

**FHWA Asphalt Binder Expert Task Group Meeting**

September 15 and 16, 2009

NuStar Conference Room

San Antonio, Texas

**Binder ETG Purpose**

The primary objective of the FHWA Expert Task Group is to provide a forum for the discussion of ongoing asphalt binder technology and to provide technical input for research, development and implementation.

A total of 58 individuals attended the meeting (17 members, 2 contract personnel, and 39 friends and visitors). Members of the FHWA Asphalt Binder ETG that were in attendance at the September 2009 meeting included:

Gaylon Baumgardner, Paragon Technical Services (Chairman)

John Bukowski, Federal Highway Administration (Secretary)

Chris Abadie, Louisiana Department of Transportation

Dave Anderson, Consultant

John D' Angelo, Consultant

Darren Hazlett, Texas Department of Transportation

Gayle King, GHK, Inc.

Mihai Marasteanu, University of Minnesota

Bob McGennis, Holly Asphalt

Bruce Morgenstern, Wyoming Department of Transportation

Ioan Negulescu, LSU

Gerald Reinke, Mathy Construction

Henry Romagosa, ICL Performance Products LP

Geoff Rowe, ABATECH

Fred Turner, WRI, Acting for Ray Robertson

Kevin VanFrank, Utah Department of Transportation

Liaison Members: Mike Anderson, Asphalt Institute

Meeting Coordinator: Lori Dalton (SME, Inc.)

Meeting Notes: Harold L. Von Quintus, (ARA, Inc.)

[Attachment A is the meeting agenda, Attachment B includes a listing of the ETG members, and Attachment C includes a listing of the Binder ETG Working committee members]

“Friends” of the FHWA Asphalt Binder ETG that were in attendance included:

Michad Arasteh, FHWA  
Haleh Azari, ARML  
Hussain Bahia, University of Wis.-Madison  
Jim Barnat, Road Science LLC  
Satish Belagutti, FHWA  
Douglas Brown, NuStar Asphalt  
John Chipy, Valero Energy  
Audrey Copeland, FHWA  
Matthew Corrigan, FHWA  
Samer Dessonky, UTSA  
Raj Dongré, DLSI  
Frank Fee, NuStar Asphalt  
Gary Fitts, Shell Sulphur Solutions  
Nelson Gibson, FHWA  
Beth Griffin, DuPont  
Tom Harman, FHWA  
Gerry Huber, Heritage Research Group  
Darin Hunter, Anton Paar USA  
Julie Kliewer, Arizona DOT  
Sang-Soo Kim, Ohio University  
Bob Kluttz, Kraton Polymers

Dallas Little, Kraton Polymers  
Shauna Tecle Marian, US Oil  
Richard May, Shell Sulphur Solutions  
Karissa Mooney, NuStar Asphalt  
Steve Mueller, FHWA  
John Murphy, UltraPave  
Mike Nuzzolo, LCY Elastomers  
Bill O'Leary, Martin Asphalt  
Hal Panabaker, DuPont  
Chuck Paugh, FHWA/ESC Inc.  
Katherine Petros, FHWA  
Olga Puzic, Process Analytics  
Simon Prout, Malvern Instruments  
Delmar Salomon, Pavt. Preservation Sys.  
Scott Veglahn, Mathy Construction  
Eric Weaver, FHWA  
Hai Fang Wen, WSU  
Jack Youtcheff, FHWA

## **Tuesday, 15 September 2009**

**1. Call to Order** – Gaylon Baumgardner (Paragon Technical Services), Chairman

**Welcome and Introductions** – Gaylon Baumgardner called the meeting to order at 1:05 PM and welcomed all participants. An attendance sign-up sheet was distributed for all members and visitors to log their attendance at the meeting. Baumgardner thanked NuStar for sponsoring the meeting.

Lori Dalton discussed various administrative arrangements and reported that the shuttle schedule was passed out prior to the meeting.

