MONTANA
MDT
DEPARTMENT OF TRANSPORTATION

MDT MAINTENANCE CRACK SEALING MANUAL

MDT's mission is to serve the public by providing a transportation system and service that emphasize quality, safety, cost effectiveness, economic vitality and sensitivity to the environment.

CREDITS:

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REFERENCES:

Cimline operator's manual, Federal Highway Administration, Foundation for Pavement Preservation.

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INTRODUCTION

Pavement preventive maintenance is a tool that has the potential to both improve quality and reduce expenditures for our pavement system. Preventive maintenance is based on the concept that periodic inexpensive treatments are more economical than infrequent high cost treatments.

Several types of treatments can be used for preventive maintenance. However, regardless of the treatment selection, appropriate treatment, timing, materials, construction procedures and quality control will determine if the treatment is successful.

The focus of this manual is crack sealing. Crack sealing provides several benefits to the roadway surface: seals cracks, prevents water intrusion, prevents pavement deterioration and extends the life of the pavement. It is critical that cracks are sealed on a regular basis to obtain the maximum life from the pavement.

The objective of this manual is to provide MDT Maintenance personnel with:

- Flow of activities from early planning through completion of the project.
- Present materials, equipment, operation and traffic control consideration needed for a successful crack sealing.
- Provide a glossary of terms, charts and forms used on a crack seal project.
- Provide standardization of materials, equipment, techniques and traffic control for a crack seal project.
- Provide a manual on crack sealer functions, troubleshooting guide and operations guide.

CHAPTER 1 – CRACK SEALING

Introduction

Project selection is determined by the Area Maintenance Chief, Superintendent, Section Supervisor, or Construction Engineers. It is important to note that this is a team effort to identify and determine the type of treatment needed for a pavement treatment. The Pavement Management system (PvMS) can also be used to direct the pavement treatment.

A cost comparison needs to be performed on any PLANNED MAINTENANCE. If the work being performed is REACTIVE MAINTENANCE, then a cost comparison does not need to be done.

The following is a link to MDT Contractor Cost Comparison worksheet.

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Preventive Maintenance

Preventive maintenance is applying the right treatment to the right pavement at the right time.

The objective of a preventive maintenance program is to extend the functional life of the pavement by applying treatments before the pavement deteriorates to a condition that requires a corrective treatment such as structural overlay or complete reconstruction.

Thin overlays, chip seal and/or crack sealing can be preventive maintenance treatments. However, PROPER TIMING of the application is the key to whether the treatment is preventative or not.

Crack sealing prevents the intrusion of water into the subsurface. This manual will discuss crack sealing only. Crack sealing can extend the life of pavement by preventing water from getting into the pavement. Crack sealing should be done after the placement of a new asphalt surface when significant stress cracking is evident. Typically, this is two to five years after the new asphalt is placed.

Crack sealant may be applied in different maintenance techniques based on the pavement treatment needed. One technique is to use routers to make a uniform reservoir for the sealant to be applied into. This also may relieve stress or pressure in the pavement. Routing is recommended on pavements that have lower crack density (less than 20%) for two reasons, the first is to clean and prepare the crack to bond to the sealant and the second is to create a defined reservoir to accept thermal movement. Routing is NOT recommended on pavements that have high crack density (greater than 20%) primarily because the pavement condition is typically not able to sustain a defined reservoir and there is less movement anticipated. This technique would involve applying crack sealant directly to the crack followed closely by a squeegee to push the sealant into the crack. The crack density is calculated by assessing the linear footage of cracks per square feet of pavement area. It is important to meet with your Maintenance Chief and Superintendents to determine the proper application method needed for your pavement.

Structural distress (Figure 1) cannot be corrected with a crack seal. Depending on the degree, severity,

and frequency of the alligator cracking, crack sealing will only temporarily seal the cracks. A very good example of a crack sealing candidate is (Figure 2).

Figure 1 Alligator cracking

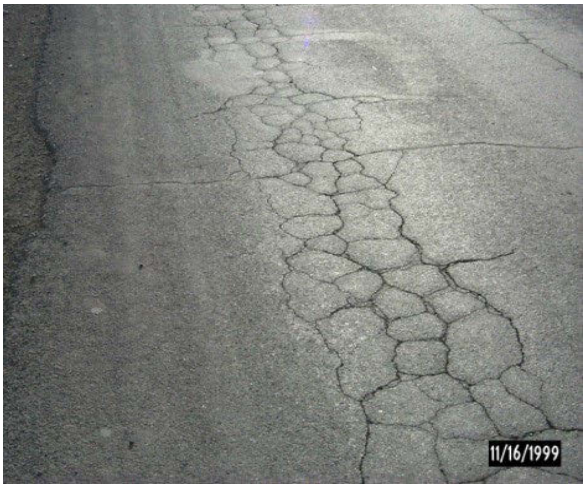

Figure 2 Transverse/Longitudinal cracking

Getting Started

To ensure a successful crack seal project, the first step is to determine the amount of crack sealant material needed. In order to do that you will need to count the cracks in the early spring or late fall. During this time, the cracks are more visible due to the lower temperatures resulting in wider cracks. Cracks can be either longitudinal (parallel to the roadway) or transverse (perpendicular to the roadway). There are several ways to determine the amount of material needed, below are a few examples:

For smaller projects, every transverse crack can be counted, and the length of the crack can be estimated by the width of the road. For example, if you have a 24-foot road and the crack goes ½ way across the length is 12-feet. A DMI is helpful for measuring longitudinal cracks. The total feet of longitudinal cracks is added to the total feet of transverse crack to determine the total footage for the project.

