Frank, Daniel, Reg. VI ~~[illegible]~~

COMMONWEALTH OF VIRGINIA

E. M. MILLER JR
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DIVISION OF LEGISLATIVE SERVICES

January 7, 1994

RECEIVED

JAN 10 1994

DEQ - OD

Richard N. Burton, Director
Department of Environmental Quality
629 E. Main St.
Richmond, VA 23219

RE: Norfolk Southern Rail Emission Study

Dear Mr. Burton:

Enclosed herewith is the above-captioned report sent to you at the request of the Joint Subcommittee Studying Ways to Reduce Emissions From Coal-Carrying Railroad Cars (pursuant to SJR 201, 1993).

I serve as staff to the Joint Subcommittee, and would be pleased to respond to any comments or questions you might have.

Sincerely,

Mark C. Pratt

Mark C. Pratt

MCP/cgl
Enclosure

RECEIVED

JAN 21 1994

REGION VI

NORFOLK SOUTHERN RAIL EMISSION STUDY

prepared for:

Norfolk Southern Corporation
Roanoke, VA

prepared by:

Simpson Weather Associates, Inc.
Charlottesville, VA

30 December 1993

INTRODUCTION

Fugitive coal dust emissions from rail cars has become an increasingly important issue from the perspective of coal transporters, coal suppliers, legislators and their constituents. This interest is based upon essentially two concerns: material and thus revenue loss during transit and the continuance of coal dust complaints.

Prior to this study, much of the evidence of coal dust emissions during rail transport came from anecdotal reports of dust plumes or coal deposition along rail corridors. Previous efforts to establish material losses by weighing coal cars at their terminus did not produce convincing results. However, the amounts and characterizations of these losses remain critical issues to be resolved before efficient control strategies can be prescribed. Norfolk Southern Corporation (NS) has contracted Simpson Weather Associates, Inc. (SWA) to address these issues in a series of field and laboratory experiments entitled "Norfolk Southern Rail Emission Study (NSRES)".

To obtain reliable results for this comprehensive study, new technology had to be designed and implemented, as there was no off-the-shelf instrumentation to produce the appropriate information. An instrument package called RTEPS (Rail Transport Emission Profiling System) was developed for mounting on the top of a loaded coal car. RTEPS provided details on the environmental stresses (wind, temperature, precipitation) and dust emissions in close proximity to the coal surface and throughout the entire mine-to-port trip. In addition a robotic vision system was developed to assess the wind erosion losses from all cars that passed under its arrangement of video cameras.

SWA has made significant progress in understanding and quantifying fugitive coal dust emissions. The primary findings of this NSRES are:

- Reliable measurements of material losses during transport have been obtained for coals that were selected because they are considered by NS and its customers to be among the dustiest coals being transported. Observations based on these coals cannot, therefore, be used to estimate total losses for all NS coal shipments. Clearly, it would be an over solution to require all coals to be treated as if they had the same dusting potential as the coals used in this study.

- Factors responsible for fugitive dust emissions are better understood and found to be measurable. These factors involve a complex array of environmental and operational stresses.

- We have identified and studied key environmental/operational stresses affecting coal dust emissions from in-transit coal cars:

    1) wind speed over the coal surface;
    2) coal surface temperature;
    3) effects of precipitation; and
    4) effects of operation such as slack action, acceleration, track switching, passing trains, movement through tunnels, etc.

- Under similar environmental and transportation stresses (e.g.,coal surface temperatures, coal moisture, coal particle size, surface wind speed, etc.), different coals produce varying intensities and frequencies of emissions. There are indications that most coal shipments produce no measurable or visible dust or material loss.

- Achievement of a substantial reduction in material loss from coal cars by wind erosion appears to be reasonable.

- To obtain a substantial reduction in material loss, potential solutions to be evaluated should include critical slope management of load top profiles and use of chemical binders.

While material loss from coal cars during transit has been studied on several occasions over the last twenty years, an extensive search of the public literature has produced very little information. Attempts to measure coal dust losses have been conducted by chemical vendors or individual coal and rail companies but the results have been regarded as proprietary. A notable exception is the multi-year study conducted by the Environmental Protection Service (EPS) of Canada.

