CONSTRUCTION ENGINEERING SERVICES
PROJECT REVIEW REPORT

Project Number:	IM 15-1(109)0 & IM 15-1(107)0	**Letting Date:**	August 26, 2010
Project Description:	Monida-Lima (SB) & Monida-Lima (NB)	**MDT District:**	Butte
Control Number:	6921 & 6923	**EPM:**	John Starcevich
Review Date:	August 11 & September 15, 21, & 27 , 2011		
Reviewed By:	Mark Snow	**In Company With:**	N/A
Project Description:	Cold milling, PMS overlay, guardrail, seal and cover and pavement markings on the Monida – Lima (SB) & (NB) projects located in Beaverhead County.		
Review Type:	☐ Constructability ☐ Post Construction	☐ Investigatory ☒ Subject Specific- Warm Plant Mix Bituminous Surfacing Paving (3/4 inch Grade "S" Volumetric)	☒ Oversight ☐ Training

CONTRACT INFORMATION	
Contractor:	Jim Gilman Excavating Inc.
Contract Amount:	$9,367,205.26
Contract Payments To-Date	$4,389,276.94 (Estimate #5)
Contract Time/Completion Date:	110 Working Days
Contract Time Used to-Date:	107 Working Days (9/30/11)
Letting Date:	August 26, 2010
Award Date:	September 7, 2010
Notice to Proceed Date:	May 6, 2011
Date Work Began:	May 6, 2011

Work In Progress: Plant Mix Bituminous Surfacing (Control) and Warm Mix Bituminous Surfacing Paving (19.0mm Grade "S" Volumetric)

19.0mm Gr. "S" Plant Mix Bituminous Surfacing for the Monida-Lima (SB) & (NB) projects was produced using a Gencor/Barber Greene Ultra 400 counter flow drum dryer. This plant is rated at 500 tons per hour. The Air Quality certification was updated in May 21, 2009. Air Quality recertification will be required in 2013. All weight equipment was certified on August 12, 2011 and the Certification documentation was available for inspection in the control house. The location of plant mix production is as follows: SW ¼ SW ¼ SE ¼ SW ¼, Section 17, Township 14 South, Range 7 West.

Gencor Ultra 400 Counter Flow Drum Dryer

19mm Grade "S" Control and Warm Mix Bituminous Surfacing Production:

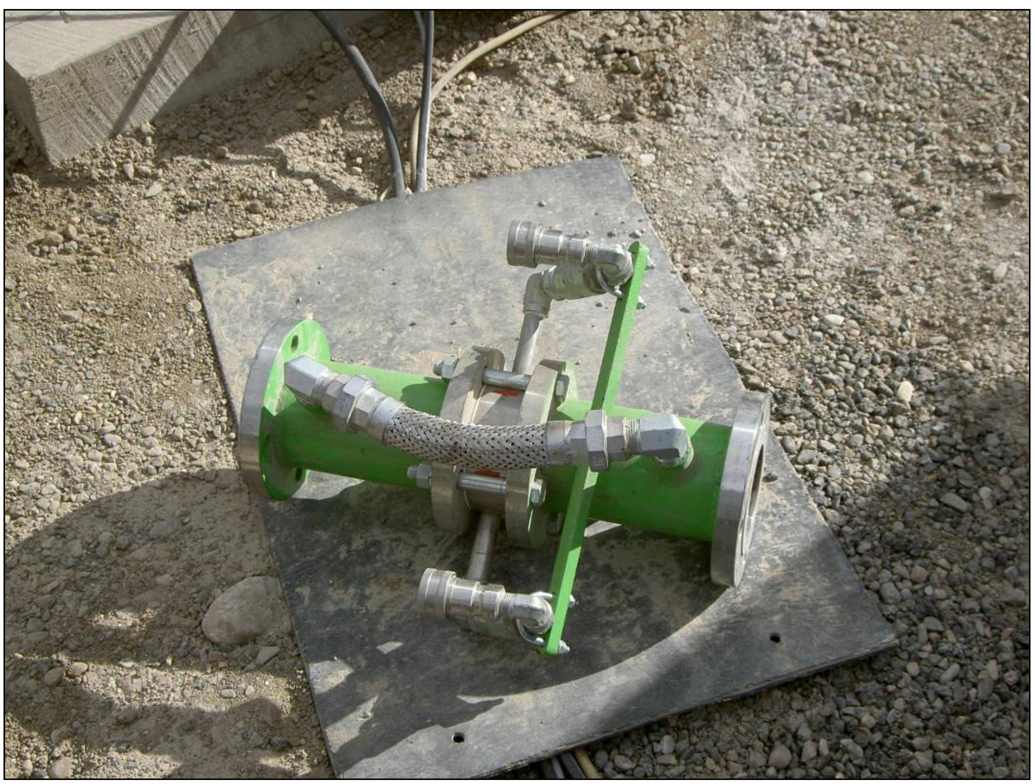
19.0 mm Grade "S" Control and Warm Mix Bituminous Surfacing were produced at an average rate of 400 tons per hour. Production commenced using mix design bin split values of 46.36% coarse, 7.89% intermediate, 44.38% crushed fines, and 1.38% hydrated lime. The start-up asphalt binder plant setting was adjusted from the mix design target of 4.6% to a plant setting of 4.55%. Spot checks averaged 4.58% through thirty eight (38) days of production. Mix moisture averaged 0.05% with 3.0% stockpile moisture entered into the plant. The above mentioned bin split values and asphalt binder setting remained constant throughout production of control and Warm Mix bituminous surfacing production. The average discharge temperature for control plant mix surfacing was 320 degrees Fahrenheit. Sasobit Warm Mix and the foamed Warm Mix average discharge temperatures were 285 degrees Fahrenheit. Evotherm Warm Mix average discharge temperature was 274 degrees Fahrenheit.