To determine the amount of material you will need, take your total length of cracks and multiply by 0.5 lbs./ft. For example, if you have 1000 feet of cracks then 1000 ft. x 0.5 lbs./ft. = 500 lbs. of crack sealant.

Another way to estimate the amount of material is to take a representative tenth of a mile for each mile in the project and count the number and length of each crack then average each tenth mile used and multiple the average by the total mileage. For example, if you have a 10-mile project count one representative tenth of a mile of cracks in each of the 10-miles. Then average those values and multiply

by 10 to get cracks per mile then multiply by the length of the project in this case 10-miles to get the total footage of cracks. Then as above multiply the total footage of cracks by 0.5 lbs./foot of material to get the quantities of crack sealant needed. Below are a couple links to different estimators that may be useful.

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Caution should be taken when estimating crack sealant needed, the depth of cracks can differ from crack to crack as well as the method of routing the cracks, making it important to discuss your estimations with the Superintendent and Maintenance Chief.

When MDT is preparing to crack seal, equipment shops need to be informed to prepare equipment for the project. Many minor unforeseen problems arise that can be repaired on the spot without delaying the project.

Make sure all employees have been trained on all crack sealing equipment and the training is documented.

Safety on the job, smooth flow of traffic, and the quality of the work are all important to the success of the project. Reference the Guidelines for Temporary Traffic Control handbook, MDT's Standard Detailed Drawings and The MUTCD manual. Identify who will be responsible for the work zone.

NOTE: If the project is being done by a contractor, they must provide a traffic control plan which must be approved by MDT.

MDT specifications recommend crack sealing be done only when surface temperatures are between 35°F (and rising) and 120°F. In cases of contracted projects, the inspectors will need to make sure the contractor is following the guidelines. If minimum application temperatures cannot be maintained, winter shut down will be determined project by project.

Make sure the project is on the road construction reports so that the traveling public can be made aware of the project and any delays from the work. For larger projects, or projects in urban areas consider informing the media.

Before beginning to route, make sure cotter pins, washers, router bit pins and router bits are in good working condition and are set to make the proper reservoir width desired.

Ensure the reservoir and crack is dry and free of dust, dirt, vegetation, and loose materials immediately before applying the sealant. It is recommended to use air equipment producing at least 100 PSI. Drain water from the compressor as needed.

Blotting is recommended if traffic is allowed on fresh sealant before it has time to cool and set up to prevent tracking. A good blotter is single-layer toilet paper applied immediately after sealant is applied using a long-handled paint roller. Glenzoil, a soapy water material, or similar product may be used if approved by Maintenance Chief.

CHAPTER 2 – MATERIALS AND EQUIPMENT CONSIDERATIONS

Sealant Considerations

There are many different crack-treatment material products on the market today, each with distinct characteristics. The products used by MDT are listed below.

- Mineral filled asphalt cement mastic
- Low-modulus rubberized asphalt
- Velocity patcher and/or plant mix for larger cracks
- Mineral-filled and fiberized asphalt are used for very large cracks with inverted cracking.

The addition of rubber polymer to liquid or heated asphalt generally improves field performance because it gives flexibility to the asphalt. The degree of flexibility depends on the type and nature of the asphalt, the percentage of vulcanized rubber used, and how rubber is incorporated into the asphalt (i.e., mixed or melted in). Other polymers are often incorporated into asphalt either exclusively or along with rubber to increase resilience.

Material Temperature Considerations

The specific recommendations provided by the manufacturer of the material to be placed should be followed closely. These recommendations generally include minimum placement temperature, maximum material heating temperatures, re-heating unused product, prolonged heating, and allowable pavement temperature and moisture conditions.

For recommended application temperatures for crack sealing materials see the Manufacture Specifications that are located on the material packaging.

Equipment

This section will make equipment recommendations and operational procedures.

Equipment that will be reviewed are the following:

- Routers
- Crack seal pot
- Air compressors

Routers

The objective of routing is to create a uniform reservoir, and to reach stable material for the crack sealant to adhere to the pavement. Routing can inflict additional damage on the pavement if not properly performed.

Make every effort to follow the crack accurately while cutting, centering the cut over the crack as much as possible. Poor routing will decrease the ability for the crack sealant to adhere to the existing crack.

Router Bits, Pins, and Washers

Carbide router bits are highly recommended over steel bits. In addition, the carbide, while more expensive, will generally last five times longer, which will increase productivity. Care should be taken that the router bit is installed in the correct direction. The carbide part of the bit should face the front of the machine (Figure 4).

Carbide router bits should be rotated on a regular basis as needed. As bits wear you will notice rounded vertical walls (Figure 4), uneven or non-uniform reservoirs, and/or router will begin to jump.

Pins and Washers must be inspected when bits are changed or rotated. All pins should be inspected for grooves and wear. If pins are showing signs of wear they must be replaced.

Depending on the reservoir size the router configuration can change. Router set up can be as simple as one bit in line (Figure 5), to bits staggered with different configurations on each pin depending on the size of the reservoir desired. (Figures 3 and 4).

Pictures below show a few different router bit configuration examples.

Figure 3: 1 ½" X ½" Router bit set up.

