404 BITUMINOUS TREATMENTS

A bituminous surface treatment is not a pavement in and by itself. Rather, it provides a protective cover that helps to resist traffic abrasion, and provides a waterproof cover over the underlying structure. Specifically, surface treatments:

- prevent surface water from penetrating pavements that have become weathered or cracked;
- plug voids, coat, and bond loose aggregate particles in pavement surfaces;
- renew a surface and restore skid resistance to traffic worn pavements;
- provide a temporary cover in cases of delayed or staged paving,
- control dust on low volume roads;
- promote adhesion of subsequent asphalt courses to aggregate bases; and
- ensure a bond between new or existing asphalt courses.

Special Provisions will normally have requirements that supplement the Standard Specifications for bituminous treatments. For example, type of material, spread rate, and basis of payment are usually specified in the Special Provisions. Some bituminous treatments, such as “Double-Application Seal Coat” cannot be found in subsection 404 of the Standard Specification. Never assume a new project has the same bituminous treatment requirements as another project you are familiar with. Always carefully read the Special Provisions for each project to understand the bituminous treatment requirements.

Prior to starting any asphalt operation, the Contractor's equipment should be checked to see that it is working properly and that no badly worn parts exist which would have an adverse effect on the finished product. The Project Supervisor is responsible for seeing that necessary Department personnel are on the project to perform the weighing and inspection operations without undue delay to the Contractor.

Bituminous materials are measured for payment by the ton, but the application rate is calculated in gallons per square yard (Liters per square meter). Therefore, inspectors must complete a “Project Asphalt Report” for each type of bituminous material applied during their shift. Refer to Exhibit 42 for an example of the completed form. A blank form is included at the end of this chapter and can be copied as needed.

At the end of each day's operation, the Lead Inspector shall collect all weight sheets, weight tickets, ticket books, and Project Asphalt Reports (spread sheets) and balance them before turning them into the field office for checking and pay purposes. This should be done before leaving for the day.

The specifications for some items allow a choice of grades or types of asphalt while others do not. If circumstances indicate that a change from the specified type or grade of asphalt is desirable, the Resident Engineer (after consulting with the District and the ADOT Materials Group) will prepare a change order for the work. Consultation on changes is very important because a change in type or grade of asphalt may cause a serious modification of the qualities desired from the bituminous treatment.

When a specific application rate for prime, tack, and fog coats is not indicated in the Special Provisions, the Resident Engineer will determine the rate. It is recommended that the Resident Engineer talk to ADOT Materials Group, Pavement Materials Testing Section when deciding on a specific application rate. Application rates are generally a function of the pavement or base conditions, weather, traffic, and the bituminous material being used.

Inspection and Observation Guidelines

Bituminous Materials

1. Is the type and grade of asphalt in accordance with the project specifications?

2. Are asphalt samples being witnessed and taken in accordance with methods that assure representative samples?

3. Are test results and certificates of compliance satisfactory?

4. At what temperature is the material being applied or mixed?

5. Are checks being made to verify delivery and complete emptying of cars or tank trucks?

Aggregate Materials

1. Have the aggregates been tested and approved before use on the project?

2. Does the blotter sand meet the gradation requirements?

3. Has the cover material for a chip seal operation been tested for;
    A. loss of Abrasion (AASHTO T 96),
    B. percent carbonates (ARIZ 238),
    C. percent (crushed faces) fractured coarse aggregate particles (ARIZ 212),
    D. flakiness Index (ARIZ 233), and bulk Oven Dry Specific Gravity (ARIZ 210)?