Gaylon Baumgardner thanked John Casola and Malvern Instruments for hosting the web cast of the Binder ETG Meeting which was made available for those who couldn't attend.

**2. Approval of the February 9-10, 2009 Meeting Minutes** – John Bukowski (FHWA), Secretary

John Bukowski noted that the minutes from the Feb. 2009 Binder ETG meeting were distributed to the members prior to the meeting for review. No changes or revisions were noted or requested.

**3. Review of Action Items from Last Meeting** – John Bukowski (FHWA), Secretary

Bukowski reviewed the agenda (refer to Attachment A) for the meeting and action items from the February 24 and 25, 2009 Asphalt Binder ETG meeting. Electronic copies of these documents were made available to the attendees prior to the ETG meeting. The following is a listing and status of the action items from the previous ETG meeting.

1. High temperature task group, John D'Angelo and Mike Anderson: Precision and bias should be finalized.

**UPDATE:** Action item included on the agenda.

2. Fatigue task group, Hussain Bahia: Two action items from the last ETG meeting.
  - a. Meet and evaluate the different tests to provide a recommendation on which test should be performed, as well as define the accuracy of the test (8 laboratories).
  - b. Bahia to send D'Angelo the draft specification or numbers of the specification so that it can be sent out to the binder ETG for review and comment.

**UPDATE:** Action item included on the agenda. Bahia not attending until tomorrow, he requested that his presentation be moved to the second day.

3. Low temperature task group, Sang-Soo Kim: ABCD test—AASHTO test procedure received from Dr. Kim. He will look at the repeatability of the stress curves and report back his findings to the binder ETG.

**UPDATE:** Action item included on the agenda. Both Sang-Soo Kim and Mihai Marasteanu will be making presentations on this item.

4. Temperature equilibrium, Dave Anderson:
  - a. Prepare a write up of the protocol for the next binder ETG meeting recommending the procedure to determine time to get equilibrium.
  - b. D'Angelo will provide him the data (MSCR and compliance values related to thermal equilibrium) and put that data on the FHWA website.

**UPDATE:** Action item included on the agenda.

5. Dave Anderson to provide marked up (red-lined) copies of the 2009 binder test procedures to John D'Angelo. These will be reviewed by the binder ETG prior to going to AASHTO for the full ballot.

**UPDATE:** Will be discussed during the meeting.

6. FHWA Studies on Acid and Durability, Terry Arnold: PPA Workshop in Minneapolis, Minnesota held on April 7 & 8, 2009.

**UPDATE:** Action item included on the agenda. Jack Youtcheff will present Terry Arnold's work and a summary of the workshop.

7. Warm mix asphalt task group, Geoff Rowe.
  - a. Wax study – Complete for lower percentage of wax.
  - b. Request assistance in analyzing the data.

**UPDATE:** Action item included on the agenda.

8. Tenderness task group, Raj Dongre.  
**UPDATE:** No action needed; not on the agenda.
  
9. Back-calculation of G\* group, Raj Dongre.
  - a. Continue to look at results and do more testing.
  - b. For E\* task force no further activity since contract now in place to produce a neural network from Richard Kim. Larger data set is being used. Gerry Reinke and Gaylon Baumgardner will provide extra data.**UPDATE:** No action needed; not on the agenda.
  
10. WRI Fundamental Properties – D’Angelo and Baumgardner will work with them to see what we can present at the next ETG meeting.  
**UPDATE:** Action item included on the agenda.

John Bukowski asked if there were any additions or changes to the action items. Baumgardner noted that there is a change to the agenda for today—Hussain Bahia’s presentation will be moved to Thursday. No other changes were noted.

**4. High Temperature Task Group** – John D’Angelo (D’Angelo Consulting) and Mike Anderson (Asphalt Institute)

**Presentation #1 Title:** *The Effect of SBS Content on the Fatigue Response of Polymer Modified Binders Using the Multiple Stress Creep Recovery Test*; John D’Angelo (D’Angelo Consulting)

Summary of Presentation:

John D’Angelo reviewed the current status of the test procedure, provided an overview of the test itself, and noted that much of this presentation was the same as for the mixture ETG meeting.

