EVALUATION OF VERGLIMIT
(A DE-ICING ADDITIVE IN
PLANT MIXED BITUMINOUS SURFACE)

FINAL REPORT
July 1989
Evaluation of Verglimit
(A De-icing Additive in
Plant Mixed Bituminous Surface)

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Evaluation of Verglimit (A deicing additive in plant-mixed bituminous surface).

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A Verglimit test section was constructed on U.S. Route 8 near Taylors Falls, MN. The applied mix appeared to be tender and some compactions difficulties were experienced. Manufacturer's recommendations were closely followed and no other unexpected difficulties occurred.

Evaluation of the test section consisted of deicing observations as well as other pavement performance characterizations. Portions of the Verglimit overlay experienced shoving and were milled and replaced. Significant deicing benefits were not observed. No future Verglimit sections are planned.
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EXECUTIVE SUMMARY

The proprietary product Verglimit claims to decrease the amount of materials and man-hours needed for snow and ice control while maintaining adequate safety levels. Verglimit consists of calcium chloride flakes encapsulated in linseed oil which are blended into the plant mixed bituminous wearing surface. The manufacturer claims that exposed CaCl will attract moisture and form a solution which prohibits adhesion of snow and ice to the pavement.

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FOREWORD

The purpose of this study is to evaluate a proprietary product called Verglimit. Verglimit consists of calcium chloride flakes encapsulated in linseed oil which are blended into the plant mixed bituminous wearing surface. Verglimit is advertised to be a deicer which will lengthen the response time for snow and ice maintenance on bridge decks, ramps, steep grades and other hazard areas. Other claimed benefits include reduced corrosion and environmental protection due to the decreased amount of salt required.

The author wishes to acknowledge the contribution of Dan Wegman, Jim Kochsiek and District 9 Construction and Maintenance personnel.

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented. The contents do not necessarily reflect the official views or policy of the Minnesota Department of Transportation. This report does not constitute a standard, specification or regulation.
I. INTRODUCTION

A. Background

Mn/DOT is continuously looking for ways to decrease the amount of materials and man-hours used for snow and ice control, yet maintain adequate safety levels. The proprietary product Verglimit claims to address this concern.

Verglimit consists of calcium chloride flakes encapsulated in linseed oil which are blended into the plant mixed bituminous wearing course. The manufacturer claims that exposed CaCl will attract moisture and form a solution which prohibits adhesion of snow and ice to the pavement. This would lengthen the response time or eliminate the need for a maintenance crew’s attention.

The purported characteristics of Verglimit lend its use to certain types of projects. It is advertised as being effective in limiting corrosion and environmentally safe since less rock salt is needed. The cost of Verglimit limits its use to hazardous areas such as bridge decks, ramps, shaded areas, and steep grades. A minimum of 5000 vehicles/lane/day is recommended to wear the surface, thus providing the proper amount of exposed product.

Verglimit is produced in West Germany by Verglimit SA and distributed by PK Innovations of Hamilton, Ontario, Canada. It has been tested throughout Western Europe. Previous North American test sites include Albany and Binghamton, N.Y.; Allentown, Pa; Winnipeg, Manitoba; and Charleston Illinois. The Albany and Binghamton studies conducted by NY/DOT had favorable results. The product limited ice buildup at temperatures just below freezing, during freezing rain and under light snow. Allentown, Pa has similar results. The Manitoba Department of Highways had limited success during the material’s first season of service, October 1978 through April 1979, and almost no perceivable advantages from October 1979 through December 1979. The test section in Illinois suffered some severe ravelling and provided little or no de-icing.

B. Taylors Falls Project

The test section included 0.34 miles of U.S.T.H. 8 from southwest of Taylors Falls to the St. Croix River bridge. The geometrics of the project are shown in Figure 1. The pavement to be overlayed was a 9-7-9 portland cement concrete. The roadway is on a 5 % grade and is partially shaded by trees on both sides. The posted speed limit is 30 mph. The two-way average daily traffic volume measured in 1986 was 7500 vehicles/day.