Three Warm Mix test sections were placed on the Monida Lima south bound project. A description of the additives and processes used to produce the Warm Mix product is as follows.

The following description of Sasobit was acquired from the product brochure supplied by Sasol Wax North America Corporation. “Sasobit is a crystalline, long chain aliphatic polymethylene hydrocarbon produced from natural gas using the Fischer-Tropsch (FT) process. The unique properties of Sasobit are high melting point, low melt viscosity and high crystallinity (hardness). These properties are used to great effect to modify the asphalt binder. The chemical structure of Sasobit is identical to paraffin waxes that are found in crude oil, except that it has a higher molecular weight. Therefore, it dissolves easily into asphalt at temperatures above 248 degrees Fahrenheit and will not separate out in storage. When Sasobit is added to softer grades of asphalt binder, there is no bleeding that is associated with low molecular weight waxes. This provides the possibility to upgrade softer grades of asphalt. Sasobit is used as a flow improver, both during the asphalt mixing process and during laydown operations. The dramatic reduction in viscosity obtained by adding Sasobit to asphalt at working temperatures makes the asphalt easier to process, providing the option of reducing the working/mixing temperatures and thereby reducing fume emissions and decreases production costs associated higher mixing and compaction temperatures. Sasobit’s high crystallinity and hardness are used to modify asphalt binders to produce rut resistant plant mix pavements. It offers an alternative to asphalt polymer modification when increased stiffness is required to prevent rutting. Sasobit can be added in combination with polymer modified asphalts to produce a binder that exhibits stiff qualities, but also offer some of the elastic benefits of polymer modification. Sasobit can be blown into the plant drum near the point of asphalt binder introduction,” however on this particular project this additive was blended into the binder at the Idaho Asphalt refinery. “The same procedures used to blend polymers in asphalt binder work when blending Sasobit into the binder. The addition can run concurrently with the polymer modification. Sasobit will aid in the dispersion of the polymer and will decrease the reaction time needed to digest the polymer. Sasobit is safe and easy to handle. It can be used in food-grade applications such as adhesives and therefore holds no health hazards for workers.”

The following description of Evotherm™ was acquired from the product brochure supplied by MeadWestvaco Asphalt Innovations. “Evotherm™ DAT (Dispersed Asphalt Technology) is a chemical additive that is injected into the asphalt binder feed line just prior to the asphalts introduction into the mixing chamber. The Evotherm™ DAT Warm Mix method chemically decreases the viscosity of the asphalt binder and adds a small amount of water to the hot asphalt binder flow, which improves coating of the plant mix aggregate and workability of the produced product. By lowering plant mix production and placement temperatures, the jobsite becomes a more comfortable odor-free working environment. Contractors using Evotherm™ have reported increased worker productivity and decreased worked fatigue. Paving with low temperature Evotherm™ technology eliminates the emissions for which asphalt paving is most scrutinized. Mixes made with Evotherm™ consistently achieve roadway densities easier than conventional hot plant paving mixtures. Even difficult to compact materials such as polymer modified asphalts and coarse mixes are easier to compact at lower temperatures. The temperature of Evotherm™ mixes is much closer to ambient temperatures than conventional hot mix products, so low temperature mixes do not lose energy as quickly. A reduced rate of heat loss, combined with improved compaction, makes Evotherm™ an effective solution to cooler temperature paving and longer hauls, effectively extending the paving season and the radius of operation for mix plants."