The Multiple Stress Creep Recovery (MSCR) test procedure has been published and is in the AASHTO Provisional Standards 2009 book. Table 3 of AASHTO M320 has also been updated to include information from the MSCR test. He pointed out that, that the temperature bumping has been eliminated with this new test procedure. The grade changes or grade bumping could still be done by changing the stiffness of the binder and not by temperature bumping. The MSCR testing can be performed on the same sample used to determine the binder DSR properties on RTFO aged sample as specified in M320 with one-minute relaxation period between the tests. The minimum values for the MSCR were presented and discussed by D’Angelo.

The mixture sliver fatigue test was also overviewed and how the test specimens were developed and prepared. The gluing can have a huge impact on the test results. Noted some issues with variability from the test. Some of the tests never failed and went past a reasonable time period for the test. Observations from some of the work completed to date include:

- Bonding of samples to end tabs affects the test results.
- The glue should be significantly stiffer than the mix samples.
- High variability was seen in sample replicates.

- Sample preparation is critical in getting good results.

D'Angelo overviewed some of the future work for this test procedure related to the issues that include:

- Use different base binder to replicate tests.
- Expand to higher SBS percentages to look at performance at higher percentages.
- Refine sample preparation to improve repeatability of test.
- Explore binder testing from fatigue task group to reflect mix test.

ETG Discussion, Comments, and Questions:

Gayle King and Dave Anderson questioned the use of some of the terms in the MSCR discussion and what they actually mean – John D'Angelo noted that delayed elastic response is the terminology that will now be used. Dave Anderson also asked for a definition of durability. John D'Angelo – Definition is on a practical basis – reduced cracking, reduced raveling.

Dave Anderson made a comment that the concept in testing mixture slivers in fatigue is similar to reinforced concrete; the concrete has to be well bonded to the steel to have any impact on the reinforced concrete. For polymer modified mixes, you have to hang on to the polymers for the materials to be of any benefit. Noted that for temperatures that are high, you do not see any benefit from the polymers and if you test too cool there is too much variability and it is difficult to conclude anything from the test. In test temperatures need to be selected between the very high and low temperatures need to be used to see the effect of the polymer. This comment resulted in some controversy regarding the effect of the polymer and its effect on very soft binders or high test temperatures.

Dave Anderson opinion was that need to run the fatigue test at the conditions that exist in the field. You should not run all fatigue tests at the same temperature. We are missing the potential impact of fatigue testing and being able to quantify the binders based on fatigue testing. You must use more than one test temperature. The test temperature will be increased because of the materials stiffness for some the higher polymer modified binders.

**Presentation #2 Title:** *Inter-Laboratory Study to Determine the Precision of AASHTO TP70 – Multiple Stress Creep Recovery (MSCR) Test*; Mike Anderson (The Asphalt Institute)

Summary of Presentation:

Mike Anderson distributed a proposed precision statement for AASHTO TP70. Dave Anderson pointed out that many people misinterpret the numbers included in a precision statement. He reported on the results from the eight labs included in the study, which followed ASTM E 691-05. These eight laboratories included: two FHWA technicians, MTE Services, Paragon Technical Services, PRI Asphalt Technologies, Kraton Polymers, Nevada DOT, and the Asphalt Institute. The asphalt binders that were used for the verification and experiment included: PG76-22 for the verification tests; and PG64-22(unmodified), PG64-34, PG70-28, PG70-34, and two PG76-22 asphalts for the experimental tests.

Mike Anderson presented the background and gave the reasons for the tiered precision statement in terms of why it was included in the precision estimate for TP70. Mike Anderson also reported that the Jnr and strain values were very low and the higher variability was for the low values. Mike Anderson noted that they still need to complete a formal report to FHWA.