II. PRECONSTRUCTION

A. Mix Design

A trial mix was performed prior to construction. The mix used was a MN/DOT standard 2341M modified to meet Verglimit manufacturer’s recommendations. The modified specifications stated that 6 % by weight Verglimit be used, air voids be 2-3 % with an asphalt content of between 5.5% and 7.5%. The minimum Marshall stability (75 blows) was 500, with a the maximum of 3,000. The minimum thickness was 1" and feathering down the Verglimit mix during construction was prohibited. A complete specification is found in Appendix A of this report.

B. Overlay Design

The two overlay cross sections used and their locations are shown on Figures 1 and 2. The variable thickness of the 2331M leveling layer in cross section B was required to correct the super elevation and provide transitions near the island.
FIGURE 1 VERGLIMIT TEST SECTION—Taylors Falls, Mn

AREA OF SUPERELEVATION CORRECTION

STA 610 + 25 TO 627 + 45

STA 627 + 45 TO 630 + 07

FIGURE 2 PROJECT CROSS SECTIONS
III. CONSTRUCTION

A. Plant Operations

A representative of the Verglimit distributor was present during all phases of construction. The Verglimit was delivered in 55 lb. plastic bags. Due to the materials tendency to attract moisture, bags were not opened until use and any broken bags were discarded. Gloves, goggles and breathing protection were employed while handling the bags to avoid skin, eye and throat irritation. (See Figure 3)

FIGURE 3—VERGLIMIT HANDLING

The bags were emptied into a grate covered hopper to screen and break up clumps. The hopper emptied onto a conveyor equipped with an automatic weighing system to monitor the rate of Verglimit addition. The Verglimit was introduced through the reclaimed material inlet on the drum mix plant.

B. Paving and Compaction.

Standard equipment and procedures were used to place the Verglimit mix. The equipment included the following:

Paver: Barber Greene with a screed adjustable to 14'.

Compactors: Raygo Ranger steel wheel vibratory.

Hyster C530A pneumatic 9 wheel roller with a maximum wheel load of 2800 lbs.

A CSS-1H tack coat was sprayed on the existing concrete followed by the 2331M levelling course. To facilitate the super-elevation correction and match in to the bridge correctly, no levelling course was placed on the east bound lane from approximately 627 + 50 to the bridge panel (300'). Instead, 2341 wear mixture was compacted into the joints and cracks before the Verglimit wear was placed.

Placement of the Verglimit wear course began at 7:00 A.M., July 9, 1986 with clear skies and a temperature of 65 F. The paver handled the Verglimit mix with no problems relating to the additive. As was specified, the first roller pass was done with a dry drum; this also went well. Beyond that step it was difficult to work. An above normal amount of rolling was employed in an attempt to meet the high compaction/density requirements (97% of maximum). Continued compaction began to mash the bituminous onto the underlying portland cement concrete and destroy the aggregate interlock. Rolling was halted even though it was felt the specified density had not been met. The sample core taken was damaged, therefore no tests were run to confirm or deny this assumption.

As was expected, rolling released quantities of CaCl and linseed oil that created a greasy slippery appearance. The specified application of sand was employed to alleviate this problem, but motorists were
still very apprehensive. Tracking also occurred as is shown in Figure 4. The day following construction, the area was flushed with water three times. Two days after construction a rain shower cleared up the problem.

IV. MAINTENANCE

No strict guidelines were set for the maintenance of the test section. Maintenance personnel were informed of the test section’s location and expected performance. Operators were to determine when de-icing chemicals were needed.

III. EVALUATION

A. Friction Numbers

The Locked-wheel Pavement Friction Test (ASTM E-274) was employed to determine friction numbers. The Verglimit section yielded slightly lower friction numbers than the control section. However, both surfaces exhibited acceptable results.