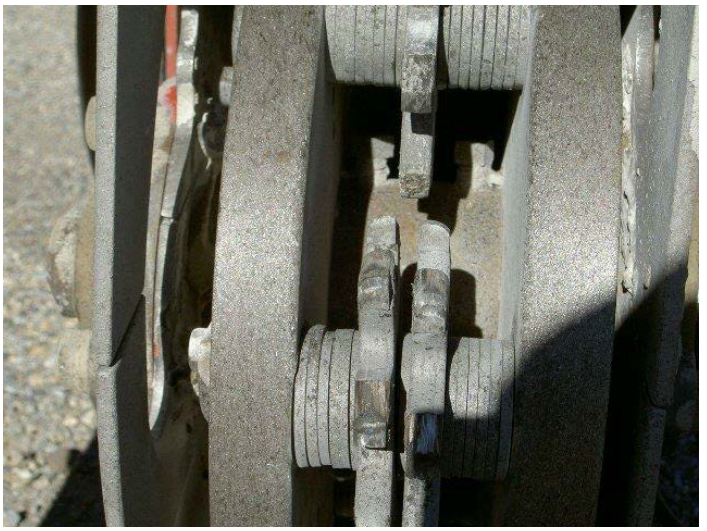


Figure 4: ¾ X ¾" Router bit set up.

Figure 5: Single bit router set up

The depth of the reservoir should be determined prior to starting work. Typically, the depth for transverse cracks are ½ inch and for longitudinal the depth is ¾ inch. The best way to do this is to conduct a test route and measure the depth. Once determined use the depth guide on the router and remember that, adjustments will have to be made throughout the day to the depth as the bits wear.

Air Compressor

High pressure compressed air with 100 (PSI) is recommended to clean both routed and non-routed cracks. The equipment used is high-pressure, high volume air compressors with hose and wand.

Compressed air provides no heat and very little drying of moisture in the cracks. Therefore, it is critical that the pavement and the crack reservoir be completely dry. Furthermore, some air compressors may introduce water and oil into the air supply. Thus, the compressors should be equipped with moisture and oil filters to remove these contaminants from the air supply. Drain moisture from air compressor as needed.

Crack Seal Pot

Rubberized asphalt materials must be heated and mixed with indirect heat, in agitator type crack seal pots. Crack seal pots burn propane or diesel fuel to heat the transfer oil, which surrounds the melting vat containing the sealant. These types of crack seal pots provide a safer, more controlled method to heat the sealant. Agitation of the sealant provides a uniformly heated material.

Depending on the type, amount of material and size of the pot, the material may take several hours to reach its proper application temperature.

It is critical that the operator keeps the crack sealant material within manufacturers recommended application temperatures. Monitor thermostats for material and heating oil temperature on a regular basis. The temperature of the heat transfer oil in the crack sealer should not exceed manufacturer’s recommendations when melting crack sealant.

CHAPTER 3 – CRACK SEALING PROCESS

Safety

Safety is the #1 priority at MDT. This is one of the most dangerous jobs that MDT does, and a safety meeting is mandatory prior to start of project. Safety meeting topics shall include:

- Setting up proper work zone
- Required Personal Protective Equipment (PPE)
- Detailed job description
- Documented training
- Hazard discussion
    - Materials and materials temp—flash point of transfer oil and sealant material. Check transfer oil daily. Do not overfill due to expansion of hot oil.
    - MSDS or SDS discussion
    - Fire Hazards
    - Debris
    - Traffic consideration
    - Fire extinguisher locations
- First Aid supplies, including burn kit, and locations
- Cleaning supplies (WD-40, water)

The major concerns for crack sealing are traffic, high material temperature, flying debris concerns, flammable materials, high pressure air and propane. The following describes the safety concerns and PPE required.

- PPE includes hard hats and ANSI class 2 vests, safety toe boots, safety glasses and face shields for the hard hats, hearing protection, long sleeve shirts, appropriate leather gloves, leather apron and chaps,
- First aid considerations: burn kit, first aid kit and fresh water (5-gallons minimum) for any burns.
- Traffic control: ensure flaggers are certified, signs are new or like new condition and include MDT traffic control plan and Detailed Drawings 618-M1, M3
- High temperature: liquid material can splash and once on skin it is impossible to remove. Do not attempt to remove until it is cooled off. Cool the material down with water and seek medical attention immediately. **Heating oil needs to be changed according to the manufactures recommendation which is every 500-hours or once a year whichever comes first**. Make sure to use only approved heat transfer oil. Additionally, know the flashpoints of the heat transfer oil and sealant and ensure you are within the manufacturer's specification. Ensure that you have a class C fire extinguisher and if there is a fire, secure the scene and call emergency services.
- Debris: router and air compressor operations can cause debris to fly out into traffic causing damage to the traveling public's vehicle. Ensure that all safety guards on the router are in good working condition and properly installed. When blowing out the cracks start at centerline and blow to the shoulder.
- Propane Tanks: ensure that the valves, hoses, flame sensor, motor, burners and propane tanks

are in good working condition with no cracks in the hoses. Regulators on propane tanks need to be correctly set at 13 to 14 PSI. Refer to manufacturer's recommendation.

Preheating

One day prior to starting the first job of the season the material in the crack sealer should be brought up to temperatures that allow internal circulation and mixing paddles rotation. The temperatures should not reach the full application temperatures. This is a very good time to insure the working order of all the components of the crack sealer. The crack sealer should be filled to maximum capacity with crack seal material.

Traffic control on the job site

The traffic control should be evaluated before setting up. Every job site is different and may require additional signing and flaggers. Involving the District Traffic Engineer in unique situations is recommended.