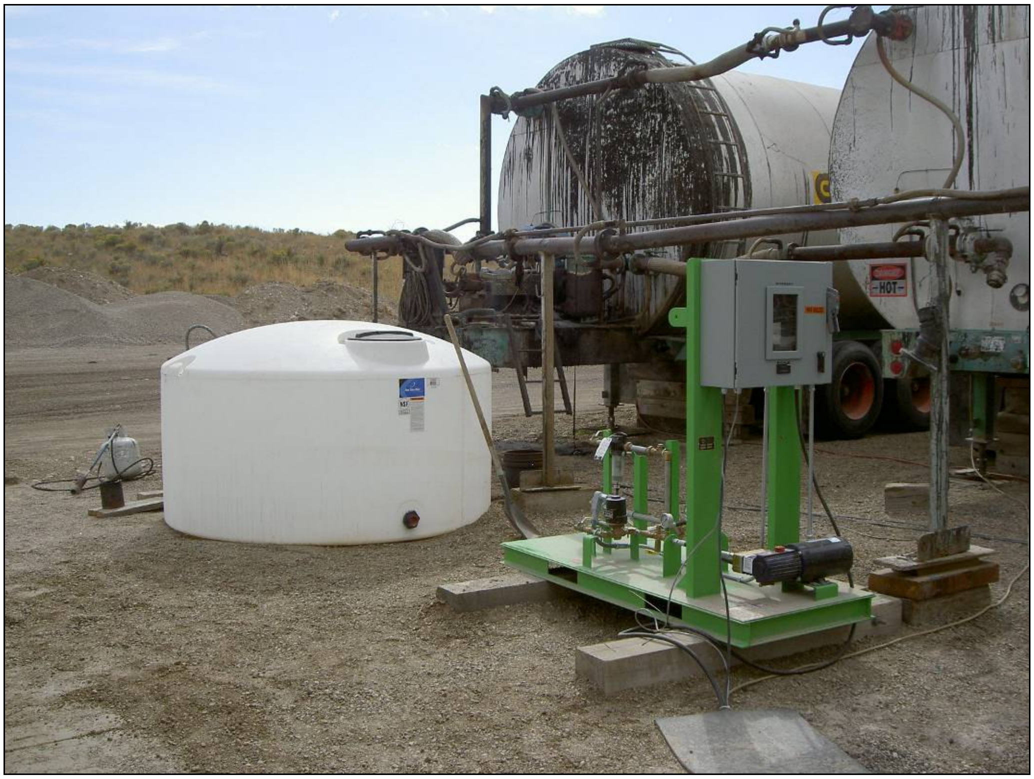
The following description of Aesco/Madsen Eco - foam – II foaming Warm Mix method was acquired from the product brochure supplied by Aesco/Madsen Corporation. "With this method pressurized water is injected into the asphalt binder flow just prior to its introduction into the mixing chamber. The Aesco/Madsen's static inline vortex mixer, known as Eco – foam II, is a motionless static mixer in which fluids are injected and rapidly mixed by a combination of alternate vortex shedding and shear – induced turbulence, which produces superior fluid mixing. The unmixed asphalt flows to the static mixer and is forced through the mixer restriction to form a high speed flow. The water/additive is injected into the low – speed reversed flow region downstream of the mixing tabs. This effectively speeds the mixing of the asphalt and the low – speed water/additive. The Aesco/Madsen's static inline vortex mixer makes use of shear zone turbulence. With a unique orifice plate design, this mixer causes great turbulence that also enhances the mixing process. Vortex shedding happens when a fluid passes an object, or obstruction, and an oscillation occurs. The oscillation, or swirls, downstream create alternating low – pressure zones, which also help in the mixing process. The dominant feature of the Aesco/Madsen's static inline vortex mixer is the production of two very strong jets emanating from the open area in the cut – out plate. Velocities in the cores of these jets reach five times that of the upstream asphalt flow. Large reverse flow regions surround these jets and very high amplitude shear layers exist in between the jet and the reverse flow. The effective area where high shear layers exist is largely due to the dual jet structure and the non – circular nature of the plate cut – outs. Injecting water directly into the center of the liquid asphalt causes the water to instantly turn to steam in the form of small bubbles. When combined with the hot asphalt, the result is a foamed asphalt mixture. This foamed asphalt temporarily reduces the viscosity of the asphalt during the mixing process this allows the aggregate in the dryer to efficiently coat at temperatures that in some cases 50 – 60 degrees Fahrenheit lower than normal plant mix. This results in asphalt mix temperatures at the discharge of the mixer in the 240 – 290 degree Fahrenheit range, while still maintaining good workability during the laydown process." Another advantage of this system is that water or additive can be injected with this equipment. On this project Evotherm^{TM} DAT and water for the foamed Warm Mix product were injected using the Aesco/Madsen's static inline vortex mixing system.