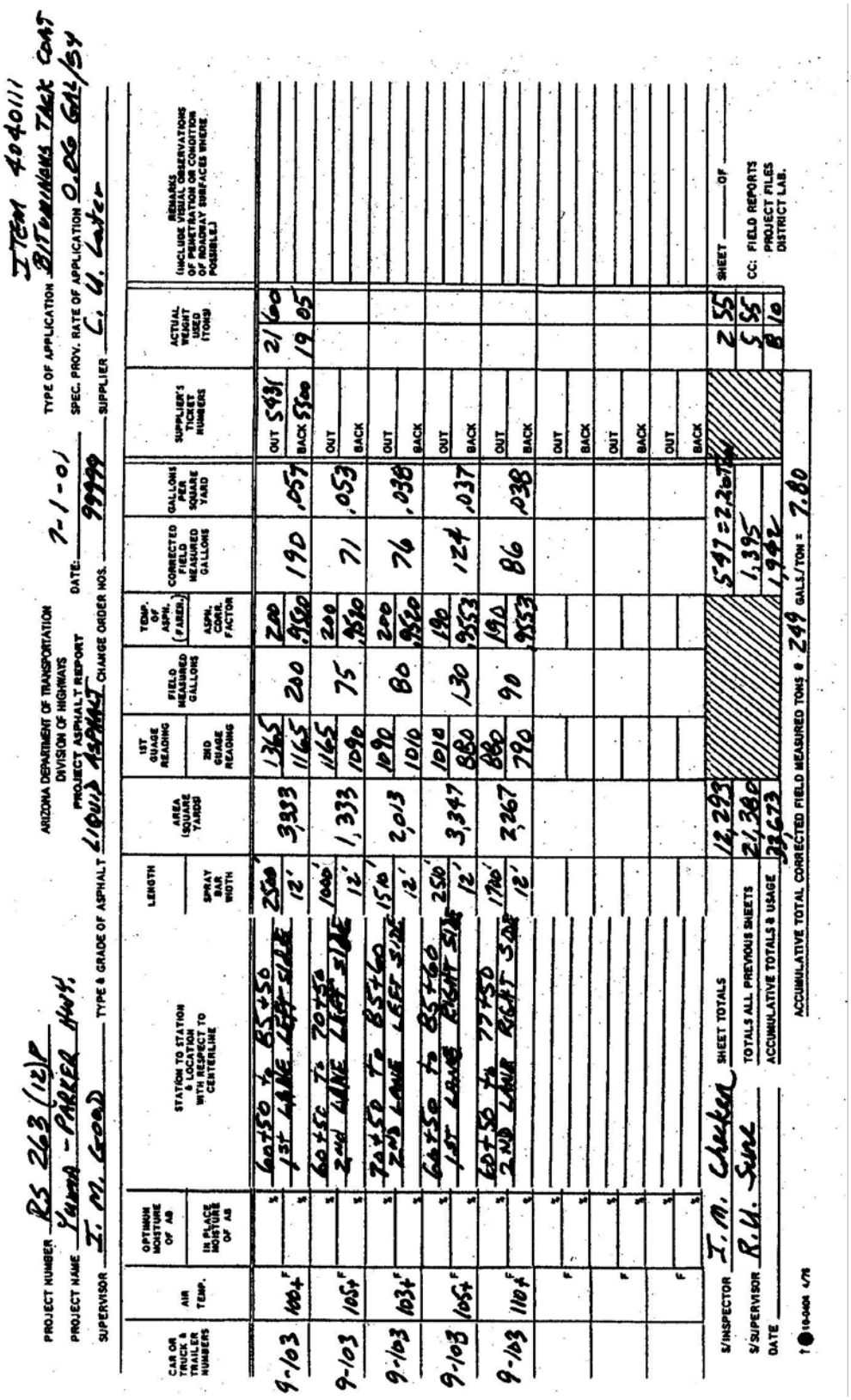


Exhibit 404-1. Project Asphalt Report Example

404-3 Construction Requirements

404-3.02 Equipment

(A) Distributor Truck

The single most important piece of equipment on any surface treatment operation is the distributor truck. The field office should, whenever possible, preapprove all distributor trucks for use on the project. Subsection 404-3.02(A) covers requirements of the asphalt distributor and its operation. These requirements are all important and should be reviewed by every Inspector prior to starting work on which a distributor is to be used. All of these requirements shall be enforced. Insist on getting test results for spread rates. Older trucks that do not have gauges and accessory equipment that meet specification should not be allowed on the project (see also Subsection 404-3.05).

In order to prevent "streaking" in a seal coat, care must be exercised to see that the spray bar is operated at the proper distance from the pavement surface and that each nozzle is functioning properly and turned to the proper angle. It is sometimes helpful to witness a trial run (say 30 feet [10 meters]) to be sure these requirements are fulfilled.

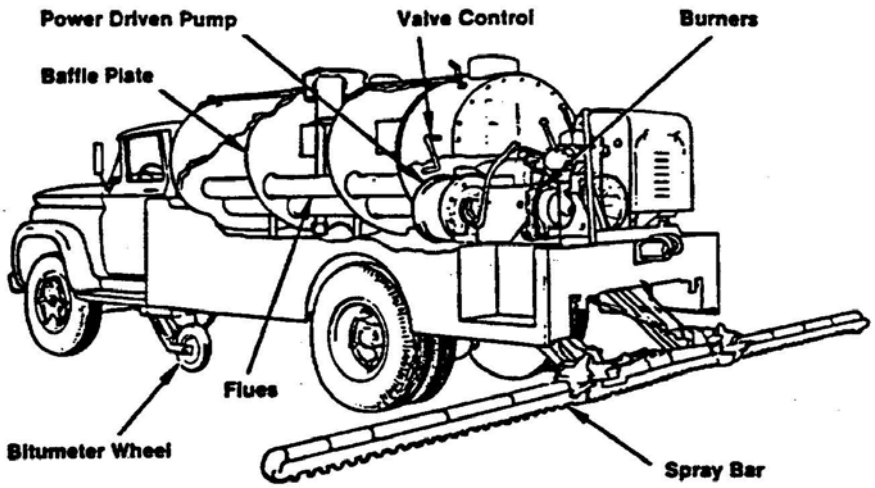
The Contractor is required to furnish evidence that the distributor has been tested and found to be capable of a uniform rate of application. The testing must have been done within the previous twelve months. Distributors used for chip seals should be retesting in accordance with Arizona Test Method (ARIZ) 411, unless only a short time has elapsed since the last test by the Contractor. Even a recently tested distributor may not provide a uniform rate of application if the nozzles or bituminous material has changed.

The most important part of the distributor truck is the spray bar. The spray bar height, the type of nozzles, and the nozzle angle all affect the uniformity of the asphalt coverage. A spray bar that is set at the incorrect height causes streaking. If it is set too high, the wind may distort the spray causing spotty coverage. If the height varies along the roadway, the coverage width will not be uniform (see Exhibit 404-3.02-1). For best results, the spray bar height should not vary by more than 1/2 inch (12 mm).

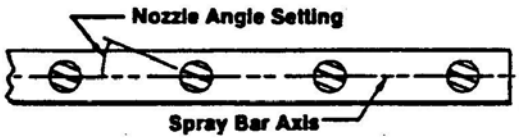
The correct nozzle sizes for the type and grade of asphalt must be used. It may be necessary to change nozzles to get acceptable coverage or rate of application. Distributor truck operators are sometimes reluctant to change nozzles. However, if uniform coverage at the required rate of application cannot be achieved, the Resident Engineer should not allow the work to proceed. If all other adjustments have been tried, it will probably be necessary to change the nozzles. Damaged nozzles shall be removed.

The nozzle angles are usually set between 15 to 30 degrees so that the spray from each nozzle does not interfere with the spray from adjacent nozzles.

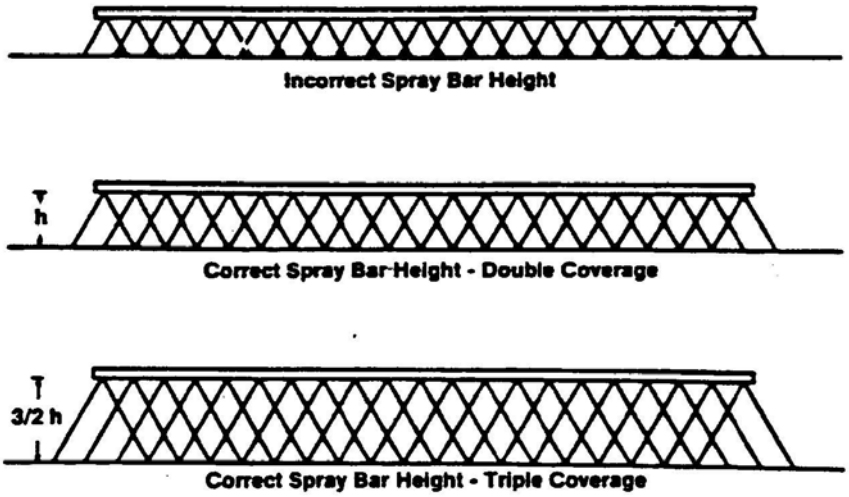
Project Supervisors and Lead Inspectors should not hesitate in removing distributor trucks from the project, which are not operating acceptably.