Between 1973 and 1985, the EPS conducted laboratory and field studies with the objective of reducing in-transit dust emissions from coal cars over a 500-mile route along the Fraser River rail corridor, from western Alberta to Vancouver, British Columbia. In terms of determining the coal losses, the results of the study were essentially inconclusive for the following reasons: (1) no direct measurements or characterization of fugitive coal dust emissions were made, (2) no end-point (i.e., "before and after") car weights were measured, and (3) rain uptake/moisture loss were not taken into account. However, based on its study the EPS estimated coal losses of one-half to three percent during transit and convinced Canadian coal producers to implement a dust control plan. The dust control plan involved loading the cars below the sill level and applying a crust-forming topical treatment. The target was to have the coal cars reach their terminus with 85% crust retention and it was assumed that the implementation of this plan would eliminate 85% of fugitive emissions. However, subsequent evaluations by SWA have shown that 85% crust retention does not necessarily produce an 85% emission reduction.

It has been suggested that NS apply the Canadian "solution" to the coals transported from western Virginia to the Norfolk port facility. The Canadian approach is not appropriate for such NS coal movements because:

1) the Canadian coal car fleet consists of identically sized and shaped cars, allowing simple, standardized load leveling and chemical application. The wide variety of shapes and sizes of the NS fleet does not allow for simple load leveling and application of topical treatments.

2) contrary to the situation in western Canada, the coal NS transports exhibits a wide range of chemical and physical attributes. In addition, each mine that NS serves processes and prepares its coal differently. This makes it extremely difficult to treat dusty coals successfully with a single chemical.

REVIEW OF OBJECTIVES

The rail emission study had the following stated objectives:

- Quantify coal losses during transit;
- Determine the key physical factors responsible for fugitive emissions from coal shipments from the mines to the port facility;
- Derive key emission factors and characterize their spatial variation along the rail corridor; and
- Select, assess and evaluate dust control options.

FINDINGS

For the entire rail trip between the mine and the port, selected and untreated metallurgical coals lost a total amount of coal averaging 0.31 tons per car (ranging from 0 to 0.8 tons). This is equivalent to a loss of approximately one pound per mile per car and is less than one quarter of an ounce per acre per car within the areas that are 500 ft on either side of the track. (Note: the top one inch of soil over an acre weighs approximately 4,000,000 ounces.) These weight loss findings are based on scale weight changes using a scale monitor car, corroborated with direct measures of erosional changes of load top profiles and passive collection of detrained material. It should also be noted that the coals considered to be dusty represent only 10% of Norfolk Southern originated coal. We emphasize that these losses are the worst case scenario for an inherently dusty coal being transported under dry and stressful conditions. Furthermore, even under the high stress conditions some coals showed no measurable material loss.

Figure 1 shows the NS research caboose used during the course of the study, coupled to a scale monitor car of known weight. The weight of the monitor car was used as a reference for coal cars weighed throughout the study. We stress that the weight loss figures are based primarily upon the study of metallurgical coals from a limited number of selected mines.

Figure 1. Norfolk Southern's research caboose coupled to a scale monitor car of known weight.

Weight changes due to wind erosion losses can be affected by rainfall, often rendering the use of mine and port weights unreliable in assessing material losses. In addition, wind erosion is strongly dependent on coal surface temperature. For example, a coal that emits intense and frequent emissions during the hot, dry daytime hours is less prone to dusting during the cooler nighttime hours.

Fugitive emissions from those coals that produce dust under the aforementioned conditions show a non-linear relationship to train speed. The most intense dusting events occur when trains traveling in opposite directions meet at normal track speeds. In addition, tunnels, rock cuts, trestles and open fields frequently result in emission episodes due to lateral wind stresses. Instruments mounted on the top of coal cars (Rail Transport Emission Profiling System - RTEPS) have shown that the frequency and intensity of emissions are significantly higher during acceleration through a speed (e.g., 30 mph) than deceleration through that same speed. While a train is stopped or moving slowly, the coal surface will heat and dry out making it more susceptible to dusting when the train begins to move again. The resulting enhanced supply of dry coal particles that participate in emissions during acceleration are quickly depleted and not available for dusting during subsequent deceleration.

Some of the coals studied can produce nearly continuous fugitive emissions during hot dry periods when relative wind speed over the surface exceeds 30 miles per hour. According to RTEPS, simply reducing speed for trains transporting dusty coal would reduce some material loss but would not eliminate the visible dusting or reduce the perception of dusting.