ETG Discussion, Comments, and Questions:

Geoff Rowe asked if anyone has looked at the effect of grade temperature on the Jnr values. In others words, if you sent the material to two labs and they were on the extremes what difference in binder grade would you get. Gayle King answered that it would be 1.5 degrees for neat asphalt binders. Other meeting participants also had similar questions.

Shauna Teclé Mariana noted that they completed a similar study using 15 labs and thought that their results were about twice the values reported and presented by Mike Anderson. D'Angelo noted that when the DSR was first introduced, the variability was much greater than what it is today because it was a new procedure.

Olga Puzic noted that once the test becomes a standard procedure this can be part of AMRL protocol because precision bias statements developed based on 8 labs applies to only those eight labs, we need to have wider labs to properly develop precision and bias statements. Mike Anderson – according to ASTM you need to have a precision statement incorporated into their test method. The original precision statements for test methods like T315 and T313 their analysis has changed as they got much more data and I would expect the same for this method.

No further changes were requested to the proposed precision statement for TP70 that was presented by Mike Anderson.

**Presentation #3 Title:** *AASHTO M320 Table 3 Implementation: Guidance for User Agencies; a Presentation made at the AI Technical Advisory Committee Meeting; Mike Anderson (The Asphalt Institute)*

Summary of Presentation:

Mike Anderson gave an update on the AASHTO M320 Table 3 Implementation and Guidance for User Agencies. Anderson reviewed some of the key points that were used in transitioning from the Vis-Pen grade system to the PG grade system. He also presented some of the talking points regarding the implementation guidance document for M320. He overviewed/summarized important notes to user agencies. For example, currently the MSCR recovery is not included in Table 3 as a specification, and shadow testing is only indicative of current products and formulations. The Asphalt Institute is developing the guidance document but wants the ETG to take a look at it and make recommendations regarding Table 3 of M320.

ETG Discussion, Comments, and Questions:

It was asked, should we not already be telling states to use the elastic recovery portion or at least strongly recommend move toward implementation. This could then eliminate the variety of different tests that States are already adding to the binder acceptance.

Bukowski noted that while M320 now contains Table 3, it will be balloted in 2010 by the Subcommittee on Materials (SOM) for removal and could be recommended to be placed in a standalone Provisional Standard. Noted that many on the SOM members (tech section 2b) do not really know what Table 3 is and what it impacts/benefits.

Dave Anderson asked what has changed by the MSCR regarding the previous PG tests being run on the binder. Only the DSR testing on the RTFO has changed.

Baumgardner requested that D'Angelo prepare a draft specification for the MSCR by taking Table 3 out as a standalone document including precision and bias statement for the binder ETG to review. It was noted that Eileen Sheehy (SOM) has already started drafting up this document. D'Angelo will contact her to ensure that this is coordinated. If the SOM approves removing Table 3 from M320, then a draft stand alone specification will be reviewed by the Binder ETG.

Baumgardner noted that Mike Anderson will provide a draft recommendation on how to implement the MSCR test method to the binder ETG for review. Comments will be provided to Mike Anderson after the review. Anderson stated that if he could get the comments back from the ETG prior to the end of this year, he felt that it would be available prior to the next binder ETG meeting. Mike Anderson noted that draft documents would be available after the Asphalt Institute TAC meeting to be held in December 2009.

Mike Anderson commented that there is a possibility of doing a webinars for the MSCR workshops and certainly could do a seminar on the implementation of MSCR test method once the documents are published. D'Angelo noted that some seminars have already been done and one is scheduled for next week. The binder ETG should consider the results from the seminar next week for planning future ones.