A TYPICAL ASPHALT DISTRIBUTOR



PROPER ANGLING OF NOZZLES



SPRAY BAR HEIGHT AND COVERAGE

NOTE:
On occasion, some operators will set end nozzles at a different angle (60 to 90 degrees with respect to the spray bar) in an attempt to obtain a good edge. This practice should NOT be permitted as it will produce a fat streak on the edge and rob the adjacent spray fan of the lap from this nozzle. A curtain on the end of the bar for a special end-nozzle with all nozzles set at the same angle will provide more uniform coverage and make a better edge.

Exhibit 404-3.02-1. Asphalt Distributor Spray Bar Height and Coverage

404-3.11 Prime Coat

Prime coats may be eliminated from the work in those cases where the aggregate base surface is tightly bound and will not displace under the laydown machine and hauling equipment. Except, never eliminate the prime coat on a secondary road project that has a chip seal, or an asphaltic concrete friction course applied directly on top of the prime coat. A change order is required to eliminate the contract item.

The purpose of the prime coat is to protect and stabilize the surface of the base and provide a uniform, firm-working platform for the next course. The prime coat is designed to:

- coat and bond loose mineral particles on the surface;
- waterproof the surface of the base; and
- provide adhesion between the base and the next course.

Before a prime coat is applied, the base should be tested for proper compaction and cross section tolerances. Since the prime coat can frequently be eliminated, the Resident Engineer should evaluate the condition of the base before allowing the application of the prime coat. ADOT Materials Group is available for consultation.

The surface of the aggregate base must be smooth and true to grade and cross-section. The surface should be slightly damp (no free water on the surface) when the prime coat is applied. A water application one to two hours ahead of the prime coat application generally causes deeper asphalt penetration, which is highly desirable.

The type and grade of asphalt to be used and its approximate rate of application will be indicated in the Special Provisions. The rate of application should be determined by observing the rate and the depth of penetration; bearing in mind the traffic conditions and schedule of paving operations. After applying a section of prime, look at the results and then adjust the rate of application as necessary. An excessive rate of application is not only wasteful but may cause a slippage plane between the base and pavement, or may cause instability and bleeding of the pavement since the extra surface asphalt will migrate upwards in warm weather through the action of traffic. Too light a rate of application may cause raveling of the surface, requiring repairs prior to paving. Asphalt in thin films is an adhesive, but asphalt in thick films may act as a lubricant.

A prime coat should not be applied until all specified weather and temperature requirements can be met.

In some cases it may be desirable to establish a guideline for the distributor operator to drive by for the first pass.

The bituminous material for prime coat is applied by means of a distributor truck, allowed to cure, and then compacted, preferably with a pneumatic compactor. Traffic is permitted on the primed surface only after compaction.

Note that there is no method of payment for compaction provided in the prime coat item. When compaction of the primed surface is started, the condition of the surface should be watched closely and if the compactor damages the surface, the operation should be altered or stopped. Sometimes the compactor action will roll larger aggregate around and break it loose. Areas heavily paved with asphalt may pick up.

During the curing period, the primed surface should be protected from traffic (including all construction traffic) until there is no tackiness to the surface. The surface should then be examined for lean or rich areas. Small lean areas should be hand sprayed. Any rich areas should be corrected before any pavement is laid over them. The corrective measures should depend on the degree of richness and the size of the areas involved.

Normally, sanding the areas which are only slightly rich is adequate. Small areas under 50 square feet (5 square meters) can be hand worked. In some cases, it has been necessary to pick up the primed surface together with an inch or more of the base, and blade mix the prime coat throughout long sections. This added expense is justified in preference to laying a pavement on a prime coat where there is free asphalt on the surface.

The prime coat application rate must be calculated and documented on the "Project Asphalt Report" spreadsheet. Exhibit 404-1 is an example of the completed spreadsheet. A blank "Project Asphalt Report" can be found at the back of this chapter.

Inspection Guidelines

1. Does the surface need prime coat? Will it hold up against construction traffic? Does it need to be sealed for poor weather?

2. Is surface to be primed of acceptable smoothness?

3. Is the surface moist?

4. What is the application rate? Does it need adjustment? Are the asphalt applications uniform?

5. Is the bituminous material suitable for its intended use?

404-3.12 Tack Coat

A tack coat is a light application of asphalt applied to a pavement, primed base, or stabilized base immediately prior to laying a course of asphaltic concrete pavement. Its purpose is to lessen the possibility of a slippage plane at the interface of the two courses. Uniform application, whether by hand spray or distributor truck, is necessary. If the tack coat is streaked or stringy, there is something wrong with the equipment or with the material being applied. The work should not be allowed to proceed when the tack coat is not uniform. The necessary adjustments should be made and the spread checked before resuming the work.

All exposed contact surfaces that are not asphaltic concrete (AC), such as curbs, should always be tacked. If the contact surface is AC, the Contractor and Resident Engineer must evaluate its condition to decide if the tack should be eliminated. Usually, new AC that is relatively free of dust and dirt is not tacked. Some judgment is needed to determine how clean and how new an AC pavement needs to be before eliminating the tack coat. A prime coat that has been in place for a long period of time may need to be tacked. The Resident Engineer should evaluate the condition of the grade after traffic has used it. Keep in mind that AC can be placed directly on unprimed aggregate base (AB). It is not necessary for most AC mats to bond to the AB; therefore, tacking the prime coat is usually unnecessary. The Materials Group is available for consultation, and should a tack coat be necessary, it would probably be a light coat.

The Contractor should protect all adjacent facilities, construction, or traffic from possible damage from over spray during application of a tack coat.

Spreading the tack too far ahead of the AC operation is to be avoided because it gets dirty and loses its tackiness quickly. Traffic shall not be permitted on the tack coat. If an emulsified tack coat is used, and it has not yet broken, the paving train must halt. The water in the emulsion must evaporate before it is covered with new AC.

The type and grade of asphalt, as well as recommended rate of application, shall be as shown on the project plans, and as required by Section 1005 and Subsection 404-3.12 of the Standard Specifications. If the Resident Engineer is given a choice, he or she should not guess which one is the best. Each type of tack has its advantages. If the Resident Engineer is given a choice then ADOT Materials Group will advise the project as to which would be best suited for the climate and circumstances. Changing the rate of application beyond the limits specified should be done cautiously and with the advice of the District office and ADOT Materials Group.

When paving grades of asphalt are used, a more uniform coverage will be obtained by heating the asphalt to the upper limits of the recommended range. Care should be used in heating because flash points differ between the various asphalt types.