Leveling the load without chemical binders or loading below the top of the car (light loading) appears to only modestly reduce material losses during transit and neither of these tactics eliminates severe dusting events. Severe dusting events can occur in load leveled or light loaded cars and are the results of the turbulent air flow caused by preceding coal cars - normally loaded or otherwise - producing wind scouring even below the top of the car.

Settling appears to be on the order of 2 to 9 inches between the mine and the port. This amount of settling offers challenges to the structural integrity of chemical binders. The amount of settling is based on approximately 200 photographic transects taken during the course of the study. These transects were taken at sequential locations along the rail corridor and before-and-after comparisons were used to calculate the amount of settling. Figure 2 on the following page depicts an example of the photographic transects taken at Bluefield, WV. Because such settling often leads to the cracking and ultimate failure of chemical binders, it may be important to select a binder pliable enough to remain intact under 2 to 9 inches of settling during transit.

Chemical binders field tested to date are only partially effective against dust losses <u>unless</u> load profile modification occurs prior to chemical application. The use of chemical binders is one of several fugitive dust control strategies assessed. Dust suppression options investigated include:

1) load leveling only,
2) load leveling plus wetting,
3) load leveling plus compaction and wetting,
4) chemical binders applied to normally loaded cars,
5) chemical binders applied to leveled load profiles,
6) chemical binders plus surfactants to normally loaded cars,
7) surfactants applied to normally loaded cars (Celco facility), and
8) water only applied to normally loaded cars (Celco facility).