Routing

Routing cracks is the most labor-intensive and time-consuming operation in the crack sealing operation. Crack spacing, reservoir dimension, pavement temperature, and type of aggregate all affect production rate. Since routing is so time-consuming, both router maintenance and safety are often overlooked. The following are some router maintenance and safety tips:

- Proper PPE: hard hat, vest, eye and ear protection, gloves, safety toed boots, dust mask,
- Prior to use, schedule router with shop for maintenance to ensure that it is in excellent working order. Router must be thoroughly cleaned with compressed air, and all dust and dirt removed. Air filters need to be checked daily and replaced if needed.
- Oil level needs to be checked daily and changed per PM schedule, grease machine at least twice a day.
- Use air compressor to blow and clean router daily.
- When beginning to route, make sure handle is set at waist level and in a comfortable position.
- Foot position is important when pulling the router, keep your front foot directly under handle while pulling backwards. This will help keep the router in the proper position.
- Make sure the brake on the router is adjusted properly.
- When cutting is finished, do not tip router forward to exit from cut; do not exit the crack by lifting up on the handle. Lift the router bits out of the pavement with the lift cylinder. For safety reasons, ensure the router bits do not come in contact with the pavement when exiting.

Blowing

A thorough cleaning of the cracks is a very important part of the crack sealing process. Make sure all cracks are clean and free of moisture and contaminants. This ensures a good bond between the pavement and sealant. Blowing must be done immediately before sealing.

- Remember the most important aspect of the crack seal operation is cleaning and drying the

routed reservoir. The single largest factor for crack sealant failures can be attributed to dirt, dust and/or moisture in the routed reservoir. Their presence greatly reduces or prevents bonding between the sealant and the reservoir walls. The sealant adheres to the dirt instead of a clean dry surface.

- Proper PPE: hard hat, vest, eye and ear protection, leather gloves, safety toed boots, dust mask.
- A complete walk around must be done daily on the compressor unit.
- Check hoses and parts for wear and drain air tanks throughout the day for moisture and oils.

Blowing Procedures

1. Start at the center of the roadway
2. Hold the nozzle no more than 2-inches from the pavement surface.
3. Blow debris in front of the nozzle. Do not walk backwards.
4. Do not blow debris towards vehicles.
5. Make slow or repeated sweeping motion until the joint reservoir is completely clean.
6. Elevate and fan the nozzle across the pavement to move debris from the joint area to the shoulder of the road where it cannot re-contaminate the joints.
7. Keep the compressor immediately in front of the crack sealer to limit re-contamination.
8. Ensure a safety wire or clip is in place to prevent hoses from separating from compressor.

Crack Sealer

This section is broken down into two parts, the equipment and the sealing procedure.

- PPE includes hard hats and vests, safety toe boots, safety glasses, and face shields for the hard hats, hearing protection, long sleeve shirts, leather gloves, leather apron and chaps.

Equipment

Prior to use, schedule the crack sealer with the shop for PM 2 to ensure it is in working order.

Checks should include the following:

- Check all gauges and replace if not in working order.
- Check transfer oil and fill to full level (cold).
- Check tires and inflate or deflate as needed.
- Clean all hoses and sheaths and replace if damaged. Also check label to see if capable of withstanding 425-degree temperatures (stamped on the hose).
- Make sure wand and on/off valve are in good working order. Turn the on/off valve open and closed a few times to ensure it is working properly. It is very important for the on/off valve to work properly for safety reasons and to prevent the excess waste of costly materials during the use of the equipment.
- After removing wand from the crack sealer, keep it pointed downward for safety reasons. Put wand back in the crack sealer when not in use and turn it on to circulate the sealant and prevent plugging.

Before heating material, crack sealing pot operators should know manufacture's heating temperatures and the effects of overheating or extended heating/reheating which can cause coking of the material.

Three guidelines for initial heating of hot-applied materials are:

1. Begin heating so that the material is at recommended application temperature when normal work operations begin.
2. Regulate heating oil temperature so the temperature of the material does not exceed the material manufacturer's safe heating temperature recommendations.
    i. Start the internal agitator as soon as material allows.
    ii. Start circulating the material internally thru the pump when material is flowable. At this time, the hose should be in the heating cabinet. Care should be taken to monitor the internal temperature of the heating cabinet so as not to burn the hose. DO NOT USE PROPANE TORCH TO HEAT DISCHARGE HOSE OR CABINET.
    iii. Shut down the burner on the pot before transporting it to the job site.
    iv. Once on the job site and material is up to manufacturers application temperature start circulating through the wand.
3. Maintain material temperatures within the recommended application temperature range throughout the entire project.

Sealing Procedures:

The proper filling of the cracks helps to ensure a quality product and thus extends the life of the roadway.

- Begin the application once the material has reached the manufacturer's recommended application temperature and the first few cracks have been prepared. From this point, the focus is on these items:
    1. Ensure material remains within the manufacturer's recommended application temperature range.
    2. Maintain a sufficient supply of heated material in the crack sealer. In general, this should be at least a ½ pot. However, this could be lower depending on the size of the job and the amount of work remaining.
- The operators must be fully aware of the recommended application temperature and the safe heating temperature of the material being applied. These temperatures are usually marked on the material packaging for quick and easy reference.
- Maintaining a consistent material temperature can be difficult, especially in windy conditions and cold weather. Under heated material may produce a poor bond and/or freeze up the application line, which causes a work delay. However, overheating will also lead to either poor treatment performance or operator safety concerns.

