campbell, KY, was \$0.16/sq yd. DCA-1295 costs \$1.65/sq yd when used to treat soils at the Fort Stewart and Fort Bliss sites.

Since both CaCl_2 and MgCl_2 control airborne dust particles by binding the fines (dust) with the larger particles in the road surface, the net result is a road surface that resists rutting longer and substantially reduces dust. It has been estimated that their use on gravel roads can reduce regravelling 1 ton/mile/year. This can result in a maintenance cost savings of 10 to

30 percent per year. The effectiveness of the brine solutions should last 12 months on the gravel roads. Due to the cohesive nature of the assault runway soils at the demonstration site, the effectiveness of the brine solutions there does not exceed 6 months.

Advantages and Benefits

The brine solutions were performed in similar fashion and were most effective on cohesionless, well-graded (sand and gravel) soils. Both controlled dust on unsurfaced soils trafficked by wheeled and tracked vehicles. They were not effective on totally fine-grained soils. Leaching of the products will occur in areas of excessive rain. In order for either of the products to perform well, the average relative humidity must be at least 30 percent. The DCA-1295 is effective on all soil types when applied to nontrafficked areas such as the shoulders of helicopter pads and assault runways, and remains so for approximately 12 months. Since DCA-1295 forms a film on the soil, rainfall will not cause the material to leach.

The tangible benefits from using a dust control program are reduced material loss (approximately 1 ton of gravel per mile of road per year), reduced maintenance costs, reduced vehicle operations costs, reduced dust intrusion, increased service life for vehicles, and especially rotary blades of aircraft. Placing a benefit to cost on dust palliatives is difficult, since the benefits are in the form of reduced nuisance (personal comfort), safety (increased sight distance), and decreased operation and maintenance cost in aircraft and military vehicles.

PART III: ACQUISITION/PROCUREMENT

Potential Funding Sources

Typically, installations fund the implementation of pavements and railroads technologies out of their annual budgets. However, the annual budget is always underfunded and normally the pavements and railroads projects just do not compete well with other high visibility/high interest type projects. As a result, it is best to seek all of the funds possible from other sources when the project merits the action. Listed below are some sources commonly pursued to fund projects.

- a. Productivity program. See AR 5-4, Department of the Army Productivity Improvement Program for guidance to determine if the project qualifies for this type of funding.
- b. Facilities Engineering Applications Program (FEAP). In the past, a number of pavement and railroad maintenance projects located at various installations were funded with FEAP demonstration funds. At that time, emphasis was placed on demonstrating new technologies to the Directorate of Engineering and Housing (DEH) community. Now that these technologies have been demonstrated, the installations will be responsible for funding their projects through other sources. However, emphasis concerning the direction of FEAP may change in the future; therefore, do not rule out FEAP as a source of funding.
- c. Special programs. Examples of these are as follows:
 - (1) FORSCOM mobilization plan which may include rehabilitation or enlargement of parking areas and the reinforcement of bridges.
 - (2) Safety program which may include the repair of unsafe/deteriorated railroad crossings and ammunition storage areas.
 - (3) Security upgrade which may include the repair or enlargement of fencing.
- d. Reimbursable customer. Examples of this source are roads to special function areas such as family housing or schools and airfield pavements required to support logistical operations.
- e. Special requests from MACOMS.

- f. Year end funds. This type funding should be coordinated with the MACOMS to ensure that the funds will not be lost after a contract is advertised.
- g. Operations and Maintenance Army. These are the normal funds used for funding pavement and railroad projects.
- h. Training exercises. Conduct training exercises in dust palliative application by engineer troop units resident at the installation.

Technology Components and Sources

Usually the only component required to be procured is the dust control product. It may be advantageous to award a single contract that includes prewetting the area to be treated and purchasing and applying the product. Experienced contractors will have large capacity (5,000 gal or greater) transport/spreader trucks which will greatly enhance daily production when compared to equipment normally available to DEH personnel. The only design work required will be the selection of a dust control product which is determined by the anticipated traffic and the type of soil at the site. This information is included in easy-to-follow flow diagrams published in TM 5-830-3/AFM 88-17, Chap. 3 (Headquarters, Departments of the Army and Air Force 1987).