B. Accident Reduction

This area has not had a high incidence of accidents. Only two accidents between January 1, 1983 and the date of construction, July 9, 1986, mentioned slippery surface conditions. No reports have mentioned slick conditions since construction. Due to the low frequency of accidents, no conclusions can be drawn about Verglimit’s ability to reduce accidents.
C. Water Quality

A runoff water collecting and monitoring barrel was placed in a catch basin to see if the Verglimit created any adverse effects. The location of the catch basin is shown in Figure 1. In general, slight amounts of chloride ions were present during light showers and in the beginning of heavier storms. Concentrations did not reach levels warranting environmental concern.

A full report of the water quality data prepared by Mn/DOT’s Environmental Engineering Unit is available from the Physical Research Unit upon request.

D. Condition

1. Failed Area

Flushing and shoving failures occurred in the 300’ area approaching the bridge. One year after construction the area had to be milled and replaced with a conventional wear course mixture. The Verglimit mixture had been placed directly on the inplace PCC in this area to match into the bridge deck.

Since the shoving failures were limited to the area where the Verglimit was placed directly on the inplace PCC surface, it could have been a major factor in causing the failure. Verglimit at the bituminous-PCC interface may have attracted moisture creating the CaCl solution in this region. The presence of fluid at the interface could have created a slippage failure.

Also of note is the location of the failed area. This section was subjected to the most severe distress caused by sharp turning, braking and accelerating of vehicles. The area of failure is shown in Figures 5 and 6.

Other possible factors contributing to the failure include:

a. Excessive rolling during construction may have destroyed the overlay’s aggregate interlock.

b. Excess fluids due to high asphalt content and moisture drawn by Verglimit may have created an unstable overlay. A high asphalt content was required due to the Verglimit mix design.

c. The tack coat may have been improperly applied.
A. LONGITUDINAL SHOVES

B. LATERAL SHOVES

FIGURE 6
2. Remaining Test Section

The remaining test section is in fair condition. The test section's surface texture is more open and the cracks are more pronounced than in the control section. This can be seen in Figure 7. Difficulties with compaction and voids created by the release of the CaCl are probable causes. Cracks are slightly more prevalent in the test section.

E. Construction Cost

One U.S. ton of Verglimit cost $895.00. Incorporating the product at 6% raises material cost $53.60/ton. The cost per ton, excluding asphalt cement, for this project was $100.00. The bid price for conventional mixture was $7.63.

Possible reasons for the large price difference:
1. Unfamiliarity with product.
2. Special handling and equipment required at batch plant.
3. Small quantity of experimental mixture compared to conventional mixture. (3865 Ton reg, 264 Ton exp)

The increase in construction cost in limited areas is claimed to be offset by decreased snow and ice maintenance.

F. De-icing

Due to the fairly remote location of the site, deicing data is limited. Research staff noted damp spots on the surface during fair or clear weather. No conclusions from the data on performance during inclement weather could be drawn. Maintenance crews did not consider the de-icing capabilities significant. They felt the moisture created by the Verglimit captured blown snow creating a more snow covered appearance than seen on the control section.

VI. SUMMARY OF FINDINGS AND CONCLUSIONS

A. The addition of Verglimit causes few problems with constructability of an overlay. Using the reclaimed material inlet is a simple and effective means of introducing the product into the bituminous mixture. Paving can be carried out in the conventional manner without problems. However, applying the right amount of compaction to meet the high specified density without releasing overt amounts of CaCl and linseed oil is difficult.

B. The Verglimit-modified bituminous wear course has slightly lower but still acceptable friction numbers compared to the conventional asphalt mixture used on this project.

C. The amount of chloride ions present in the rain runoff from the site does not warrant environmental concern.

D. A Verglimit-modified asphalt mixture should not be used for a thin overlay directly on Portland cement concrete.

E. As the Verglimit-modified asphalt mixture wear course ages, the surface becomes more porous than the conventional asphalt mixture used on this project. The cracks in the test section are more open and ravelled than those found in the control section.
A. CRACK IN VERGLIMIT SECTION

B. CRACK IN CONTROL SECTION

FIGURE 7
CRACK COMPARISON
8. Mixture Placement and Spreading

Mixture may be placed by conventional paving equipment.

a) Placement Temperature

Minimum mixture placement temperature, as measured behind the paver, shall be within the range of 270 to 300 degrees F.

b) Paving Equipment

If screed extensions are required, they shall be capable of being operated in a vibratory mode.