Guidelines for maintaining hot-applied material in a sufficient quantity and at the proper temperature during application are:

1. Check the temperature of the material at the nozzle and in the melting vat. It is recommended that the temperatures be checked using a hand-held infrared temperature gun.
2. Adjust the heating controls to reach the manufacturer's recommended application temperature or as near to as possible without exceeding the safe heating temperature.
3. Check the sealant temperatures regularly and adjust as necessary.
4. Watch for carbon buildup on the sidewalls of the heating chamber and visually inspect material for changes in consistency.
5. Check the level of material in the melting vat periodically by looking into the vat carefully.

Add material on a regular basis to avoid heat loss from adding a large quantity of cold material. Make sure that the material blocks added to the vat are clean to prevent plugging of the nozzle.

a. Care needs to be taken when opening and adding material blocks while the wand is recirculating in the vat as hot rubber can splash out of the vat when you open the lid. **NEVER drop material into the vat**. Place material on vat door and add material by closing the door.

General guidelines for material application include:

1. Set puck/cup or nozzle on the road surface and open material valve.
2. Adjust pressure valve so that wand valve can be fully opened while sealing.
3. Apply the material in a continuous motion, making sure to fill the crack to the proper level.
4. Reapply material to crack segments where material has sunk into the crack or an insufficient amount was furnished in the previous pass.
5. After removing wand from the sealer, keep it pointed downward for safety reasons. Put wand back in the vat during idle times and turn it on to circulate the sealant to prevent plugging.
6. Properly dispense the right amount of material into the crack reservoir. This includes flush fill, filling with a puck/cup (Figures 4 & 5), or band-aid method.
   Note: Make sure to keep debris and gravel free from puck/cup and/or clean as needed to ensure that contaminants are not added back to the vat which may cause plugging.

Figure 4: Crack sealing cup

Figure 5: Crack sealing puck

Blotting

Blotting prevents tracking and allows traffic back in the sealed lane much quicker than without blotter.

- Proper PPE: hard hat, vest, eye and ear protection, gloves, safety toed boots.

Material Blotter

The objective of blotting is to provide sufficient cover or protection of the uncured treatment material so that it does not track under traffic. The equipment necessary for this activity depends on the type of blotter material to be used.

Single ply toilet paper and Glenzoil are often used to prevent tracking. Apply these blotters immediately after finishing so that they stick to the material and serve as temporary covers. Single ply toilet paper works the best as double ply separates and creates excess litter. Apply the toilet paper with a long-handled paint roller, and the Glenzoil with a backpack sprayer.

Toilet paper rolls can usually be loaded on the same truck with the prepackaged sealant blocks. For easy application, individual rolls can be placed on a modified paint roller (equipped with a long handle).

Crack Sealer Cleanup Considerations

In order to keep the equipment in good working order and prevent plugging of lines care should be taken to clean the crack sealer at the end each working day.

- For full cleaning and troubleshooting directions refer to the specific crack seal equipment manual, under the Materials System Cleanout section

CHAPTER 4 – OPERATIONAL CONSIDERATIONS

Weather Considerations

Traditionally crack sealing has been done in the summer which has caused premature failures of the sealant. The best results are achieved in cooler weather—in early spring and late fall—when cracks are open to the optimum width.

The ideal conditions for applying a crack sealant are 35°F surface temperature and rising with relatively low humidity, and little or no wind. For the best results do not apply sealant if the pavement temperature is over 120 F. You must, however, check the surface temperature every morning before any sealant is applied. This is done using an infrared surface thermometer.

Wind

Wind may work partially in your favor and against you at the same time. A gentle wind, if it is constant in speed and direction, can help to cool the sealant sooner. This can reduce some of the potential for tracking problems that usually comes when traffic is applied too soon.

Wind may force a change in plans as to which lane is sealed first, and the direction of work, in order to minimize the effects of loose debris from blowing back into the clean reservoir.

Remember, cold wind will increase heating time in the crack sealer.

Rain

Sealant should **NEVER** be applied during rain. If rain is in the vicinity and predicted for the area, you should suspend operations until it clears.

Sudden, unexpected showers are common. Sometimes they appear with no warning and pass very quickly. In this case stop crack sealing immediately and wait until the shower is gone and the cracks are dry before resuming operations.

Recheck pavement temperatures and be aware of the increased humidity.

Urban Considerations

When crack sealing in urban areas, special considerations should be made. A pickup broom may be required to clean the pavement after routing cracks. This should be discussed with the Superintendent and area Maintenance Chief and/or District Traffic Engineer.

Use the MDT standard detailed drawings and manuals for all traffic control plans. A much more extensive traffic control plan is required for crack sealing projects in urban areas. Side streets entering into the work area need detours and additional personnel for traffic control.

Increased traffic volumes require larger storage space for stopped vehicles waiting to be piloted

through the work zone and additional pilot vehicles should be considered. Traffic signals at intersections may need to be disabled and flaggers used when the project interferes with normal traffic through intersections.

List of Good Practices

- Determine whether a crack seal is the proper strategy for the project.
- Public notification about the project should be relayed to our road information system.
- Pre-project safety meeting.
- Attention to weather factors forecast temperature, humidity, etc.)
- Appropriate traffic control and flagging operations.
- Appropriate PPE, i.e., leather gloves, ear and eye protection, safety toed boots and long-sleeved shirts.
- Routing uniformity; proper depth, width and vertical sidewalls.
- Clean and dry routed reservoirs.
- Sealant application temperature within Manufacturers specifications
- Blotter material when needed.