Aesco/Madsen's Eco – Foam II Static Inline Vortex Mixer Prior to Installation

Aesco/Madsen's Eco – Foam II Static Inline Vortex Mixer after Installation

Control House Installed Digital Flow Rate Controller



Water/Additive Injection Pump and Water Storage Tank

19mm Grade "S" Control and Warm Mix Bituminous Surfacing Placement:

19mm Grade "S" Plant Mix Bituminous Surfacing was placed using a Volvo PF 6170 paver with a Cedarapids MS - 2 pickup machine. Compaction on the top lift placed at the time of my visit was performed using one (1) Caterpillar CB64, one (1) Ingersoll Rand DD – 158, one (1) Ingersoll Rand DD – 130HF and one (1) Hamm HD+140. All four rollers were dual steel drum vibratory rollers. The Caterpillar CB – 634D and Ingersoll Rand DD – 158 worked in tandem providing break down, with the Ingersoll Rand DD – 158 working intermediate compaction. Finish rolling to remove any remaining surface irregularities was completed using the Hamm HD+140. Placement commenced at project stationing 2887+81, in the north bound passing lane.

Volvo PF 6170 Paver and Cedarapids MS – 2 Pickup Machine

Ingersoll Rand DD – 130 HF, Ingersoll Rand DD – 158 & Caterpillar CB64 Rollers

Quality Control (QC) Conducted by the Contractor:

The contractor did not have an employee/consultant on the site to run sieve analysis or to perform plant mix volumetric testing. Density testing to control plant mix compaction was performed by an employee of Jim Gilman Excavation Inc. using a Seaman C – 300 Density Gauge.

Jim Gilman Excavating Inc. C – 300 Seaman Density Gauge

Quality Assurance (QA) Testing:

The Project Quality Assurance (QA) acceptance samples were acquired at the plant in accordance with standard specification MT – 303. Quality Assurance testing at the time of my visit was performed by MDT WAQTC certified technicians and was in accordance with specified test methods. All Quality Assurance samples for Control and Warm Mix acceptance were fabricated and tested in a timely manner by Butte District Materials Laboratory personnel.

(Control) Consultant Design, Helena Verification
And Field Evaluated Volumetric Comparison Data:

	VMA	VFA	VTM	D/A	Rice
*Consultant	13.0	73.8	3.5	1.4	2.458
Helena Lab	13.6	64.8	4.8	1.5	2.459
** Field Lab	12.8	78.0	2.9	1.7	2.455
*** Field Lab	13.2	76.0	3.2	1.6	2.454
**** Prelim. Targets	13.6	76.0	3.4	1.6	

* Consultant mix design by HKM Engineering Inc.

** Avg. of four (4) field run courtesy samples.

*** Avg. of sixty (60) field run Quality Assurance control samples.

*** Sasobit preliminary targets set at 3000 tons.

(Sasobit Warm Mix) Consultant Design, Helena Verification
And Field Evaluated Volumetric Comparison Data:

	VMA	VFA	VTM	D/A	Rice
*Consultant	13.0	73.8	3.5	1.4	2.458
Helena Lab	13.6	66.4	4.6	1.5	2.454
** Field Lab	13.2	71.0	3.8	1.6	2.463
*** Field Lab	12.9	73.2	3.5	1.6	2.463
**** Prelim. Targets	13.2	71.0	3.8	1.5	

* Consultant mix design by HKM Engineering Inc.