#### Action Items:

- John D'Angelo to prepare a draft stand alone specifications for the MSCR test method including precision and bias statements and submittal to the ETG by December 15<sup>th</sup> 2009.
- Mike Anderson will submit the implementation recommendations of the Asphalt Institute for MSCR test method to the ETG for review for the next ETG meeting by December 15<sup>th</sup> 2009.
- John D'Angelo will prepare a proposed study of cylindrical mix DSR fatigue vs. conventional mixture fatigue testing such as trapezoidal or four point bending beam fatigue and any other commonly used mix fatigue tests and forward to the ETG Chair for distribution to the members. The study proposal should be prepared prior to the next binder ETG meeting in Feb. 2010.

#### 5. Fatigue Task Group – Haifang Wen (Washington State University)

Presentation Title: *Development of Master Curve of Critical Strain Energy Density of Asphalt Binder*

Presentation Summary:

Haifang Wen reviewed the critical strain energy density approach. Some have called this term the yield energy or fracture energy, but Wen decided to use the term that has been used by most industry – CSED (Critical Strain Energy Density). He identified and explained why we need the master curve for the CSED—the effects of time and loading speed. He then reviewed the experiment and what factors were included in the testing and data collection plan. He presented some of the binder  $G^*$  master curve that have been measured, and showed the shear strength master curve. Wen also concluded that CSED and the  $G^*$  are definitely related and have a good correlation. Shift factors appear to be the same between CSED and  $G^*$ . Thus, you can use the shift factors from  $G^*$  for CSED. Haifang Wen provided a summary of conclusions from this work of the fatigue task group, which include:

- CSED is a promising material property and fatigue indicator.
- A master curve of CSED, as well as shear strength, can be developed to account for the effects of time and temperature.
- The shift factors for  $G^*$  master curve can be used for the CSED master curve.

ETG Discussion, Comments, and Questions:

The majority of the debate from this presentation was on the shift factors determined from  $G^*$  and CSED testing – the master curves from each data set.

Raj Dongre asked if the maximum point on the curve to determine the CSED represents failure. Haifang Wen replied that it is not a complete failure of the test specimen, but there is damage to the specimen. Dongre commented that for fatigue, we think about tension but you are doing shear; how do you hypothesize this? - Is this a shear fatigue or tension fatigue? Haifang Wen replied; within the mix, tension is usually the primary mode but for the binder, shear is probably more critical. Dongre believes that tension is the primary mode of failure in the binder. D'Angelo noted that you have to look at what type of failure you have and how that failure propagates through the mix in relation to the binder (cohesive versus adhesive failure models). D'Angelo agreed that this is only explaining one of the mechanisms for a fracture failure. Haifang Wen agreed with these comments.

Dave Anderson asked how did you determine the shear strain; one for the steady state shear test or constant shear rate? Haifang Wen commented that the rotation rate is fixed, it is like a constant shear rate test. Dave Anderson asked are the failures the same as for this high shear rate? Haifang Wen agreed. Noted that it would be useful in presenting the data is to show the binder stiffness on the curves or relationships. The shift factors are basically the same. Rowe noted that you have gone into a nonlinear area of the relationship where you run the CSED test; the shift factors from the CSED in comparison to the shift factors from the linear part of the  $G^*$  master curve, you should separate them, they will not be the same. Haifang Wen stated that the results were the same with the exception for the low temperature range.



Rowe and Dongre both noted that the failure designated from the test is going to be some value less than the true failure of the material – this is more like the yield energy rather than failure or the true fracture energy.

Dave Anderson noted that many of the steps were left out the presentation in explaining the test procedure. D'Angelo reminded the group that Hussain Bahia has made many presentations where details on the procedure and its development have been presented. Hussain Bahia will make a presentation on this subject tomorrow, which might clear up some of the debate or confusion.

Mihai Marasteanu asked how did you select the shear rate? Haifang Wen answered that this was a trial and error procedure, no specific procedure was used.

No action item resulted from the presentation or discussion on this subject.