CHAPTER 5 - TRAFFIC CONSIDERATIONS

It is recommended that one person be in charge of a crew whose sole responsibility is traffic control. Their duties include placing and moving temporary signs, flagging and piloting operations (if necessary).

Any permanent signs that are in conflict with the project must be covered until the project is complete

Sign Setup

The first priority prior to start-up should be the correct positioning of the signs as per the MDT Detail Drawings. Sign layout is critical, so motorists are adequately warned before any equipment is moved onto the highway. Be sure the traffic que is adequate for stopped vehicles.

Check to ensure that all signs specified in the Traffic Control Plan and/or Work Zone Safety Guideline handbook are:

- In good condition.
- In the proper sequence; the correct distance apart; clearly visible to motorists.
- Positioned correctly so the devices themselves do not pose a hazard to traffic.

Flagger
All flaggers must be certified and must have proof of certification while flagging.

As soon as the flagger sign is placed in position, a flagger should also be in position. You should ensure the flagger is using the correct signals.

If there are flaggers at both ends of the project, which there usually are on a two-lane road, make certain they have whatever communication tools are necessary.

Always remember that the flaggers are vital to the safety of motorists and workers in the construction area. Refer to the MDT flagger manual for proper flagging attire and requirements.

APPENDIX A

Glossary of Terms

Adhesiveness – The ability of a material to remain bonded to crack sidewalls and/or pavement surface.

Band-aid – An over band configuration where material is shaped/finished to desired dimensions. (See figure 6)

Figure 6: Band-aid routed

Figure 1: Band-aid un-routed

Cohesiveness – The ability of a material to resist tearing and separation from the asphalt
Cost-Effectiveness – The degree to which a treatment is both useful and economical.

Crack Reservoir – A uniform crack channel resulting from natural cracking (uncut) (See figure 7) or routed crack. (See figure 8)

Figure 7: Crack channel

Figure 8: Routed crack

Crack Treatment – Maintenance in which cracks are directly treated through sealing operations.

Inverted cracking – A depression in the pavement profile along crack edges caused by damaged or weakened sublayers.

Edge Deterioration – Secondary cracks and spalls that occur within a few inches of the edges of a primary crack. (See figure 9)

Figure 9: Edge Deterioration

Elasticity – The ability of a material to contract and expand.

Longitudinal – Parallel to the centerline of the pavement or laydown direction. (See figure 10)

Figure 10: Longitudinal Crack

Secondary Crack – A crack extending parallel to and/or radially from a primary crack. A form of edge deterioration. (See figure 11)

Figure 11: Secondary Crack

Transverse – Perpendicular to the pavement centerline. (See figure 12)

Figure 12: Transverse crack

Working Cracks – Cracks that experience considerable horizontal and/or vertical movement as a result of temperature change or traffic loading.

TROUBLE SHOOTING

Trouble Shooting Guide		
Burner will not ignite.	Fuse burned out	Check fuse
	Burner relay inoperative	Check for 12 VDC at relay
	Orifice is clogged	Clean orifice
	Primary control fuse	Check fuse
	Air in fuel line	Bleed burner
	Thermocouple(s) inoperative	Replace thermocouple(s)
Agitator will not rotate.	Sealant materials not hot enough	Allow material to heat longer
	Too many biscuits added at one time	
		Continue heat up and reverse agitation to break biscuits free
	Low hydraulic oil level	Check oil level
	Worn agitator motor	Replace motor
Material pump will not rotate.	Sealant material not hot enough	Allow material to heat longer
	Too much material left in lines	
	Low hydraulic level	Check oil level
	Foreign object lodged in line	Remove foreign object
	Pump damaged	Repair or replace pump
Material pump rotates but does not pump material.		
	Pump worn or damaged	Repair or replace pump
	Pump rotating in wrong direction	Check rotation
	Pump inlet line plugged	Check material filter and 6nes
	Too much material left in lines from previous use	
		Heat plumbing and valves

Trouble Shooting Guide		
Material recirculates but will not flow through sealing wand.	Sealing hose froze up	Remove wand and place hose in cabinet to melt material
	Sealing wand froze up	Heat wand and melt material
	Sealing hose valve not completely open	Open valve to the full "on" position
Material heat up time slow.	Burner orifice clogged	Remove orifice and clean
	Hot oil pump worn	Replace or rebuild pump
	Heat transfer oil is worn out	Check oil level and replace if necessary
During sealing operation, material stops flowing.	Wand valve left in "off' position to long before returning to access port for recirculation	Place hose in cabinet to melt material. Refer to heating a plugged hose on page
	Too many biscuits added at one time causing cold material to enter pump	Heat hose and plumbing system. Reverse pump momentarily to force cold material into tank
	Material temperature too low	Check control box settings

Controls and Their Functions

NOTE: This general outline will only familiarize you with the machine. Read through the entire manual before putting this machine into operation.

1) Tank Outlet Valve: Allows melted material from the tank to flow into the pumping system.

2) Access Port: The sealing wand is placed in here when not in use. This allows the operator to continue circulating material through the hose to prevent material from cooling and freezing up.

3) Loading Door (2 on Model 225): Place the material on the safety door to load the melting tank.

4) Oil Temperature Gauge: Monitors the heat transfer oil temperature.