The paver screed (including extensions) shall be operated at the highest compaction settings.

c) Mixture Spreading

No hand work will be allowed unless it is unavoidable. In no case shall hand work be allowed in the wheel paths. No loose or excess mixture shall be spread (broadcasted) on the uncompacted surface.

Areas placed by hand shall be sealed with a cationic emulsified asphalt before opening to traffic.

9. Construction Joints and Edges

a) VERGLIMIT pavements must not be feathered. A butt joint is required. The edges of the butt joint must be clean and treated with tack coat. No feathering of VERGLIMIT mixture will be permitted.

b) Longitudinal Joints

When the longitudinal joint is placed cold (edge of first paver pass cold, new pass hot), the adjoining surface being laid shall, after final compaction, be slightly higher (but not to exceed 1/8 inch) than the previously placed strip. If the longitudinal joint is not constructed properly, it may ravel under traffic. A poorly constructed joint, in time, could be more visible due to the leaching VERGLIMIT.

10. Deslicking the Surface

The surface shall be deslicked. The deslicking is necessary in order to reduce the slipperiness of the surface resulting from fracturing of the VERGLIMIT particles during the compaction operation. The Contractor shall apply a dry sand (Spec. 3127, FA-1) at a rate of approximately 2 lbs. per sq. yd. in order to absorb the linseed oil from the VERGLIMIT coating. The application shall be made before final roller passes on the warm surface (approximately 190-200 degrees F). Method of application is at the option of the Contractor. However, prior to application, the deslicking method shall be submitted to the Engineer for his approval.
F. The average cost of a ton of the Verglimit-modified mixture was over ten times the cost of a ton of conventional mixture used on this project, with no documentable savings to offset these costs.

G. Significant de-icing benefits have not been observed. At times, the surface moisture created by the Verglimit captured blown snow creating a more snow covered appearance than observed on the conventional control section surface.

Winter conditions are a possible explanation for the lack of de-icing. Areas such as Western Europe, New York State and Pennsylvania with relatively warm, wet winters have had positive de-icing results; however, areas with colder, drier winters such as Minnesota, Manitoba and Illinois have not seen de-icing benefits.

VII. RECOMMENDATIONS

A. The test section could possibly continue to be observed to gather information of possible de-icing benefits and monitor the deterioration of the surface. Of special interest will be the surfaces compatibility with crack sealants.

B. While this experiment had honorable purposes, no future Verglimit sections should be constructed unless compaction problems are solved, crack opening and spalling can be decreased and cold-dry winter de-icing characteristics are displayed.
11. Compaction Equipment and Operations

a) Breakdown and finish rolling shall be performed by steel wheeled static roller(s). The roller(s) shall weigh not less than 10 tons and have wheel loads of at least 250 lbs./lin. inch. An approved vibratory type roller may be used on a performance basis.

Roller drums may be moistened with a minimal amount of water to prevent mixture pickup.

b) Intermediate rolling shall be performed by pneumatic tired roller(s). The roller(s) shall exert a pressure of not less than 200 pounds per inch of rolling width.

c) Pneumatic roller(s) shall be driven dry. A very fine spray of fuel oil will be permitted if mix pickup becomes a problem.

d) All rollers shall be equipped with adjustable scrapers and means to prevent mixture from adhering to the wheel(s) surface.

e) At the Pre-Construction Conference, the Contractor shall provide the Engineer with the number, types, and weights of rollers that will be used for the compaction operation.