During all of these demonstrations except one, the products were purchased from a supplier and then applied with a modified asphalt distributor that was owned by the Waterways Experiment Station. A list of the suppliers of the three dust control products used during the demonstration are as follows:

DCA-1295 (polyvinyl acetate)
Union Carbide Corporation
40 Veronica Avenue
Somerset, NJ 08873
(201) 823-3793

Magnesium Chloride
Kaiser Chemical
7311 E. 41st Street
Tulsa, OK 74145
(918) 627-0100

Calcium Chloride
Dow Chemical
4150 S. Sherwood Forrest Blvd, Suite 101
Baton Rouge, LA 70816
(504) 293-2222

During the demonstration at Fort Campbell, KY, a contract was awarded to one company to prewet the areas and to furnish and apply $MgCl_2$ and $CaCl_2$. The contract was awarded to:

W & W Sales & Leasing Co.
119 S. Main St.
P.O. Box 486
Edwardsville, IL 62025-0486

Procurement Documents

The DEH is usually capable of preparing all documents required for the purchase of dust control products or the services of a contractor to furnish and apply these products. The specifications should include the responsibilities of the Government and the contractor. Usually the Government will be responsible for grading and compaction of the sites. The Government should also provide descriptions and locations of the sites and locations of storage areas and water sources. The contractor is usually responsible for the delivery of the product and in some case the prewetting and application of the product. The PVA should conform to Military Specification, MIL-M-52882 (ME), entitled "Membrane, Liquid, Dust Control," and $CaCl_2$ and $MgCl_2$ are common commercially available materials that are described in the example specification in Appendix C.

Procurement Scheduling

Dust is usually more evident during the hot dry season and is not as much of a problem during the rainy season. Therefore, it is usually more reasonable to schedule the application of dust control products in early summer.

If PVA is to be used, it must not be transported, stored, or applied at temperatures below 40°F. If allowed to freeze, this

material crystallizes, an irreversible process. Aggregate surfaced roads treated with CaCl_2 or MgCl_2 may be trafficked immediately after the brine solution has been applied; therefore, no traffic interruption should be anticipated. A minimum cure period of 4 hr is required for PVA. None of these products required a long lead time for procurement.

PART IV: POST ACQUISITION

Initial Implementation

Equipment

A motor grader is needed to blade the area to be treated, and a rubber-tired roller and/or steel-wheel roller is needed to compact the bladed surface. A water truck is required to prewet the surface and a distributor with a positive displacement pump or a common asphalt distributor can be used to apply the dust control product. If an asphalt distributor is used, its pump must be modified to permit external lubrication since none of these products are natural lubricants. The distributor should be thoroughly cleaned and flushed with diesel fuel at the end of the project.

Personnel

Experienced operators are required for the motor grader, compaction equipment, water truck, and asphalt distributor. A civil engineering technician or an engineer familiar with dust control material application should be present when the material is being placed.

Procedure

The following is a general procedure for planning the application of dust control products to an area.

- a. Determine the area to be treated (square yards).
- b. Evaluate the surface soils and classify according to USCS. Consult TM 5-830-3/AFM 88-17, Chap. 3 (Headquarters, Departments of the Army and Air Force 1987) for suitability of treatment method and application rate.
- c. Order enough material to treat the area.
- d. Plan the project so equipment and personnel are available to accomplish the preparation and application procedures in an orderly step-by-step process.
- e. Select a storage area for the materials near the project site.
- f. Locate a water point.

The following is a general construction procedure for applying dust control products to an area.

- a. Blade away all ruts, potholes, washboard, and loose excess surface material.
- b. Compact the bladed surface (as necessary) with a pneumatic rubber-tired roller to ensure a hard surface is achieved so rutting is not caused by traffic.
- c. Prewet the selected area (as necessary) to reduce surface tension and increase the brine solution penetration. Recommended application rate for the prewetting operation is between 0.03 to 0.30 gal/sq yd (application rate is dependent upon temperature, soil type, and evaporation rate).
- d. Dilute the PVA at a rate of 3 parts concentrate to 1 part water prior to application. The brine solutions should be applied as delivered, they do not need to be diluted.
- e. Spray the dust control product with a device capable of metered application at the manufacturer's recommended application rate. A 6- to 12-in. overlap of treated strips is required to ensure a uniform application is maintained on the treated area.
- f. Allow treated area to cure until vehicle passage can be achieved without the treated material sticking to the wheels. Vehicles can be allowed to traffic gravel roads almost immediately. Finer grained materials may require a longer curing time.
- g. Compact treated area (as necessary) after curing is complete. Finer grained soils generally require some compaction, whereas coarse gravel does not.