The tack coat application rate must be calculated and documented on the “Project Asphalt Report” spreadsheet. Exhibit 404-1 is an example of the completed spreadsheet. A blank “Project Asphalt Report” can be found at the back of this chapter.

Inspection Guidelines

1. Is tack coat necessary? When a new course is placed directly on an existing course that is only three to five days old that has not been turned over to traffic, tacking is probably not necessary.

2. Is the surface clean and free of dust? Did the broom get against the curb or pavement edge?

3. Is the application of tack uniform?

4. What is the rate of application?

5. Are haul truck tires free and clear of debris?

6. Is contractor making continuous effort to minimize tracking?

404-3.13 Fog Coat

A fog coat is a very light (about one pint per square yard [half a liter per square meter]) single application of asphalt material without a cover material. Over application will cause the surface to bleed or become unstable, resulting in rutting. This treatment is often called a "flush coat". It is occasionally used to rejuvenate deteriorated pavement ahead of chip seals (to prevent too much absorption of the chip seal's asphalt). Fog coats may also be applied using various emulsions to help retain the chips on an older seal coat, which is beginning to strip. Considerable use has been made of fog coats as an asphalt rejuvenating agent - sealing small cracks and surface voids and inhibiting raveling. This material has a petroleum resin oil base, emulsified in water. The material is normally diluted 1:1 after receipt on the project by adding one part water to one part of the agent. The asphalt in asphaltic concrete goes through an aging process, which starts immediately when the asphalt is exposed in thin films to heat and air. An asphalt-rejuvenating agent prolongs the life of old and new pavements by reducing the viscosity of the aged asphalt. The material is applied through a distributor; heating of the material is not required. The rate of application depends on the condition of the surface. The Special Provisions will specify the type of bituminous material and the approximate application rate determined by the ADOT Materials Group. The Resident Engineer should contact the ADOT Materials Group before changing the type of material or application rate.

Before applying the fog coat, the surface should be cleaned by brooming or by some other cleaning method.

Areas of oil and grease drippings should be removed by burning off with a weed burner or by other means. Holes or badly eroded areas should be patched prior to applying the fog coat.
In most cases the fog coat leaves the surface extremely slippery, so it is sanded (blotted) in order to permit earlier use of the pavement. Sanding also appears to have beneficial effects in that it aids in healing cracks and pitted surfaces. The Special Provisions will indicate an approximate application rate for blotter. Either under applying, or over applying, the blotter can be hazardous to traffic. Never open to traffic without sufficiently blotting to eliminate the slippery surface. Over application may require brooming to keep excessive blotter material from damaging vehicles, or personnel.

The Resident Engineer is strongly urged to familiarize himself or herself with the ADOT Materials Group Policy and Procedure Directive (PPD) #96-9, "Provisional Seal Coat". This document will answer most questions concerning the need and desirability of fog coats.

Since fog coats may be necessary on short notice while on a paving project, the Resident Engineer should consult with the Contractor prior to beginning the paving operation in order to ensure the availability of acceptable materials on short notice.

Traffic is kept off fog coats for at least 2 hours except as needed to accommodate turning or crossing traffic. Use of a fog coat is not recommended for new pavement surfaces that are to receive a chip seal or friction course. This is because the surface is softened, causing excessive aggregate embedment.

The fog coat application rate must be calculated and documented on the "Project Asphalt Report" spreadsheet. Exhibit 404-1 is an example of the completed spreadsheet. A blank "Project Asphalt Report" can be found at the back of this chapter.

404-3.14 Chip Seal Coat

General

A chip seal coat consists of an application of bituminous material followed by cover material. This type of surface treatment is used to provide new non-skid wearing surface that is watertight. The source of the cover aggregate normally is not specified so it is the Contractor's responsibility to locate a source and to furnish samples to be tested by ADOT. All the specification requirements pertaining to pits must be complied with, and the Contractor must pay all costs involved in the use of the source. Chip sealing consists of a single application of asphalt followed immediately by a single application of cover material. The approximate rate of application for both the asphalt and the cover material will be in the Special Provisions.

Application Rates of Bituminous and Cover Material

The application rates shown in the specifications for bituminous material and cover material are estimates only. The bituminous and cover material application rates will be determined by the Regional Materials Engineer using the chip seal coat design formula (See ARIZ 819). The Resident Engineer may adjust the rate slightly at the time of construction. The design rate should result in the asphalt/chip relationship shown in Exhibit 4-4. The depth of embedment of average size particles should be 50 to 70% (voids filled 50 to 70% with bituminous material), depending on the anticipated traffic volume and, to some degree, the climatic conditions. For heavy traffic and lower desert climates, 50% embedment of average size particles is adequate. For light traffic and high altitude 70% embedment would be proper. In cases where chip seals are to be applied to new AC, the rate of bituminous application should be reduced since some embedment into the new surface may be expected. This is especially important when the chips are heated and pre-coated with asphalt, and when asphalt is the bituminous material. Excessive amounts of chips above the desired single layer can also have a

detrimental effect on the overall quality of the chip seal coat. The excess chips can act as wedges during the rolling process, which in turn will dislodge, or weaken the bond of embedded chips.
ADOT Inspectors should be actively involved in overseeing and inspecting the entire operation continuously. The Project Supervisor should rotate Inspectors so that lunch and restroom breaks can be provided. The Inspector should continually check the completed chip seal coat to determine if there is satisfactory embedment of cover material and if the surface is completely covered. The surface should be examined immediately after rolling and also after the seal has cured enough to withstand having the excess cover aggregate brushed away by hand. This evaluation requires good judgment and experience.

The bituminous material application rate must be calculated and documented on the "Project Asphalt Report" spreadsheet. Exhibit 404-1 is an example of the completed spreadsheet. A blank "Project Asphalt Report" can be found at the back of this chapter. Actual roadway widths should be checked against those shown in the plans before starting the seal coat, and the Contractor should be notified of any quantity adjustments.

Preparation of Pavement Surface

The application of the chip seal coat should have been anticipated weeks in advance by the District Engineer, and needed pavement repairs should have been made. Use asphaltic concrete to build-up any low areas and fill any holes in the pavement surface well in advance of seal coating so proper compaction can be obtained by traffic, and the surface will be comparable to pavement surrounding the patches. It is important that pavement repairs be made as far in advance of the chip seal coat as possible to prevent fresh asphalt from bleeding through the seal coat.