5) MaterialTemperature Gauge (optional): This gauge shows the temperature of the material inside the melting tank. This gauge is for reference before pumping starts. Once pumping begins, gauge (6) will be an exact reading of material passing through the system. (Not shown)

6) Material Temperature Gauge: Reads material temperature as it pumps through plumbing system.

7) Pressure Valve: This valve controls the flow rate of the material being pumped to the hose and sealing wand by changing the pressure setting (turning the valve clockwise will increase the pressure which in turn will increase the flow). During sealing operations, this valve alone can be used to regulate flow.

8) Sealing Hose Valve: Opening this valve will allow the material being pumped to flow through the hose and sealing wand. The valve should be in the full “on” position during operation to prevent flow restriction.

9) Agitation Drive Control Knob: Rotate knob counterclockwise to start agitation. Rotate knob clockwise to reverse agitation, which is useful for dislodging material. Center position is neutral.

10) Pressure Gauge: This gauge measures the pressure required to turn the agitator. By observing this gauge, the operator can tell if the agitator is rotating.

11) Pump Drive Control Knob: Rotate knob counterclockwise to start material pump for sealing operation. Rotate the knob clockwise to reverse the material flow. Reverse flow is used for system cleanout. Center position is neutral.

12) Air Cleanout Valve (optional): Connect airline or solvent line to this connector to flush out system. This valve should always remain closed other than cleanout.

13) Temperature Control Box: This control allows the operator to set the desired oil temperature. The setting will be maintained automatically.

14) Engine Throttle: Refer to Engine Manual for startup and maintenance procedures.

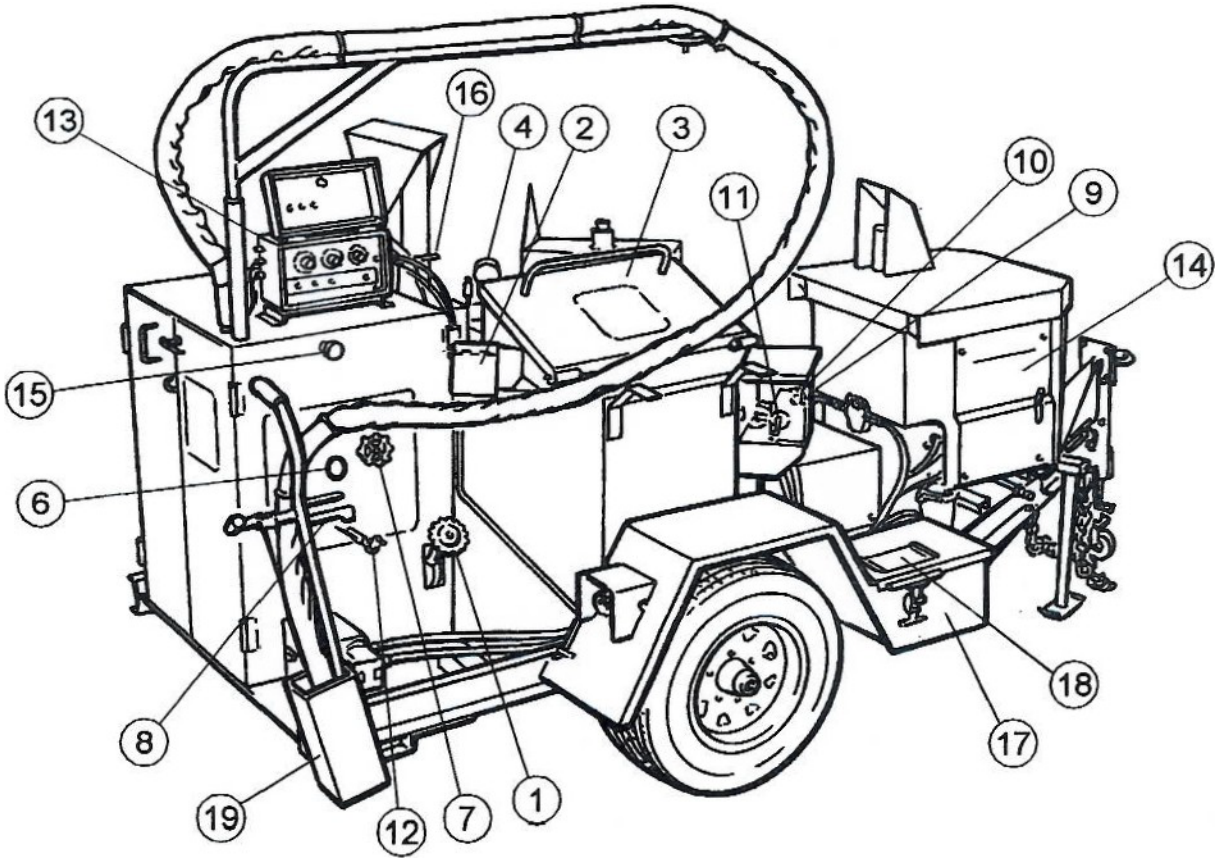
15) Cabinet Temperature Gauge: Indicates the temperature inside the cabinet. Do not exceed 320ºF. If conditions permit exceeding this temperature, open cabinet door.

16) Thermal Regulating Gate: Lift lever (A) to open gate (B) which will direct hot air to cabinet to heat pump and plumbing.

17) Battery Box: Battery and related electrical components are located inside.

18) Ignition Access Door: On Diesel models lift this door for access to ignition key.