Operation and Maintenance

PVA is biodegradable and will dissolve from a treated soil area with continued exposure. A second application at one-half the rate of the first application should be planned/anticipated following 10 to 14 months of service.

Following periods of low rainfall and low humidity (humidity less than 30 percent), the hygroscopic properties of the brine solutions will be rendered ineffective, and dust will appear again. The solutions can be reactivated with an application of plain water at approximately 0.10 to 0.20 gal/sq yd. Periodic watering should be repeated as long as the dry period continues. Salts leach from the treated soil with continued exposure. A second application should be planned/anticipated following 10 to 14 months of service. The second application should be the same as the first except applied at 0.25 gal/sq yd.

Service and Support Requirements

No special services or support is required to implement or maintain this technology.

Performance Monitoring

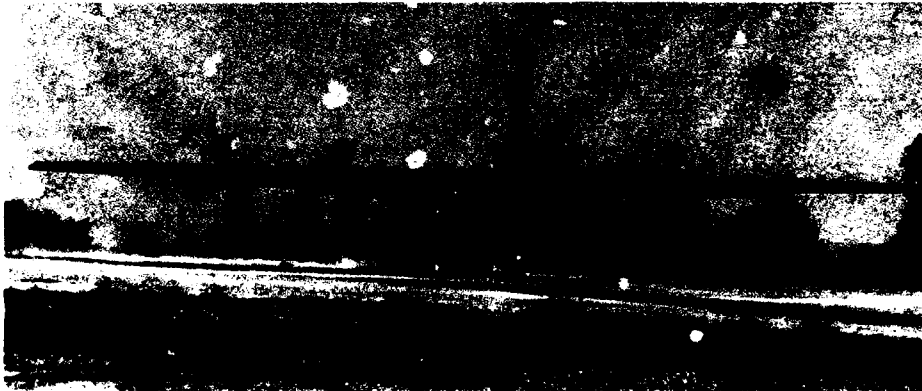
Installation personnel can monitor and measure the performance of dust control products by observing the amount of dust generated as vehicles traffic the treated area. It is also suggested that pilots of aircraft that operate on treated runways be interviewed to determine the extent of dust control on assault runways. Normally a treated area can be expected to be effective for approximately 1 year, but the effectiveness of any dust control product is largely dependent upon weather conditions and the volume and type of vehicles that traffic the treated area.

APPENDIX A: AD FLIER

Dustproofing



Before: Typical dust cloud after a C-130 lands on untreated clay assault airstrip at Fort Chaffee, AR.



After: No dust appears on the Fort Chaffee airstrip after treatment with magnesium chloride.

- PROBLEM:** Dust generated by traffic on unpaved surfaces can:
- Impair vision and reduce safety
 - Increase vehicle and road maintenance costs
 - Reduce operational capabilities of unsurfaced areas.

- TECHNOLOGY:** Treating unpaved surfaces with dust suppressants such as:
- Magnesium chloride,
 - Calcium chloride,
 - Polyvinyl acetate.

- DEMO SITES:** Fort Stewart, GA and Fort Bliss, TX – FY84
Fort Irwin, CA and Fort Chaffee, AR – FY85
Fort Campbell, KY – FY86

- BENEFITS:**
- Improves safety
 - Prolongs service life of traffic areas
 - Reduces equipment and road maintenance costs by approximately 30 percent.