Just prior to application of asphalt, the surface of the pavement must be cleaned by whatever method is necessary. The use of a good power broom supplemented by hand brooming where necessary is usually adequate. It may be necessary in rare instances to wash the surface with high-pressure water. If there are areas where motor vehicles have dripped accumulations of oil and grease, it may be necessary to burn off the deleterious materials. If asphalt is spilled on the pavement, the spill area should not be sealed over without first cleaning the surface. Don't apply an extra heavy coat of chips to cover a spill; clean it up.

Application of Binder

Section 404 indicates the necessity for checking the distributor against the requirements of the Standard Specifications. In addition to determining that the distributor has the required equipment and accessories, it must be determined that this equipment, accessories, instruments, etc., are in proper working order. Nozzles are all to be of the same type and size and set at the proper angle. The spray bar is kept at the proper elevation so that the desired spray pattern will result. Verify there is no excessive dripping when the nozzles are closed and each nozzle remains free of slugs while in operation. The proper functioning and operation of the nozzles and spray bar is the responsibility of the operator but the Inspector should be certain that all equipment is operating properly.

When applying binder in areas with steep grades or sharp curves, it is very important to have the chip spreader as close to the distributor truck as possible to prevent the binder from running down the cross slope or grade. The truck should have adequate power so that a constant speed can be maintained, even on hills, while in the process of spraying. Hydraulic pumps on some newer distributors have resolved many problems including uniform flow at the bar tips.

The distributor driver should be able to operate the truck in a manner that will result in longitudinal and transverse joints that have no overlaps or skips. Building paper can be used to make transverse joints when starting and stopping the distributor truck.

When the distributor runs out of asphalt, the flow may not stop abruptly. The flow may sputter and spurt as differing amounts of air and asphalt enter the flow. Emptying the distributor truck is called "blowing" and should never be permitted on the pavement. The spray bars should be cut off when 200-300 gallons of asphalt are still in the tank. The results of "blowing" are an extremely spotty and uneven application with everything from grossly over-rich areas to no asphalt at all. "Blowing" is to be done in an approved area where the asphalt can be safely disposed.

SPEED OF THE DISTRIBUTOR AND LENGTH OF SPREAD

Distributor speed may be determined by:

where:

$$v = \frac{9Q}{WA\,(1 + c)}$$

v = road speed, fpm;
Q = spray bar output, gal per min;
W = spray bar width, ft;
A = application rate, gal per sq yd; and
c = expansion coefficient resulting from heating the asphalt.

where:

$$c = \frac{T - 60}{30\,(100)}$$

T = application temperature, F.

Based on the number of loaded aggregate trucks on hand when operations begin, the length of spread may be determined by:

where:

$$L = \frac{9V}{WA}$$

L = length of spread, ft; and
V = total gallons to be applied to the surface

The number of gallons sprayed is limited by the capacity of the tank; but, for the loaded aggregate trucks on hand, the number of gallons, V, may be determined:

where:

$$V = \frac{AW_a}{S}$$

W_a = weight of aggregate on hand, lb; and
S = spreading rate of aggregate, lb per sq yd.

Asphalt should be at the proper temperature for spraying viscosity. If it is, application at the correct rate presents no problem. The driver merely maintains the pre-determined speed as indicated on the dial of the bitumeter.

Checks on the amount of asphalt used are made after each run with the distributor. This is done quickly and easily by calculating the gallons per square yard applied, using the formula:

where:

$$A_1 = \frac{9TM}{WL}$$

A_1 = actual rate of application, 60 F, gal per sq yd;
T = total gallons spread from the distributor at spraying temperature (H equals gauge stick reading before spread minus guage stick reading after spread); and
M = multiplier for correcting asphalt volume to basis of 60 F, from temperature-volume tables.

RELATIONSHIP OF QUANTITY OF ASPHALT REQUIRED TO SIZE OF CHIPS

Correct asphalt quantity, voids 50% to 70% filled

Insufficient asphalt, screenings not firmly held

Excess asphalt submerges chips and causes bleeding

Exhibit 404-3.14-1. Speed of Distributor & Length of Spread

No bituminous material shall be spread when weather conditions are unsuitable or when the temperature of the pavement surface is below 85 degrees Fahrenheit (30 degrees Celsius). The application of bituminous material shall not be permitted unless there is complete assurance that cover material will be available to immediately cover the application in its entirety. No matter how hot the asphalt is when sprayed, it will cool to the temperature of the pavement in one minute or less.

When the chip spreader stops, the distributor should stop. There are some methods of constructing a joint "on the run" that allow the spreader to keep moving. The Contractor must supply some way of signaling the distributor driver to stop the spread of bituminous material in case there is any delay in the application of the cover material.

Inspection and Application of Cover Material

Cover material for a chip seal coat must meet all the requirements described in Subsection 404-2.02(C). Aggregates should be as uniform in size and shape as possible so that the seal coat will have essentially one layer of aggregate.

Care must be exercised in the stockpiling and handling of cover material to avoid contamination from dust, intermingling with other aggregates, and other contaminates. This includes picking up underlying soil or stones when cover material is being loaded from stockpiles. If the particles are coated with dust silt, or clay, the coating forms a film that prevents asphalt-aggregate adhesion. A very small amount of certain contaminants can render a large amount of cover material unusable. Oversize stones can plug the spreader box.

The specifications require cover material, when used with emulsified asphalt, to be wet but free from running water. The purpose of requiring the wet cover material is to nullify the effect of any dust on the aggregate particles. The wet aggregate also reduces the absorption of the water in the emulsion. Dusty aggregate and absorption of water tend to cause an early "break" which may reduce the effectiveness and uniformity of the asphalt coating.

When emulsified asphalt is used, the cover material shall be wet, but free of running water at the time of spreading. When bituminous material other than emulsified asphalt is used, the cover material, at the time of spreading, shall be at least as dry as the material dried to a saturated surface dry condition in accordance with the requirements of Arizona Test Method 210. Wetting stockpiles for dust control is not permitted. Do not use wet aggregate with cutback or paving asphalts.

Cover aggregate is weighed as it is delivered, and the weight of water is deducted to determine the dry weight per ton. This dry weight is converted to cubic yards by dividing by the dry weight per cubic yard. Dry weight per cubic yard is determined in accordance with the requirements of AASHTO T 19. The quantity of cover material in cubic yards is the basis of payment to the Contractor. This also provides the Resident Engineer with the means by which he or she can determine the actual rate of application whether by the load or over an extended distance. This can be compared with the theoretical rate.

Any deficiencies or any excesses in the application of the cover material should be remedied by hand methods where necessary in order to avoid bleeding areas or build-up areas.