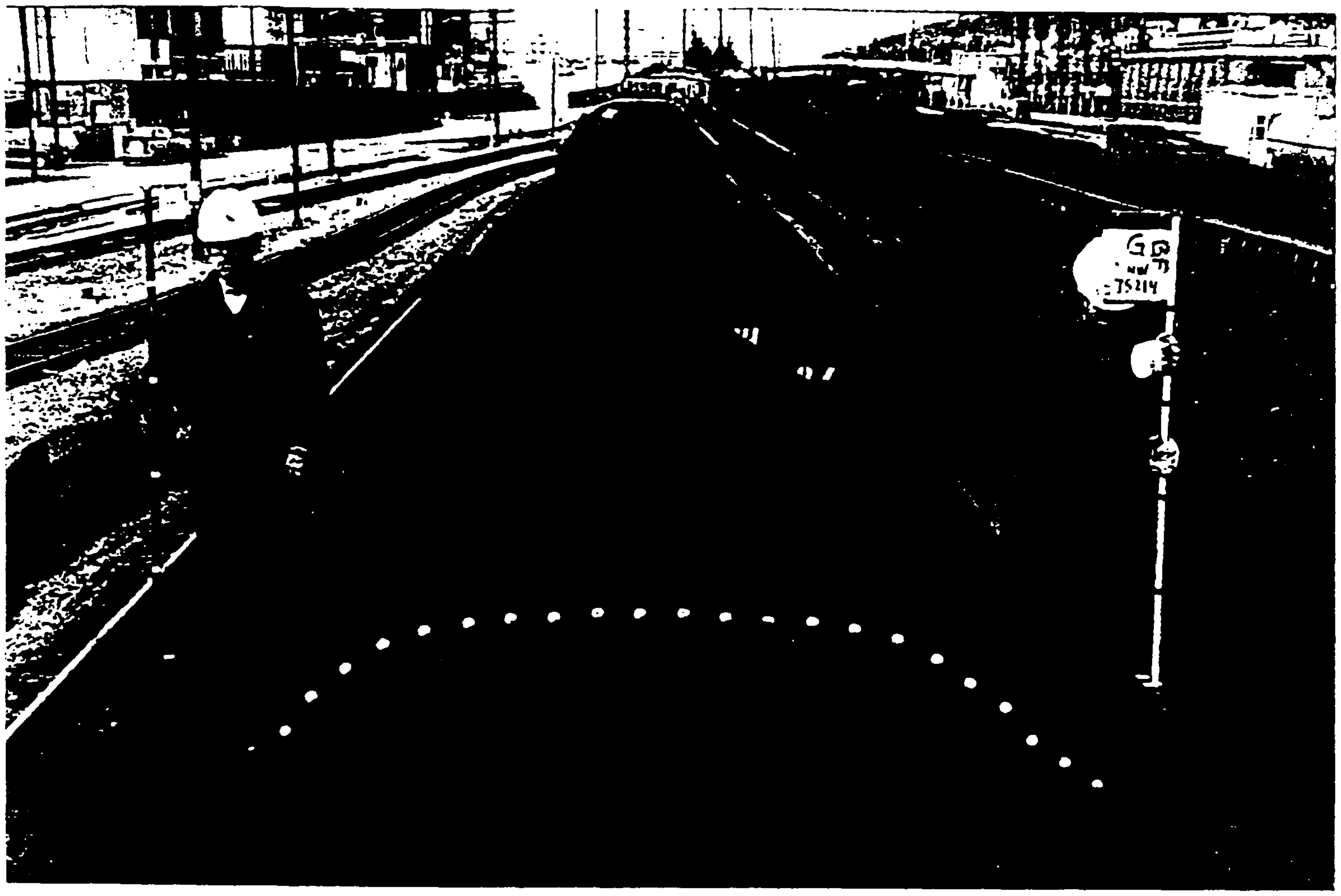

Figure 2. Photographic transect of a load profile. These photographs were taken sequentially along the rail corridor to evaluate settling during transit.

Figure 3 is an example of a coal car that was manually load leveled, wetted and compacted.