** Avg. of four (4) field run courtesy samples.

*** Avg. of eleven (11) field run Quality Assurance Sasobit samples.

*** Control preliminary targets set at 3000 tons.

(Evotherm™ Warm Mix) Consultant Design, Helena Verification
And Field Evaluated Volumetric Comparison Data:

	VMA	VFA	VTM	D/A	Rice
*Consultant	13.0	73.8	3.5	1.4	2.458
Helena Lab	12.6	73.2	3.4	1.5	2.452
** Field Lab	13.0	76.0	3.2	1.5	2.456
*** Field Lab	13.1	75.2	3.3	1.5	2.456
**** Prelim. Targets	13.0	75.0	3.4	1.6	

* Consultant mix design by HKM Engineering Inc.

** Avg. of two (2) field run courtesy samples.

*** Avg. of ten (10) field run Quality Assurance Evotherm™ samples.

*** Control preliminary targets set at 2500 tons.

(Foamed Warm Mix) Consultant Design, Helena Verification
And Field Evaluated Volumetric Comparison Data:

	VMA	VFA	VTM	D/A	Rice
*Consultant	13.0	73.8	3.5	1.4	2.458
Helena Lab	13.6	64.8	4.8	1.5	2.459
** Field Lab	12.9	78.0	2.9	1.6	2.452
*** Field Lab	12.9	76.3	3.1	1.5	2.456
**** Prelim. Targets	13.0	75.0	3.4	1.5	

* Consultant mix design by HKM Engineering Inc.

** Avg. of two (2) field run courtesy samples.

*** Avg. of ten (10) field run Quality Assurance control samples.

*** Control preliminary targets set at 2600 tons.

MDT

Hamburg Wheel Track Testing:

Control Hamburg Wheel Track samples were submitted for analysis on August 13, 2011. At 15,000 passes the results averaged 3.2mm of specimen surface deformation from the Helena Materials Laboratory analysis. The Helena Materials Laboratory Hamburg Wheel Track analysis at the time of mix design verification averaged 6.8mm at 20,000 passes.

Sasobit Warm Mix Hamburg Wheel Track samples were submitted for analysis on September 15, 2011. At 15,000 passes the results averaged 1.6mm of specimen surface deformation from the Helena Materials Laboratory analysis. The Helena Materials Laboratory Hamburg Wheel Track analysis at the time of mix design verification averaged 6.5mm at 20,000 passes.

Evotherm™ Warm Mix Hamburg Wheel Track samples were submitted for analysis on September 21, 2011. At 15,000 passes the results averaged 2.0mm of specimen surface deformation from the Helena Materials Laboratory analysis. The Helena Materials Laboratory Hamburg Wheel Track analysis at the time of mix design verification averaged 7.8mm at 20,000 passes.

Foamed Warm Mix Hamburg Wheel Track samples were submitted for analysis on September 27, 2010. The results for these samples were unavailable at the time of this report. The Helena Materials Laboratory Hamburg Wheel Track analysis at the time of mix design verification averaged 6.8mm at 20,000 passes.

Quality Assurance Density Testing:

Quality Assurance density testing was performed to obtain percent compaction on cores taken randomly from the roadway. Through twenty one (21) lots of Control Quality Assurance density tests, the density average was 94.6%. Eleven (11) of these twenty one (21) lots had calculated Quality Assurance density incentive. There were no disincentive/deduct lots associated with control plant mix placement. The average of five (5) Sasobit Warm Mix Quality Assurance density lots was 94.0%. Two (2) of the five (5) lots had calculated Quality Assurance density incentive. One (1) of the five (5) lots had calculated Quality Assurance density disincentive/deduct. The density average (Xn) of this deduct lot was 93.6%. The average of four

(4) Evotherm™ Warm Mix Quality Assurance density lots was 94.5%. Three (3) of the four (4) lots had calculated Quality Assurance density incentive. There were no disincentive/deduct lots associated with Evotherm™ Warm Mix placement. The average of three (3) Foamed Warm Mix Quality Assurance density lots was 94.5%. None of the three (3) Foamed Warm Mix density lots had calculated Quality Assurance density incentive or disincentive.

Troxler NTO Asphalt Content Ignition Oven Data:

The ignition burn oven scale verification was 0.014% at 5000 grams which is acceptable being less than 0.025% according to manufacturer's recommendations. The average of ninety one (91) field production burns was 4.66%. Spot checks averaged 4.58% through thirty eight (38) days of production. Mix design target asphalt binder content was 4.6% Idaho Asphalt P.G. 70 -28. The average 200 mesh percentage from the field burn sieve analyses was 7.3%. Mix design target results for the 200 mesh were noted at 5.8%.