Careful operation of the chip spreader and the hauling equipment is essential to obtaining a uniform surface. Truck drivers should be instructed before the work starts that they are to:

- stay off asphalt which has not been covered with aggregate;
- avoid speeds in excess of 15 mph (25 km/h) and driving in the same wheel tracks repeatedly when driving on new seal coats;
- avoid turning movements and sudden applications of brakes on new seal coats; and
- avoid lining up a number of trucks behind the spreader and preventing the rollers from working as close to the spreader as possible.

The spreader box should not be allowed to be emptied completely between loads because the spread rate is usually affected.

Because of the rapid cooling of the asphalt as it hits the pavement, it is necessary to apply the cover aggregate immediately to get good chip retention. The entire operation must be organized to achieve a rolled chip surface as quickly as possible after the asphalt is applied.

The distance between the distributor trucks and the chip spreader should always be the minimum distance that safety will allow. A good operating range is 50 to 75 feet (15 to 20 meters). Close coordination between the distributor truck and the chip spreader will assure that when the chip spreader stops the asphalt distributor will stop.

Joints

The specifications permit the Contractor some latitude in the method he or she uses in making transverse joints. The use of building paper has been a generally accepted method to make a clean bituminous material cut-off. With proper coordination, the contractor may also switch distributor trucks in one of two ways that eliminate the use of paper. If the chip spreader is stopped just before the end of the shot of emulsion it can then be backed out of the way and the second distributor truck can tie onto the fresh end of the previous shot. This must be done quickly enough to allow the chips to be dropped onto the emulsion before it breaks. The variation on this theme is to allow the spreader to “fall back” 100 to 200 feet (30 to 60 meters) and then move as slow as practical while the distributor trucks are switched out. This works better in cooler weather since the emulsion will not break as fast. If the distributor truck operators are not able to tie onto the fresh edge without overlapping the emulsion, then the contractor must use the paper “stop and go” method.

It is important that the distributor is at proper speed when application of asphalt starts; also, the spray bar should be shut off before it "blows" or pumps air at the end of each application.

It is important that the Resident Engineer and the Contractor work out a satisfactory procedure to be used when the threat of rain requires the work to be stopped. Equally important is an agreement between the Inspectors and the Contractor’s paving crew as to what constitutes a “dry” pavement after the pavement has become wet.

The specifications are clearly defined in requiring the butt-type longitudinal joint. This method requires the full rate of application of both asphalt and cover material to the extreme edge of the lay ribbon. Care must be taken to not get too much asphalt along the butt joint. A *cut off nozzle* should be used to attain a sharp cut off of asphalt at a butt joint rather than using a shield. Turning the end nozzle 90 degrees is not acceptable.

The correct speed is also important in the operation of the chip spreader. The rate of application will usually be heavy until the spreader gets up to speed. When starting the spreader, there is also a slight delay until the full flow of chips begins. The spread at the joints should be overlapped enough to allow for the delay in the flow of chips. If the Contractor tries to hit the joint too close, it will probably result in a strip having little or no chips that must be covered by hand and will surely result in a bump.

If the operator is not careful when starting a spread, the wheels of the spreader will slip slightly before getting traction. The wheel slip usually leaves a spot the size of the tire print that will be stripped of cover aggregate and/or asphalt. The stripped areas cannot be patched without leaving a permanent mark.

It is often difficult to get Contractors to perform the necessary handwork to get a first-class job. When necessary, handwork needs to be done in a timely manner. Typical of handwork often needed is the cleanup of piled aggregate spilled when trucks dump into the spreader. The piles are to be cleaned up before the roller gets to them. Areas deficient in aggregate also need to be corrected before being rolled. A hand-sprayer, aggregate, and labor should be available just behind the spreader so that handwork can be done without delay and before rolling.

Rolling

The specifications require that a sufficient number of rollers be provided to cover the width of the material in one pass and that rolling will continue for a specified number of passes. The number of rollers needed will be governed by the speed and width of the spreader. The optimum time for rolling is immediately after spreading chips so that it will be done before the emulsion breaks, or the asphalt cools. Remember, the asphalt cools to the pavement temperature in less than a minute. One pass coverage immediately behind the chip spreader is a key requirement for a successful chip seal coat.

If a roller breaks down, the operation should be stopped at once until repairs are made or a replacement is in operation. Furthermore, rolling should not stop to wait for pavement repairs— keep rolling, even if it means they have to remove part of the seal coat later to make the repairs.

The completed seal coat should be examined at intervals after the rolling has been completed. The aggregate should be properly embedded without excessive asphalt showing through. Complete coverage should be achieved (see Exhibit 4-4).

Traffic Control on Chip Seal

Subsection 404-3.03 covers the handling of traffic through or around work which involves the application of bituminous treatments. For safety and inspection considerations, the chip seal operation should be completed in time to return traffic to normal by sunset. The Contractor should organize his or her work to avoid the sunset hazard and to only rarely restrict traffic after sunset. Most seal coat projects require the use of pilot cars and flagger. Attention should be paid to the Special Provisions of each chip seal coat contract since traffic control features are often changed for particular job conditions, or to reflect the most recent revisions in traffic safety policies.

Subsection 404-3.14 provides that the speed of motor vehicles shall not exceed 15 mph (25 km/h) when it is necessary to travel on a new chip seal coat. This includes the pilot vehicle, the vehicles being piloted, the Contractor's vehicles, and ADOT vehicles. The minimum 3 hour traffic-free period shall be observed. Often ADOT and Contractor's vehicles are the worst offenders. It is necessary that the Resident Engineer be firm in enforcing the speed limit and the traffic-free period. If weather conditions are adverse to rapid curing of the asphalt, the traffic-free period may have to be longer. It is mandatory that the Contractor's and ADOT's drivers, as well as the public, observe all traffic controls. Sharp turns and hard braking on fresh chip seals are to be avoided. The Contractor should not be allowed to turn his or her trucks around on a fresh seal.

Removal of Loose Cover Material

Specifications state that all loose cover material shall be removed in not less than 12 hours nor more than 36

hours except when conditions dictate a longer period is desirable. Power brooms are required for removal. Broom pressure that dislodges material from the asphalt is not permitted. The surplus material should not be allowed to remain on the pavement edges. It should be removed completely from the paved surface. In the event there are curbs alongside the pavement, it will be necessary for the Contractor to pick up the surplus cover material and remove it from the road.