12. Density Requirements

a) The Specified Density Method will be used to determine compliance with density requirements. The mixture shall be uniformly compacted to a density not less than 97 percent of the target density.

b) Target density will be determined by Mn/DOT personnel. Three mixture samples will be taken from each driving lane. The samples will be taken from behind the paver at randomly selected locations. Each sample will be reduced in size and compacted in accordance with the Marshall Method. The specimens will receive 75 blows on each face. Bulk densities will be determined for each specimen. Marshall compaction and bulk density testing will be conducted in accordance with procedures on file in Mn/DOT’s Bituminous Engineering Office.

c) The average bulk density of the six field-laboratory prepared specimens will be used to establish the target Marshall density.

d) The Contractor shall cut six cores (3 per lane) from the compacted pavement at randomly selected locations as determined by the Engineer. Chilling the compacted mixture before cutting the specimen may be required so that the specimen can be removed intact and can be handled without disintegrating. The samples shall be cut with a core drill and they shall be of sufficient size to permit determination of reliable test results. All core samples shall be taken and delivered by the Contractor, under the supervision of the Engineer, to the Department’s field laboratory for testing. All core sample holes shall be refilled by the Contractor immediately after removal of the sample. The holes shall be refilled with 2341 Modified—Fine Mix. The mixture shall be properly compacted. After compaction the mixture shall be slightly higher (but not to exceed 1/8 inch) than the adjacent surface. All operations incidental to sampling shall be done at the Contractor’s expense.

e) Sample shall be taken not later than the next working day following the date of placement.
The compacted pavement will be accepted with respect to density when the individual core density is at least 97 percent of the target density.

f) If the acceptance density is not obtained, further rolling to obtained conformance will be prohibited. The Contractor may submit one retest core sample for each failing density test. The retest core must be taken adjacent to the failing core sample. The higher of the two core densities will be used to determine whether the mixture represented by the cores will be accepted or rejected. All retesting shall be done within three (3) Working Days after placement of the bituminous mixture.

g) The area of mixture represented by the failing test will be considered as extending from the average distance between adjacent cores for a given lane.

h) Any portion of the compact pavement surface that fails to satisfy these density requirements shall be removed and replaced with mixture meeting these specification requirements.

i) The Contractor shall remove the failing mixture at the direction of the Engineer.

j) All cost involved in removing and replacing the Anti-Icing Wearing Course that fails to meet these density requirements shall be at the Contractor’s expense.

k) Fog Treatment

All porous areas (as determined by the Engineer), construction and longitudinal (centerline and edge) joints shall be treated with a CSS-1 or CSS-1h cationic emulsified asphalt. The emulsion shall be applied the same day the mixture is placed. The centerline longitudinal joint shall be treated after placement of the adjacent lane. The emulsion shall be diluted with up to 50 percent water, by volume. Joints shall be fogged for a minimum width of 6 inches, but shall not exceed a 12" width.

13. Maintenance of the Pavement after Placing

VERGLIMIT released from the mix by the paving and compaction process shall be washed off using pressurized water (wet power brooming or street cleaner may be required). This washing process shall be performed at least once and may have to be repeated several times during the first 2 to 6 weeks following mixture placement in order to remove surface deposits. (The manufacturer has advised, “During compaction, the VERGLIMIT particles in the upper 1 to 3 mm of the surface have been crushed, which results in increased VERGLIMIT activity at the beginning and a rich surface appearance. This effect can occur until the asphalt cement on the exposed coarse aggregate is worn off by traffic, which might take—depending on the traffic volume and speed—from 2 to 6 weeks. This surplus of VERGLIMIT should be washed off with a large surplus of water for several days using high pressure units. This way the carryover of the VERGLIMIT to the adjoining pavement can be stopped. If, during dry days, the VERGLIMIT activity is too high, washing should occur again. Once the pavement is worn in, washing is no longer necessary. Treatment will normally only be required in high speed or traffic conflict situations where year round high skid resistance is required. VERGLIMIT representatives should be contacted for advice if there are any questions concerning these procedures.)