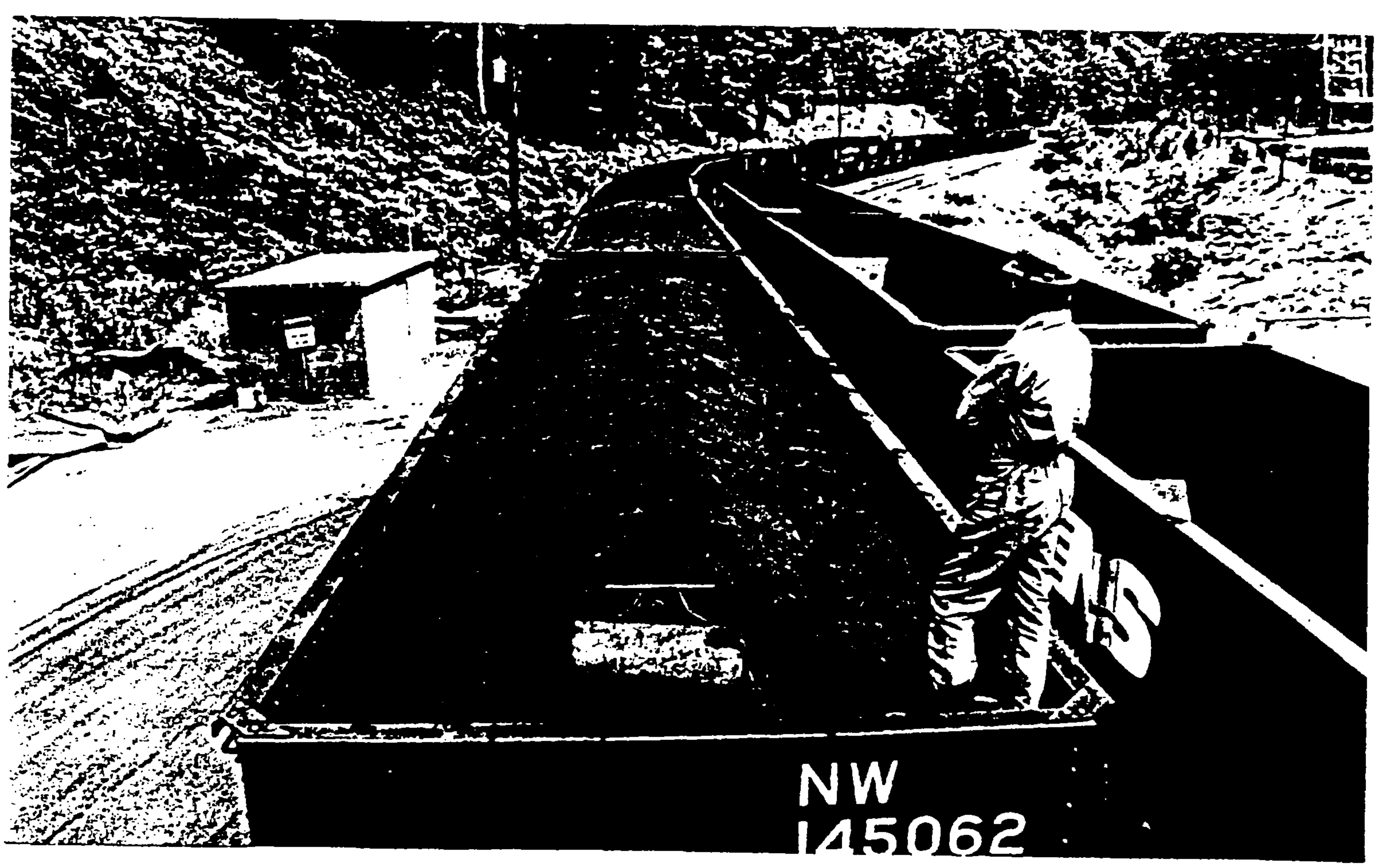

Figure 3. As part of the topical treatment evaluation, this car (NW145062) was load leveled, wetted and compacted.

After investigating a variety of mitigation techniques, the most successful combination appears to be load profile modification followed by application of a chemical binder.

SPECIAL STUDIES

Throughout the NSRES a series of special studies have been conducted, including assessment of the Celco spray facility, infiltration and retention of rain water in coal cars and a dust information telephone line to log and respond to dusting complaints.

On selected metallurgical coals during relatively stressful rail trips, spraying water on the surface from the Celco facility is an effective dust mitigator for a limited period. This time frame varies depending on the hydrophobicity of the coal and the environmental and transportational stresses. Approval to conduct a limited set of experiments involving a surfactant application at Celco was granted by the Virginia Department of Environmental Quality. One test indicated that adding a surfactant to the spray appears to prolong the dust mitigation for up to several hours depending on the coal's physical characteristics and the stresses (e.g., tunnels, passing trains, temperature, solar radiation) to which it is subjected after application. The Celco facility continues to be a valuable research tool for evaluating dust control chemicals and strategies. Figure 4 shows coal cars being sprayed with water at the Celco facility.