Extra care is necessary when brooming chips in town, or in front of businesses or homes close to the roadway. Chips and dust thrown out by the broom can cause damage and inconvenience, so a change in procedure is needed. Speeds should be adjusted to eliminate throwing chips and dust. It may be necessary to hold down the dust by watering lightly. Running the broom so as to leave the chips in the center of the pavement is effective but it may require more handwork. The primary thing to consider is that the comfort and convenience of the property owners are at least as important as the Contractor's convenience.

Brooming during hot weather is generally limited to cooler morning hours. Heat will loosen the chips so that they are either torn out or rolled over. Stop the brooming at the first sign of chip loss. The Inspector will need to be out on the road to observe the operation properly.

The number of brooms provided by the Contractor will govern the distance he or she can seal and still remove the excess chips in time. The number of brooms required can be quickly determined by the following procedure:

Assume.

- Three passes are needed for one broom to sweep a 12-foot wide pavement.
- Broom speed is 15 mph.
- 4-1/2 hours are available for brooming.

Calculate what one broom can cover:

- 15 mph x 4 1/2 hours = 67.5 miles per shift.
- 67.5 miles / 3 passes per lane = 22.5 miles of 12 feet wide pavement per day.

Determine the required brooming operations.

- One broom is needed for cleaning up in front of the sealing operation.
- One broom is needed to remove the previous day's loose cover material.
- One broom should be available as a spare or to speed up the other operations.

Therefore, three is the minimum number of brooms normally needed for a chip seal coat covering up to 23 miles of 12 feet wide pavement per day.

After the brooming is completed, the centerline is replaced, usually by state forces. The Resident Engineer is responsible for keeping the District informed so that the centerline can be repainted as quickly as possible. Temporary reflective markers must be placed until the painting has been done, and they must be placed before dark. Do not neglect necessary warning signs.

Chip Seal Inspection Guidelines

1. Is the Contractor contaminating the cover material with the loading operation?

2. How is the weighing of cover material being handled? Is there adequate documentation of the conversion of tons of cover material to cubic yards?

3. If using emulsified asphalt, are the chips wet, but free of running water?

4. Are weather conditions suitable and is the surface temperature within specifications?

5. Has the surface been properly prepared?

6. Has the absorptive property of the surface been inspected and is the asphalt application rate proper for the existing surface conditions?

7. Are the asphalt distributor and the spreader box mechanically capable of making a uniform application?

8. Have tests been made to determine uniformity of application of the asphalt and of the cover material?

9. Are proper precautions taken to prevent spattering of asphalt on curbs, handrails, traffic, etc.?

10. In making transverse joints, is the Contractor using roofing paper or some other suitable material to ensure a proper junction with the preceding work?

11. Does the Contractor have sufficient labor force to do the necessary brooming and disposing of surplus cover material?

12. Is the cover material being promptly and properly rolled after application?

13. What types of rolling equipment are being used?

14. Are rollers staying close behind the aggregate spreader?

15. Is traffic control effective in keeping traffic off of the fresh seal?

16. Are the Contractor's haul units damaging the fresh seal by excessive speed, sharp turns, etc.?

17. Is traffic kept off the fresh seal the minimum time required by the specifications?

404-3.20 Slurry Seal Coat

Slurry seal consists of a mixture of sand, Portland cement, water, and emulsified asphalt mixed to a rich, creamy consistency. It is spread in a thin layer over the pavement. Portland cement is added to aid in stabilizing and setting the slurry. See the Special Provisions for slurry seal coat requirements. Slurry seal coats are normally used to fill cracks and minor depressions in older AC pavement and to provide a quieter riding surface. Cracks will usually reappear but will be smaller. ADOT has been quite successful in using slurry seal coats to skid-proof bleeding areas of older pavements.

Most slurry seal work is now being applied with continuous flow mixing and spreading units. Such units must be equipped with metering devices and feeders that will introduce the aggregate, Portland cement, water, and emulsion into the mixing chamber in predetermined, specified proportions. The emulsion shall be introduced into the mixing chamber by means of a positive displacement pump which is synchronized with the aggregate feeder belt. There should be an active control for the amount of water introduced that can be used to quickly adjust the flow rate of water.

Calibration Check of Slurry Seal Machine (Example)

The following is a sample calculation the Inspector can use to check the emulsified asphalt content of the slurry seal mix.

Determine the following values:

- Width of Belt = 20 inches
- Length of Belt Travel per Revolution = 3 feet
- Depth of Material (Gate Opening Height) = 3 inches
- Density of Aggregate = 100 pounds per cubic foot
- Emulsion added per Revolution = 2.75 gallons
- Density of Emulsion = 240 gallons per ton (see Standard Specification table 1005-6)

Calculate Weight of Aggregate Per Revolution
(belt width) x (belt travel) x (material depth) x (density) = Aggregate Weight
(20/12) x (3) x (3/12) x (100) = 125 pounds

Calculate Weight of Emulsion per Revolution
(gallons per revolution) x (gallons per ton) = Emulsion Weight
2.75 x 2000 / 240 = 22.9 pounds

Calculate Emulsified Asphalt Content
(Emulsion Weight) / (Aggregate Weight) x 100 = Emulsion Content
22.9 / 125 x 100 = 18.3%

The specifications require approximately 18% emulsion per weight of dry aggregate (sand), and approximately 22 pounds of dry aggregate per square yard of pavement. ADOT's interpretation of "approximately" is ± 1% for the emulsion and ± 1 pound for the dry aggregate.

The slurry seal machine will have an adjustable squeegee at the rear of the mixer that spreads and squeezes the mixture into any cracks and holes both on grades and level pavements. Sufficient water should be sprayed on the pavement ahead of the machine so that the surface is damp by the time the slurry seal is applied.

Other Slurry Seal Inspection Points:

All materials including the emulsion, sand, Portland cement, and source of water should be approved before work begins. Only potable water should be used. Water from irrigation canals or wells that are unfit to drink (regardless of the reason) should not be allowed.

Mixing, placing, spreading and surface preparation shall conform to Subsections 404-3.04 and 3.05 of the Standard Specifications. The spreader box should be equipped with a canvas, or burlap drag to provide a rough surface texture. The drag must be replaced daily in accordance with the Special Provisions.

Special care must be taken with longitudinal and transverse joints to prevent either excessive buildup of slurry (ridging) or streaking. The adjoining lane should be allowed to completely cure before making the joint.

404-3.30 Crack Sealing (Asphaltic Concrete Pavement)

See the Special Provisions for Crack Sealing requirements. Cracks are sealed in asphaltic concrete (AC)

pavements for two reasons:

1. To prevent the intrusion of incompressible materials (like small stones or sand).

2. To prevent the intrusion of water into the underlying pavement layers.

Asphalt-rubber sealant is used by ADOT as crack sealant. A certificate of compliance must accompany the material before the use on the project.