0341.4 Method of Measurement

The method of measurement shall be the same as that specified in 2331.4 (Plant Mixed Bituminous Pavement), except as modified by the following:
APPENDIX

(Construction Specifications)
APPENDIX

March 20, 1986

Specification 2341

MODIFIED PLANT MIXED BITUMINOUS PAVEMENT

(Anti-Icing Wearing Course - Fine Mix)

0341.1 Description

This work shall consist of producing and placing an anti-icing plant mixed bituminous mixture using VERGLIMIT. Specification 2341 Modified (Wearing Course - Fine Mix) shall apply except as modified herein.

0341.2 Materials

A. VERGLIMIT

VERGLIMIT is a multi-component chemical deicer which is added to bituminous mixture. Verglimit consists of approximately 95% calcium chloride, some caustic soda and is coated (or hydroabated) with linseed oil. VERGLIMIT IS A PROPRIETARY PRODUCT; THERE ARE NO KNOWN EQUALS THUS NO SUBSTITUTIONS WILL BE ENTERED BEFORE OR AFTER BIDDING.

The contractor shall provide the Engineer the name of the company supplying the VERGLIMIT material within 10 days after the award of the contract.

For information only, one source of the VERGLIMIT is:

P.K. Innovations
244 South Service Road
Stoney Creek, Ontario L8E2N9
Telephone (416) 662-7137

P. K. Innovations provided the following information on VERGLIMIT particle size:

Size Range 5.0 mm (0.197 inches) to 0.1 mm (0.004 inches) (Ranges from No. 4 to No. 16 sieve)

B. Aggregate

Mineral aggregate shall meet the requirements of Specification 3139 (Graded Aggregate for Bituminous Mixture); except that the combined aggregate(s) shall be uniformly graded from coarse to fine and shall meet the following gradation and quality requirements:
Mineral Filler: 3145
Hydrated Lime: 3106

Mineral filler or hydrated lime may be added in an amount not to exceed 5 percent or 2 percent, respectively, of the total weight of aggregate. No direct compensation will be made for incorporation of any such additives.

The composite of aggregates shall meet the requirements of 3139 for a BA-1 aggregate relative to running average, percent crushing, Los Angeles Rattler loss and spall material.

C. Bituminous Material 3151

Asphalt Cement 85/100 or 120/150 penetration.

Bituminous Tack Coat shall be a Cationic Emulsified Asphalt.

D. Reflectorized Pavement Marking Tape 3353

0341.3 Construction Requirements

Construction requirements shall be the same as those specified in 2331.3, except as modified or supplemented by the following:

1. Preconstruction Plan

The contractor shall submit, in writing, his plan for mixture production and placement of the VERGLIMIT test section. The plan shall be submitted to the Engineer for his review and approval at the pre-construction conference.

2. Restrictions

a) Bituminous mixture shall be placed when the weather is dry and warm. Mixture shall not be produced or placed when weather is rainy or foggy.

b) Pavement surface shall be dry and have a minimum temperature of 50°F. before mixture placement will be allowed.

c) No paving will be allowed during rain. In case of rain, the Engineer shall stop all paving. Mix in transit cannot be placed until rain stops and the surface is dry.

d) Haul units shall be covered at all times.

3. Job Mix Formula (J.M.F.)

a) At least 21 days prior to the start of bituminous mixture production, the Contractor shall submit to the Department’s Bituminous Engineer (or his designee) representative aggregate samples of each of the respective materials that he proposes to use in mix production. The submittal shall consist of approximately 300 pounds of aggregate.
establish a new job-mix formula based on the test results from a new trial mix submit-
tal

In accordance with Specification 1503, it is the intent of this Specification that the ag-
gregate materials shall be uniform in character and shall conform as nearly as possible
to the middle portion of the working range (J.M.F.). The working range is to accom-
modate occasional variation from the J.M.F. which are unavoidable for practical
reasons.

f) Addition of VERGLIMIT at the time of mixture production shall be between 5.7 and
6.3 percent, by total weight of mixture.