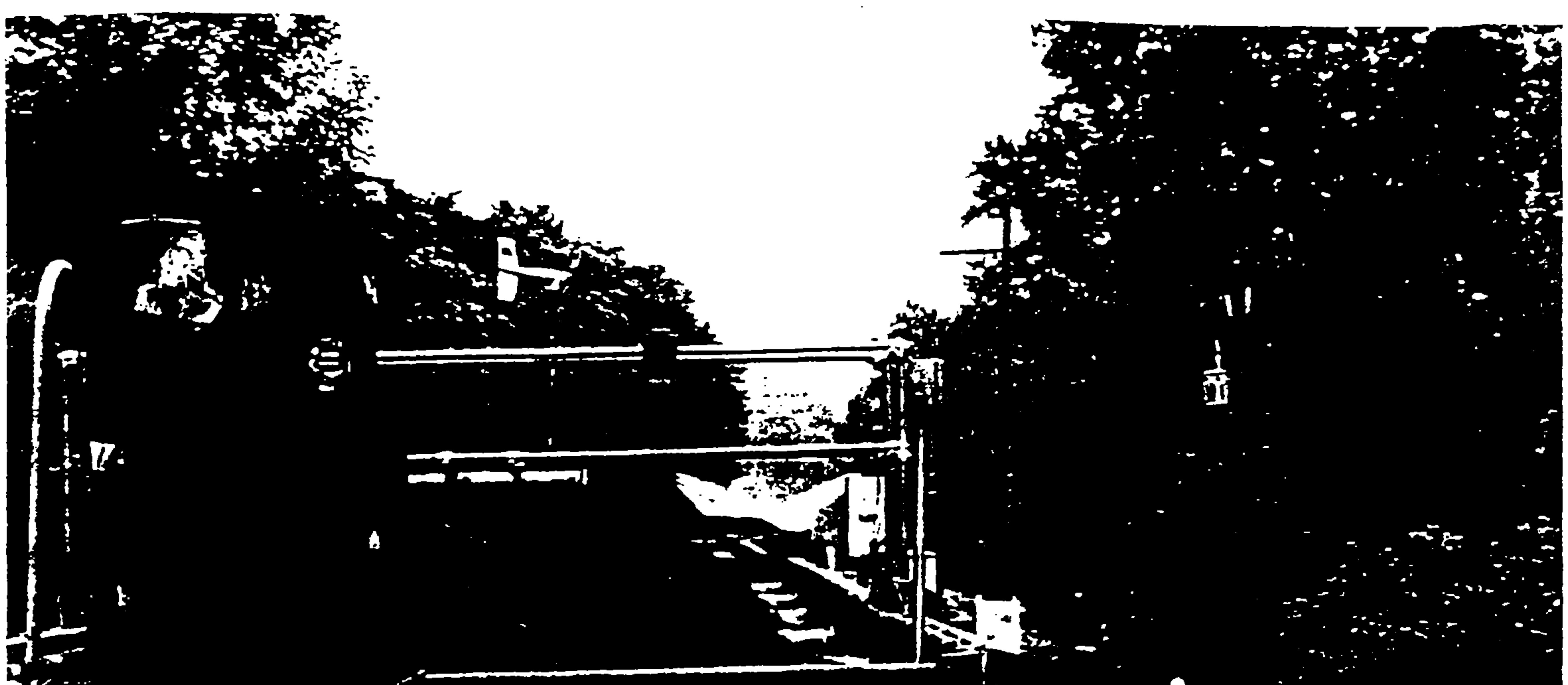

Figure 4. This photograph depicts RTEPS in the foreground as water is being applied to the load tops at the Celco facility.

The infiltration rate and retention of water into various coals has been studied. Findings indicate that at an average rate of 0.35" precipitation/day, a less hydrophobic coal such as a coarse steam coal can produce approximately 35 gallons of leachate per day; this is about 300 lbs weight change per day. It is likely that the more hydrophobic coal such as finer metallurgical coals would show a slower rate of weight change as the water infiltration rate is less.

In April 1993, SWA installed the Dust Information Telephone Line to receive coal dust complaints. To date we have responded to 37 calls. These complaints have been concentrated in the western part of Virginia around Shawsville, Altavista and Whitethorne.

CONTINUING EFFORTS

Efforts are continuing to establish the basis for prescribing the optimum solution to control fugitive coal dust emissions. Presently, SWA/NS are developing laboratory techniques to assign a specific SARTDX (Seasonally Adjusted Rail Transport Dusting Index) to individual coals transported to the port facility. This index will be seasonally adjusted, i.e., we will delineate between coals that dust for say 8 months of the year - and therefore require more consistent treatment - from coals that dust only during the hot summer months. Again, we must avoid the over-solution that would result from treating all coals under all conditions. Instead, the goal is to treat coals only when they are likely to encounter stress conditions that produce fugitive emissions.

SWA is continuing pre-field/laboratory screening of dust control products. These are phased laboratory evaluations to determine if specific dust control products are viable candidates for further field testing. Products are evaluated not only for their dust control properties but also for their impact on coal moisture content.

Recognizing that (1) weighing cars at the mine and again at the port cannot be relied upon to assess material losses and that (2) many cars from many mines need to be evaluated to achieve any statistical significance, SWA, with a subcontract to the University of Virginia, has developed a prototype of a Coal Car Load Profiling System (CCLPS). CCLPS is designed to detect and estimate wind erosion losses during transit. The prototype CCLPS has been used to supplement scale weight measurements and we expect that the final version of CCLPS will play a major role in monitoring the success of any dust control strategy that is implemented. Figure 5 depicts the CCLPS prototype.