Federal Highway Administration Research Testing:

The Federal Highway Administration (FHWA) mobile research testing facility was moved to the "Monida – Lima NB & SB" project site near Lima, Montana from a high RAP (40%) research project located near Tilton, New Hampshire. The trip covered approximately 2500 miles. At the Monida project site samples of control and warm mix were evaluated for volumetric properties, void distribution, bulk gravity, maximum specific gravity, ignition burn asphalt content, moisture content, fine aggregate angularity, coarse aggregate angularity, particle coating, and aggregate sieve analysis. FHWA s' personnel obtained and fabricated additional gyratory samples of control and Warm Mix surfacing for future off-site research testing. Other samples obtained for off-site research testing included samples of P.G. asphalt binder, hydrated lime, aggregate and non-compacted control and Warm Mix surfacing. The off-site research testing will be conducted at the FHWA s' research center located in Washington, DC and at the Texas Transportation Institute located on the A & M University campus in Austin Texas. Some of the off-site testing will include Hamburg wheel track rut testing, tensile strength ratio testing, G-star P.G. asphalt binder testing, extracted binder content and sieve analysis.

MDT

Federal Highway Administration's (FHWA) Mobile Field Testing Facility (External View)

FHWA's Mobile Field Testing Facility (Internal View))

FHWAs' IPC Servopac and Pine Field Gyratory Compactors

FHWAs' Maximum Specific Gravity (Rice Gravity) Testing Equipment

<u>FHWAs' Field Laboratory Personnel Sampling (Control) Plant Mix Surfacing</u>

<u>A Portion of FHWAs' Field Gyratory Compacted Specimens (for off-site testing)</u>

In the pictures above Federal Highway Administration (FHWA) mobile research testing facility is shown in external and internal views, the two gyratory compactors used for field specimen fabrication, maximum specific gravity testing equipment, FHWAs' staff obtaining five-gallon buckets of the control plant mix product and a portion of the field gyratory specimens compacted for off-site testing.

Washington State University Research Sampling:

Representatives of Washington State University were also on-site to collect samples for future off-site research testing. Samples acquired included compacted gyratory specimens, roadway drilled cores, P.G. asphalt binder, hydrated lime, aggregate and non-compacted control and Warm Mix surfacing. Gyratory compacted specimens were fabricated for the Washington State University representatives by Montana Department of Transportation Butte District Materials Laboratory personnel and FHWA field research staff. Roadway drilled cores were provided Montana Department of Transportation Butte District Materials Laboratory personnel. This reviewer would like to extend a special "thank you" to the Butte District Materials Laboratory personnel and the FHWA field research staff for the extra effort involved in the fabrication of gyratory specimens and acquiring core drilled roadway samples.

Issues Discussed & Resolved:

- No issues were noted at the time of my visit

Questions from E.P.M. and Staff:

- A member of the field construction staff asked. "What is the proper protocol to be followed when setting the field target density?" The proper procedure is outlined in Materials Manual section Mt 328 sub section 3.3 & 3.4, as noted below.

3.3 “When two (2) field maximum specific gravities have been determined using MT 321, average the results. Use the average for the field target density. This target will be effective retroactive to the start of plant mix production on the project.”

3.4 “When four (4) field rice gravities are completed, average the four test values. If a change of 0.5 pounds per cubic foot (8.0 kg per cubic meter) or greater is calculated change to the new average density. This change will become effective at the time the last sample was obtained.”

Daily Maintenance Practices in MDT Field Testing Facilities:

The field testing trailer was found in a clean condition with all pertinent equipment in working order. The lead technician informed this reviewer that the volumetric flask used in determining maximum specific gravity (Rice Gravity) was calibrated daily. The Gyratory compactor was greased daily or as needed, depending on the number of specimens compacted. Molds, splitting pans, spatulas & various tool used in the testing procedure were cleaned after every test.

Dynamic Angle Validation (DAV) Internal Angle Results:

A check was performed on the internal angle of Pine Instrument Company model AFGB1A Gyratory compactor serial number 5263 which was being used for Quality Assurance specimen fabrication. The calibration sticker attached to this machine was dated December 9, 2010. The measured average internal angle from the calibration certificate was 1.156 degrees. A field check was accomplished using DAV model number DAV-1, serial number 132. The resulting angle was 1.161 degrees which is within the specified range of 1.140 to 1.180 degrees.

View Looking South from Project Stationing 2603+79 South Bound Prior to Resurfacing

View Looking South from Project Stationing 2603+79 South Bound after Resurfacing