4. Mix Preparation and Mixing Details

a) The design composition of the mix shall be followed very carefully.

b) Handling VERGLIMIT shall be performed with care in order to keep the crushing of
the VERGLIMIT particles as low as possible.

c) Storage of VERGLIMIT shall be in a dry place. VERGLIMIT is delivered in 55 and
2000 lb. bags. To avoid undesirable absorption of moisture, the bags shall not be
opened prior to placement into the mixer.

d) Plant personnel placed in direct contact with the VERGLIMIT particles shall wear
protective goggles and gloves. It is further recommended that these workmen wear
protective masks (see labeling on bags). Contact with the skin must be avoided. The
Contractor shall contact the supplier/manufacturer of VERGLIMIT for properly han-
dling of the VERGLIMIT materials.

e) VERGLIMIT shall be added to the mixer (drier drum or pugmill) through a screened
hopper to eliminate occasional lumps. The screen shall have openings of approxima-
tely 3/4" by 3/4". The openings of the screen should not be too small as to interfere with
the flow of material to the mixer.

f) The Contractor should not open bags nor allow VERGLIMIT to set in any bin for more
than one (1) hour. Depending on the humidity, the VERGLIMIT could conglomerate.

g) Bituminous mixtures containing VERGLIMIT may be produced in a Batch Plant, Con-
tinuous Mixing Plant or Drum-Dryer Mixing Plant subject to the provisions of
Specification 2331 and the following:

Batch Plants and Continuous Mixing Plants

VERGLIMIT must be added continuously and loosely into the pugmill. The
method/equipment used to add VERGLIMIT to the pugmill shall be capable of adding
the material in no less than 5 and no more than 10 seconds so as to avoid crack-
ing/degradation. The VERGLIMIT shall not be exposed to air for a long period of time.

The VERGLIMIT manufacturer has offered that if a batch mixer is used the following
systems have been proven successful:

Addition directly into the pugmill through a hopper or via a conveyer belt.
Addition directly over the filler scale.
Auger systems are to be avoided because they might lead to a considerable amount of cracking/degradation of the VERGLIMIT particles. If an auger has to be used, it should not be longer than 6 feet and should be used only for horizontal transportation.

Introduce VERGLIMIT after all aggregates, including the fines, are in the pugmill. After at least 1/3 of the asphalt cement is added, the VERGLIMIT addition can be started and it should be finished at approximately the same time as the asphalt cement addition is completed.

After all components including VERGLIMIT have been added, mixing shall be of a sufficient length of time for all aggregate particles (including the VERGLIMIT particles) to become fully coated with asphalt cement. No uncoated particles shall be visible after mixing. Once all VERGLIMIT is in the mix, additional mixing time should not exceed 15 seconds. The manufacturer stated that total mixing time normally is unchanged from standard procedures.

**Drum-Dryer Mixing Plants**

If a drum-dryer plant is used, the system used to add the VERGLIMIT shall be calibrated. In particular the specific weight of VERGLIMIT (11.23#/ft³) must be considered. No VERGLIMIT shall be incorporated with the mineral aggregate prior to introduction into the drum-dryer.

The VERGLIMIT shall be added in such a manner that it does not come into direct contact with the burner flame. The use of a center feed, such as that used in the production of recycled mixture, will be considered as a means of introduction provided that the VERGLIMIT does not come into contact with the flame and is mixed with the asphalt cement as specified.

The mixing time after all components have been added shall only be long enough for all particles (including VERGLIMIT) to become thoroughly coated with asphalt cement. No uncoated particles shall be visible. The total mixing time is usually unchanged from normal procedures according to information supplied by the manufacturer.

5. **Mixing and Storage Temperatures**

A maximum mixture plant discharge temperature of 325°F shall not be exceeded at any time, since the mix might otherwise become like a mastic asphalt (bituminous mastic concrete) in character. If the mix is stored in heated/insulated silos, this maximum temperature shall not be exceeded.

6. **Transportation of Mixture**

All mixture shall be covered while in transit unless otherwise directed by the Engineer.