Description of Technology. Dust generated by vehicles or aircraft can hamper operations, decrease safety, and cause premature equipment failure. To remedy this problem, a surface penetration method of dustproofing has been effectively demonstrated using magnesium chloride ($MgCl_2$) or calcium chloride ($CaCl_2$) brine solutions. The brine solutions (low viscosity hygroscopic materials) are sprayed directly onto soils after prewetting. These solutions work best on well-graded gravel, but have been used effectively on clay-type soils, although with a more limited life span. The brine solutions draw moisture from the atmosphere, causing the smaller dust particles to bind to coarser material, thereby reducing the amount of dust in the air. The effective life of the brine solution on highly trafficked surfaces is greatly enhanced when compaction equipment is used after application and prior to use. Gravel roads may be traversed immediately after application, while fine-grained soils may require some cure time. This dustproofing method is best for highly traveled areas. A second solution to the dust problem is the surface blanket method using a polyvinyl acetate (PVA) emulsion diluted with water. PVA provides a film that resembles a viscous white glue (before curing) and covers the surface like a blanket to prevent dust from becoming airborne. Because this surface film may be torn under heavy traffic conditions, PVA is better suited for non-traffic areas such as the shoulders of helipads or airstrips, where dust can completely eliminate visibility.

Details of Demonstration. Dustproofing techniques have been demonstrated effectively on clay, silt, sand, and gravel. Treated areas include tank trails, unsurfaced roads, assault airstrips, maintenance areas, marshalling areas, and bivouac areas. Preparation of the sites normally includes blading with a motor grader and prewetting with a water truck. Compaction with rollers can improve bearing capacity and increase the life span of the treatment. Dustproofing compounds should be applied with a liquid distributor capable of metered application. Brine solutions are most effective in areas where the humidity is greater than 30 percent.

Benefits of Using Technology. Brine solutions produce a tighter road surface that resists rutting. Savings of one ton per mile annually can be achieved on regravelling gravel roads. This can result in a maintenance cost savings of up to 30 percent. Reduction in turnaround time for C-130 sorties at unsurfaced assault airstrips can be over 50 percent. The effective life of brine solutions is usually 8-12 months but may be significantly less on fine-grained soils. PVA was originally developed for use on the shoulders of C-130 airstrips and CH-47 helipads in Southeast Asia where engine and rotary blade life were reduced over 50 percent due to dust. Its expected life on non-traffic areas is 10-15 months, shoulders of airstrips and helipads is 4-8 months, and concentrated traffic is 1-3 months.

Points of Contact. Mr. Richard H. Grau, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, (601) 634-2494. Mr. Ken Gregg, CEHSC-FB-P, U.S. Army Engineering and Housing Support Center, Building 358, Fort Belvoir, VA 22060-5516, COMM 703-355-3582.

APPENDIX B: BIBLIOGRAPHY

1. Technical Manuals:

Headquarters, Departments of the Army and the Air Force. 1987 (Sep). "Dust Control for Roads, Airfields, and Adjacent Areas," TM 5-830-3/AFM 88-17, Chap. 3, Washington, DC.

2. Technical Reports:

Styron, C. R. III, Hass, R. A., and Kelley, K. 1985 (Sep). "Dustproofing Unsurfaced Areas: Facilities Technology Application Test Demonstrations, FY 84", Technical Report GL-85-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Hass, R. A. 1985 (Dec). "Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 85", Technical Report GL-86-20, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

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3. Specifications:

Military Specification, MIL-M-52882(ME), Membrane, Liquid, Dust Control.

4. Video Tape:

"Dustproofing Unsurfaced Areas: Facilities Technology Application Test", Video Report GL-86-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

"Dustproofing Unsurfaced Areas: Facilities Technology Application Test", Video Report GL-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

"Dustproofing Unsurfaced Areas: A Summary of Facilities Technology Application Tests (FTAT)", Video Report GL-88-3, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

APPENDIX C: EXAMPLE OF SPECIFICATIONS

SECTION C - DUSTPROOFING

1. GENERAL. The Contractor shall provide all supplies, labor and equipment to apply, at a controlled rate, solutions of calcium chloride (CaCl_2) and magnesium chloride (MgCl_2) to specified areas at Ft. Campbell, Kentucky, for dust control studies. Portions of the site are located in the State of Tennessee. A map of the area is attached.