Prior to sealing, it is absolutely necessary that all cracks be thoroughly cleaned to remove incompressible material by either high-pressure air or by routing. If grass or weeds are growing through the crack, those areas should be marked prior to cleaning and an approved liquid herbicide should be injected in the crack after cleaning.

The Inspector shall spot check the depths of the cleaned cracks for conformance to the specifications prior to sealing. The Contractor may have to rout some of the cracks in order to achieve the specified depth. Depth is important in order to achieve a long lasting seal.

404-3.40 Joint Sealing (Asphaltic Concrete Overlay)

Joint sealing is used for a different purpose than crack sealing. Joint sealing is required when an asphaltic concrete (AC) overlay is placed directly on an existing Portland cement concrete pavement (PCCP). The AC must be saw cut and sealed at every PCCP joint to prevent reflective cracking. See the Special Provisions for Joint Sealing requirements.

404-5 Basis of Payment

Tack Coats

Asphalt cement is the only approved tack coat for Specification 407 ACFC, 413 AR-AC, and 414 AR-ACFC. Emulsified asphalts are typically used for all other tack coats. Emulsified asphalt is a mixture of asphalt cement and water. This asphalt/water ratio is about 60/40. Sometimes a special type of emulsified asphalt is specified in the Special Provisions or by the Resident Engineer. The special type of emulsified asphalt is 50/50 mixture of water and emulsified asphalt. The effect is to further dilute the asphalt cement reducing the asphalt/water ratio.

When the special type of emulsified asphalt is used, a pay factor adjustment (see the Standard Specification table in Subsection 404-3.12) is needed to account for the dilution. Since the pay item in the bid schedule is for undiluted emulsified asphalt, a cost adjustment needs to be made to the pay item 4040111. The field office should create a subitem for the cost adjustment and pay at a rate of 70% of the unit price for the bituminous tack coat item. The payment amount should be adjusted to the nearest dollar (see Section 404-5 of the Standard Specifications).

Bituminous Material Price Adjustments Due to Market Price Changes

The price of crude oil and its byproducts change daily. Price fluctuations in crude oil can be volatile and influenced by world events. To eliminate the risk Contractors take in bidding work that uses large amounts of bituminous materials, the Department allows monthly price adjustments to asphalt cement, liquid asphalt, and emulsified asphalt used on the project. The price adjustments are based on the selling prices of asphalt cement listed in the Asphalt Weekly Monitor. ADOT's Contracts and Specifications Section publishes a

monthly Bituminous Material Price Adjustment bulletin which indicates the average price for asphalt cement that month.

The price adjustment is the difference between the asphalt cement price when the asphalt was used on the project and when the project was bid, times a factor for the type of bituminous material. For example, if the price of asphalt cement was $120 per ton when the project was bid and the price changed to $100 when the asphalt cement was purchased and delivered to the project, then a $20 deduction would be made for each ton of asphalt cement used. The adjustment for emulsified asphalt would be $20 x 60% = $12 per ton used, and the adjustment for asphalt-rubber material would be $20 x 80% = $16 per ton used. The method for calculating price adjustment is revised periodically, so always see the Special Provision for the latest method.

To pay for these adjustments, the field office needs to create pay item 4040000, Bituminous Material Price Adjustment. This should be a lump sum, open account where a price adjustment for different bituminous materials used on the project can be paid.

Exhibit 404-5-1 is an example of the recap the field office produces. This recap should be sent to Field Reports when submitting the final estimate for the project.

Note that a pay adjustment factor of 0.6 is shown in Exhibit 404-5-1 for emulsified asphalts. As mentioned previously under Tack Coats, emulsified asphalts contain only 60% asphalt cement. The pay factor adjustment accounts for the water in the emulsion. For the special type of emulsion, a pay factor adjustment of 0.3 is used since only 30% of the diluted emulsion contains asphalt cement.

The final recap (Exhibit 404-5-1) should contain the following:

1. price of asphalt cement at bid time;
2. the pay times affected;
3. the month the material was used;
4. the price at the time of use;
5. difference between current and bid prices;
6. total tons for the month;
7. pay factor (when applicable); and
8. total net adjustment (should equal the lump sum amount for pay item 4040000).

Documentation Requirements for Bituminous Materials

Office documentation requirements needed for final payment include:

1. invoices, and
2. recap sheet(s) (Exhibit 404-5-1) of bituminous treatments used on the project containing:
    A. date material used,
    B. pay tons,

C. weigh backs (when partial loads are used), and
D. accumulative totals.

The office documentation should be submitted to Field Reports for review with the final estimate.

BITUMINOUS MATERIAL PRICE ADJUSTMENTS

ADJUSTMENT REPORT BY PROJECT

PROJECT	H668901C EHRENBERG - PHOENIX HWY CM-010-B(200)A
CONTRACTOR	COFFMAN SPECIALTIES, INC.
BID DATE	10/27/2006
SUBSTANTIAL COMPLETION DATE	08/08/2007
INITIAL COST	383.00

4040111 BITUMINOUS TACK COAT (SS-1)

Section 1

Lot	Date	Price	Diff	Tons	Factor	50:50	Pretax Adj	Sales Tax	Other Tax	Adjustment
01	04/29/2007	321.00	-62.00	0.73	0.3	Y	-13.58	-0.71	0.00	-14.29
02	07/02/2007	327.00	-56.00	1.54	0.3	Y	-25.87	-1.36	0.00	-27.23
02a	07/10/2007	327.00	-56.00	2.69	0.3	Y	-45.19	-2.38	0.00	-47.57
				4.96			**-84.64**	**-4.45**	**0.00**	**-89.09**

4040282 ASPHALT BINDER (PG 76-16) (PG 76-XX)

Section 1

Lot	Date	Price	Diff	Tons	Factor	50:50	Pretax Adj	Sales Tax	Other Tax	Adjustment
01	04/29/2007	321.00	-62.00	42.02	1.0	N	-2,605.24	-137.17	0.00	-2,742.41
02	07/02/2007	327.00	-56.00	39.63	1.0	N	-2,219.28	-116.85	0.00	-2,336.13
				81.65			**-4,824.52**	**-254.02**	**0.00**	**-5,078.54**
			TOTALS	**86.61**			**-4,909.16**	**-258.47**	**0.00**	**-5,167.63**

Exhibit 404-5-1. Bituminous Material Price Adjustment Example