7. **Surface Preparation**

   a) Pavement surface upon which mixture is to be placed shall be dry and free of dirt and dust.

   b) Bituminous tack coat shall be applied in accordance with Specifications 2331 and 2357. Only Caltione Emulsified Asphalts will be permitted.
material. If it is proposed to use multiple aggregate sources/types, the 300 pounds may be proportioned to reflect the proposed blend (100 pound minimum). The aggregate samples shall be obtained from production. At the time of the aggregate(s) submittal it is recommended that the Contractor submit aggregate stockpile gradations for each of the different types of materials intended for use. The Contractor shall indicate the proposed proportions of the aggregate materials to be incorporated into the mixture. At the time of the aggregate submittal the Contractor shall also submit a representative sample of VERGLIMIT. The submittal shall weigh at least 30 pounds.

b) VERGLIMIT shall be incorporated into all mixtures at the rate of 6.0 percent, based on total weight of mixture.

c) Using the representative aggregate(s) and VERGLIMIT samples submitted by the Contractor and his proposed mixture proportions and gradations, trial mix tests will be conducted to evaluate the acceptability of the proposed blend and gradation of the aggregates and to establish the percentage of asphalt cement (by weight of total mixture) to be used in production of the bituminous mixture. Mixture evaluation will be based on the trial mix tests and the corresponding requirements listed below.

<table>
<thead>
<tr>
<th>Trial Mix Tests</th>
<th>Test Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>Marshall Stability</td>
<td>500</td>
</tr>
<tr>
<td>(75 blows-pounds)</td>
<td></td>
</tr>
<tr>
<td>Air Voids in Mix</td>
<td>2</td>
</tr>
</tbody>
</table>

Test procedures are on file in the Department of Transportation Materials Engineering Laboratory in St. Paul.

d) Asphalt cement content, as determined by the trial mix test procedures and above criteria, shall not exceed 7.5 percent nor be less than 5.5 percent by total weight of mixture.

e) The requirements for mix proportions shall be in accordance with 2331.3E; except that, the Job-Mix Formula (J.M.F.) percentages and permissible working range will be established based on the composite mineral aggregate gradation (without VERGLIMIT) of the approved trial mix sample. The working range will be determined by applying plus and minus tolerances to the J.M.F. in accordance with the following:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Tolerance Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 in.</td>
<td>± 7</td>
</tr>
<tr>
<td>No. 4</td>
<td>± 7</td>
</tr>
<tr>
<td>No. 40</td>
<td>± 6</td>
</tr>
<tr>
<td>No. 200</td>
<td>± 3</td>
</tr>
</tbody>
</table>

The working range for the No.s 4 and 200 sieves shall not exceed the specification gradation limits previously established within these specifications.

The job-mix formula, as originally established, shall remain in effect until modified in writing. Should a change in source of aggregates (including VERGLIMIT) be made, or when unsatisfactory results or other conditions make it necessary, the Engineer will...
Bituminous Mixture

Bituminous mixture containing VERGLIMIT will be measured by weight and will be based on the weight of loads hauled and placed from the mixing plant. No deductions will be made for the bituminous materials incorporated therein.

0341.5 Basis of Payment

The basis of payment shall be the same as that specified in 2331.5 (Plant Mixed Bituminous Pavement) except as modified by the following:

Payment for the accepted quantities of the anti-icing bituminous mixture and the bituminous material incorporated into the mixture, at the Contract prices per unit of material, shall be compensation in full for the cost of furnishing all labor, materials (including VERGLIMIT), tools and equipment including preparation of the surface, mixing, tacking, placing, compaction, deslicking, fog treatment and, all other incidentals necessary to satisfactorily complete the work as required and to maintain the pavement after mixture placement (as previously described under “Maintenance of the Pavement after Placing”).

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2341.504</td>
<td>Bituminous Material for Mixture</td>
<td>Ton</td>
</tr>
<tr>
<td>0341.508</td>
<td>Modified Plant Mixed Bituminous (Anti-Icing Wearing Fine Mix)</td>
<td>Ton</td>
</tr>
</tbody>
</table>