2. GOVERNMENT RESPONSIBILITIES. Grading and compaction of the surface materials at each site will be conducted by the Government both preceding and following the application of the chemical solutions. Railroad tank car storage, Contractor equipment storage, and existing natural water sources will be provided at the locations shown on the map. The Government will provide access to an existing office with a telephone for the Contractor's use during the course of this contract. The Government reserves the right to photograph, videotape, and record all aspects of the Contractor's operations. Random hydrometer sampling tests for specific gravity will be made by the Government at the work site.

3. CONTRACTOR RESPONSIBILITIES. Within 7 days after contract award, the Contractor shall submit a list of personnel and equipment to the Ft. Campbell Provost Marshall and the Facilities Engineer. Personnel will be issued identification passes by the Government prior to beginning work. The Contractor shall be responsible for delivery of all materials to the site, prewetting certain areas, and application of the materials at the specified rates.

4. MATERIALS. Solutions shall be formulated as follows:

Calcium chloride (CaCl_2): 38% liquid form

Magnesium chloride (MgCl_2): 32% liquid form

A one gallon sample of each solution shall be submitted within 10 days after contract award along with Material Safety Data Sheets. Approval by the Contracting Officer's Representative shall be obtained in writing prior to delivery of materials to the site.

5. APPLICATION. If prewetting water is pumped from an existing lake or stream, the Contractor shall provide all pumps and screens. When placement of dustproofing materials requires more than one pass, a minimum of 6 inches of overlap shall be provided. Application rates may be adjusted as directed by the Contracting Officer's Representative.

5.1 Area A. Area A consists of an assault airstrip at Centerline and Woodlawn Roads (Center Mass Coordinates 520455) with dimensions of 110 feet by 4,500 feet (55,000 SY). It consists of red sandy, clayey, silty soil. Up to five 100-foot test strips shall be applied with or without prewetting. The area shall be

prewet with water at the rate of 0.10-0.30 gallons per square yard. CaCl_2 shall be applied after prewetting at the rate of 0.25-0.30 gallons per square yard as directed by the Contracting Officer's Representative.

5.2 Area B. Area B consists of a 10-mile segment of the 24-foot wide West Perimeter Road (Center Mass Coordinates 300545 to 340640) (140,800 SY). It consists of a gray, crushed limestone gravel. No prewetting is required. CaCl_2 shall be applied at the rate of 0.25-0.30 gallons per square yard.

5.3 Area C. Area C consists of a 5-mile segment of the 24-foot wide Patton Road (Center Mass Coordinates 400560 to 380620) (70,400 SY). It consists of a gray, crushed limestone gravel. Prewetting with water at the rate of 0.10-0.30 gallons per square yard is required on up to 100% of the area as directed by the Contracting Officer's Representative. MgCl_2 shall be applied at the rate of 0.42-0.50 gallons per square yard.

5.4 Area D. Area D consists of a 2-mile portion of the 24-foot wide Indian Mound Road and a 200-foot by 400-foot recreation area parking lot (Center Mass Coordinates 420485) (37,049 SY). It consists of gray, crushed limestone gravel (road) and tan, well rounded cherty gravel (parking lot). No prewetting is required. CaCl_2 shall be applied at the rate of 0.25-0.30 gallons per square yard.

6. DISTRIBUTION EQUIPMENT. A tank truck or spreader unit assembly, equipped with spray bars and nozzles shall be used. A positive displacement pump driven from a power source (other than the engine of the truck) or from the wheels of the spreader unit assembly shall be used to develop sufficient pressure at the spray bar nozzles to insure uniform distribution of the solution. Spray bars of various lengths shall be used so that the solution may be applied in widths varying from 4 feet to 24 feet. The motor vehicle shall be capable of maintaining a constant speed during the time of application. The tank truck or spreader unit assembly shall be equipped with a suitable device, visible to the driver, to accurately determine the rate at which the solution is applied. Suitable charts shall be furnished to enable correlation of the vehicle speed and rate of application. The Contractor shall submit photographs and other information to completely describe the characteristics and capabilities of the proposed distribution equipment prior to its delivery at the site. Approval of the proposed equipment by the Contracting Officer's Representative shall not relieve the Contractor of his responsibility to meet the requirements of the specifications contained herein.