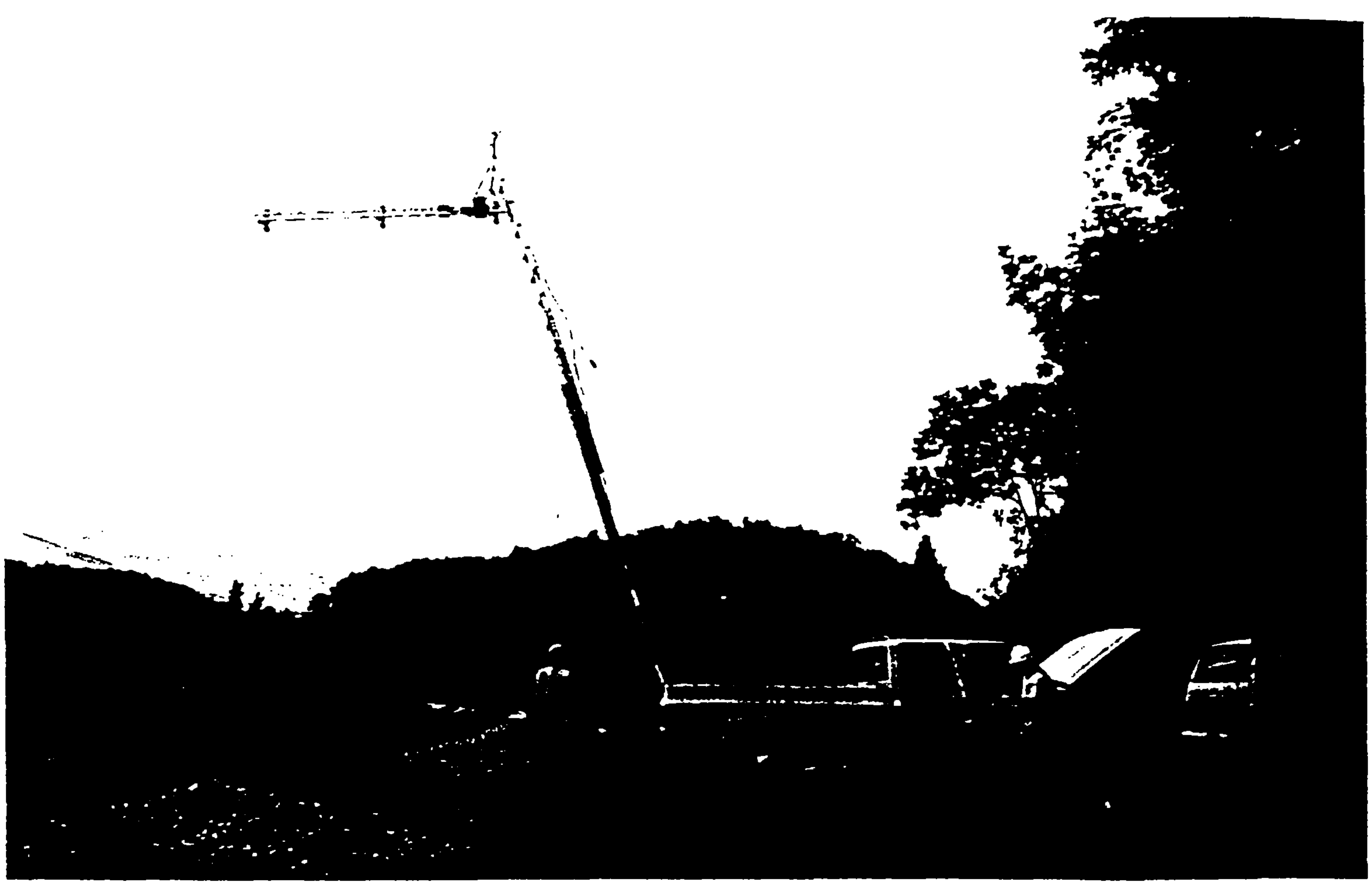

Figure 5. The robotic-vision CCLPS system just after profiling a test train near Pembroke, VA.

RECOMMENDATIONS

- We believe that the most promising solutions to fugitive coal dust emissions from rail cars include critical slope management of load top profiles <u>and</u> use of chemical binders.

- We recommend that a test plan be made for evaluating potential solutions. Such a plan should include one or more coal suppliers who will install load profile management equipment and make chemical applications.

- We recommend the development of success criteria and monitoring procedures for a fully implemented dust control plan.

- We recommend a one year (all seasons) test period during which evaluation of prescriptions for dust control products, load profiles, and surface binder applications can be optimized and performance monitoring procedures can be refined.

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The following pages contain the Optical Character Recognition text of the preceding scanned images.

COMMONWEALTH OF VIRGINIA

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DIVISION OF LEGISLATIVE SERVICES FAX (804) 371-0169

January 7, 1994

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Department of Environmental Quality

629 E. Main St.

Richmond, VA 23219 Drz-0 - C; 0

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Mark C. Pratt

MCP/Cal
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Enclosure

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J A N 2 1 I 9 4

NORFOLK SOUTHERN RAIL EMISSION STUDY

prepared for:

Norfolk Southern Corporation
Roanoke,VA

prepared by:

Simpson Weather Associates, Inc.
Charlottesville, VA

30 December 1993

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14

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