19) Wand Holder: On models with the electrically heated hose, the wand is placed into this holder.



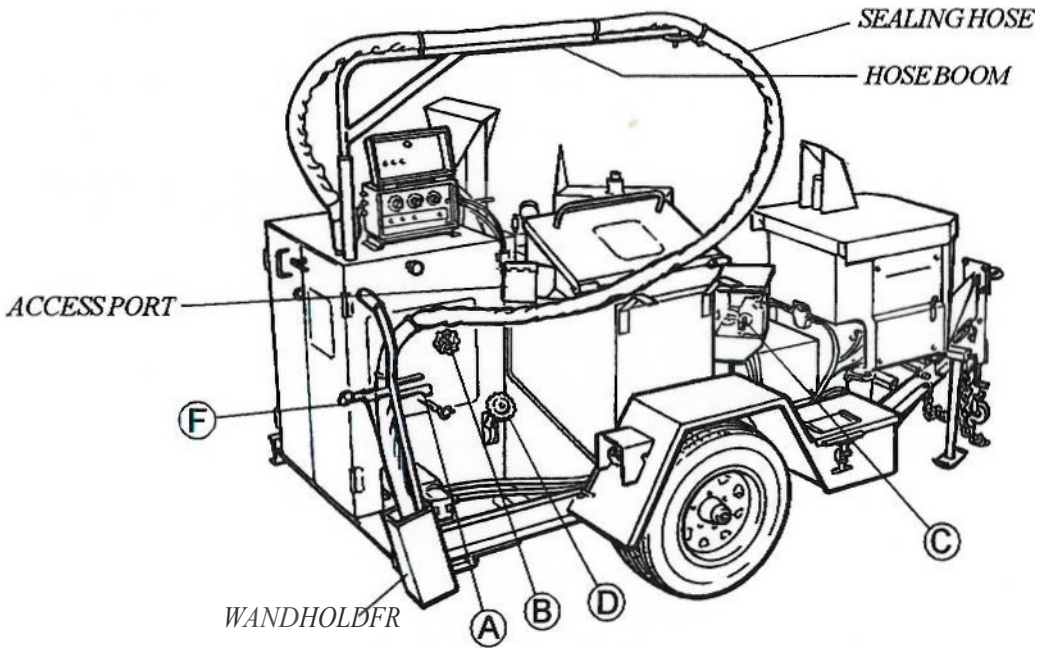
Material -System Cleanout

Approximately 10-15 minutes before the end of the work period, turn the temperature control knob(s) “off”. There are two methods of cleaning that can be used; reverse flow, and air.

NOTE: The material loading doors and wand access port must be closed at all times.

REVERSE FLOW CLEANOUT METHOD

1) To clean out the machine at the end of the day, return the wand to the wand return and open the wand valve (F). Turn the pressure valve (B) clockwise until closed and reverse the material pump by turning the material pump drive knob (C) clockwise. Run the pump in reverse for 2-3 minutes.
2) With the hose still in the hose holder, elevate the hose over your head and physically walk the length of the hose, shaking it to drain any residual sealant out of the hose.
3) Close the sealing hose valve (A) by turning clockwise and continue with the pump in reverse for 2-3 minutes.
4) Close the tank outlet valve (0) by turning clockwise.
5) Turn the pump off and open the pressure valve by turning counter clockwise.
6) Coil the hose back into the heating cabinet and shut the machine down (Non-heated hose models only).



Material Cleanout

AIR CLEANOUT METHOD (OPTIONAL)

1) Place material pump in neutral.

2) Remove sealing tip and return wand to access port.

3) Open wand valve (F) and sealing hose valve (A).

4) Close tank outlet valve (D).

5) Increase (close) pressure valve (B) to maximum.

6) Connect air hose and open air cleanout valve.

7) Allow air to blow freely through sealing hose. (Turn wand valve (F), open and closed several times during this phase, to aid in cleaning valve. Leave valve open).

8) Open tank outlet valve (D) momentarily, then close.

9) Decrease (open) pressure valve (8) and leave open.

10) Close sealing hose valve (A).

11) Shut air hose off at compressor, close air cleanout valve and disconnect hose.

12) Proceed with normal machine shut down.

Bottle Hookup and Ignition

Bottle Hookup and Ignition (LP Units only)

NOTE: Liquid withdrawal requires optional hose adapters and engine vaporizer.

1) Place 100 lb. propane bottle(s) in rack and secure in place with chain binder(s). Model 225 melter uses (2) bottles, Model 105 holds (1).

2) Connect hoses (A) to bottle(s).

NOTE: POL fittings are left hand thread. All connection must be air tight.

3) Place 100 lb. propane bottle(s) in rack and secure in place with chain binder(s). Model 225 melter uses (2) bottles, Model 105 holds (1).

4) Close hand torch supply valve (8). (Optional)

5) On models with two bottles, open the valve (C) from one bottle or the other.

6) Open valve on LP bottle and set regulator (D) at 13 to 14 PSI.

WARNING: DO NOT exceed 14 PSI.

7) Set the oil controller (E) to 550F. Set the material controller (F) to the recommended material working temperature (typically listed on can or box). (Optional)

8) Ignite the burner by turning the toggle switch (G) “on”.

NOTE: If the burner does not ignite within 8-10 seconds, the unit will require resetting. Turn switch “off”, allow time for the unburned fuel to exit the chamber and repeat procedure.

9) If ignition does not occur, check the fuse and gas supply.