#### **6. PAV-Degassing – Gerald Reinke (Mathy Construction)**

Presentation Title: *Update on the Proposal to Eliminate the Need to Vacuum Degas PAV Residues for the Determination of BBR S & m-Value and PAV DSR  $G^* \cdot \sin \delta$*

#### Presentation Summary:

Gerald Reinke overviewed and provided background on the proposal to eliminate vacuum degassing procedure. The original presentation was made in July 2007 at the ETG. The justification of the argument was, there is really no need to run the PAV-degassing procedure on the PAV residue if you are not running the Direct Tension Test. He summarized the purpose of the investigation, overviewed the experimental design, presented a summary from a statistical analysis of the results from the initial test results, and the conclusions. The conclusions from the initial results at that time was, there appears to be no need to continue performing vacuum degassing if the direct tension test is not going to be performed. Reinke presented the results of degassing and nondegassing, one operator, a single piece of equipment from an ILS study conducted by Mike Anderson, Asphalt Institute on three which showed insignificant effect on the grading of materials used in the study. In 2008 Western Co-operative Test Group (WCTG) did do the degassing and non-degassing testing on three binders that were sent out to several labs. This was the WCTG study.

Gerald Reinke and Olga Puzic recently gathered the data sent by Bruce Morgenstern from the WCTG study and completed a detailed analysis of the data. Gerald Reinke reported that there was no difference between any of the specimens or test results. Reinke stated that based on all test data collected to date, there is not enough evidence to recommend that degassing be required. Reinke suggested, in the revised procedure, that the degassing only be used as the degassing procedure.

#### ETG Discussion, Comments, and Questions:

Shauna Tecele Marian asked why would one leave it in as a referee method when it does not make a difference. Reinke replied that it is the standard method and a requirement, and there are still

users that use it. This question and response resulted in more discussion and debate on why degassing is required or should be required. Reinke recommended and concluded that it should not be required and left as an option to the user.

Sang-Soo Kim asked if the analysis was a paired-T test? Reinke replied yes it was.

Raj Dongre asked will there be a problem with not requiring it. Reinke's opinion is that he does not see it that way and does not believe that there will be a problem.

Dave Anderson noted that there is a systematic difference—one method always results in a stiffer binder. Dave Anderson asked if anything been done to explain why that consistency or systematic difference exists. Reinke believes that the reason for the consistent difference is related to temperature. Dave Anderson was asking whether it was oxygen on the binder that increased aging. Mike Anderson noted this is a practical issue for routine testing – you do not go through the degassing procedure. He agrees with Shauna Tecle Mariana that if it remains as a referee test, then most will still run it. Mike Anderson was suggesting that if there is enough evidence then do not run the test. For Table 1, use the degassing but for Table 2 degassing would not be required. John D'Angelo noted that before the IDT, it was an issue; before the PAV mixing and other activities were done, but when the PAV came on line, then mixing and other activities became unimportant activities. Mike Anderson stated that he would gladly rewrite that section. Gerry Reinke noted that there is always a possibility that individuals did a poor job of running the tests.

Reinke commented that he would get rid of the referee procedure, but did not remember what the procedure was regarding stirring and checking for bubbles and would have to dig it out and review. Kevin VanFrank commented that degassing must be there for fracture testing, and all agreed with his comment. In summary, it would appear that it is acceptable with it being optional for the Table 1 specifications but required for Table 2. Some questioned whether to allow an option. Mike Anderson volunteered to rewrite the section on the degassing option. In conclusion, Chairman Baumgardner asked Gerald Reinke to write up procedure A and B, send it to the binder ETG and then decide on what to do with it.

Action Item:

Gerry Reinke will draft procedures concerning PAV degassing (Method A and Method B) and will send out the proposed procedures to the ETG members for review and comments by December 15<sup>th</sup> 2009 for the next ETG meeting.

**7. High Endurance Polymer Mix – Bob Kluttz (Kraton Polymers)**

Presentation Title: *Highly Modified Binders for Enhanced Pavement Performance*

Presentation Summary:

Bob Kluttz overviewed why they got started on this topic. He also acknowledged those that are involved in the study; Kraton Polymers, Technical University Delft – Road and Railways, and Technical University Delft - Mechanics.

In discussing this topic, Kluttz noted the importance of the relationship between tensile strain and number of cycles to failure for different mixes that have been measured in the laboratory. Bob Kluttz then overviewed the economics of using a highly polymer modified mix versus some neat mixtures in terms of thickness requirements – a 40 percent reduction in thickness. You get a breakeven in construction cost at a 30% reduction in thickness requirements – only on raw materials. Kluttz also showed that a 40% reduction in thickness results in a two-fold reduction in damage. Bob Kluttz mentioned that this mixture did perform well during construction and placement of these mixtures at the NCAT test track; contractor did not report any problems with constructability. Kluttz noted that you must keep the material agitated. If you let it set for awhile, it will begin to set up. It did compact very well on the projects where it has been produced and placed.

ETG Discussion, Comments, and Questions:

Noted that we have to remember that part of pavement thickness design is to protect the subgrade and unbound materials or layers. Reducing layer thickness may not do that. Bob Kluttz replied that they have built or placed sections along the NCAT test track, and in New Jersey and Louisiana over soft soils.

Geoff Rowe asked why not use a greater difference in stiffness between the highly polymer modified and neat HMA mixtures? Mihai Marasteanu asked have you run these problems or examples through the MEPDG. Kluttz responded that they have for the NCAT test section, but NCAT concluded that the section would fail in a short period of time.

Gayle King asked if this is designed as a rich bottom base or a regular bottom mix. Kluttz replied that it is a standard 4% mix design mix; not a rich bottom base layer.

Nelson Gibson commented that FHWA looked at the mathematics and used the simplified method which appeared to explain the cracking measured at the ALF sections reasonably well. This was one of Richard Kim's simplified work tasks that uses  $E^*$  as a failure test. John D'Angelo asked do you really believe that a material like this, which is so outside typical conditions, that  $E^*$  can be used to predict the fatigue of the section. He understands what Richard Kim is doing, but will those tests really capture the critical performance characteristics on a diverse material as this. This generated a lot of debate and discussion.

Action Item Summary:

No action item resulted from the presentation or discussion on this subject.

The binder ETG meeting was adjourned for Tuesday by Chairman Baumgardner at 4:45 PM.

**Wednesday, 16 September 2009**

**Call to Order** – Gaylon Baumgardner (Paragon Technical Services)

Baumgardner called the meeting to order at 8:10 AM. The meeting started a little later than scheduled because of issues with the website connections. The signup sheet was again distributed.

**8. Acid Modification** – John D’Angelo (D’Angelo Consulting)

Presentation Title: *Polyphosphoric Acid Modified Asphalt Binders – Usage, Why, How*

Summary of Presentation:

John D’Angelo reviewed some of the work and findings that have been done with PPA; much of the information included in this presentation was given at the April 2009 PPA workshop. He also provided additional information to establish a baseline of where we are at, and where we need to be in the near future. He provided a definition for PPA and presented a survey of PPA use in the US.

D’Angelo also defined the Useful Temperature Interval (UTI) and how it has been used regarding whether modification is required. He overviewed some examples of what the UTI would be for different grades. D’Angelo also overviewed the different specification categories used by agencies related to PPA. He showed test results from several studies conducted by FHWA, Gaylon Baumgardner and Raj Dongre related to using various percentages of polymers and PPA to achieve a specific grade. PPA used in combination with polymer improves the material in terms of cross linking and mixing effect and improves mixture properties. PPA appears to improve the SBS elastomeric response.

D’Angelo summarized work completed in the moisture sensitivity area and PPA issues related to moisture. An analysis and summary of test results found that as long as you are lower than 1.5% PPA in the binder, the effect of moisture is similar to neat asphalt. Regarding mixtures, test results from the Hamburg device indicate that PPA performs well with proper anti-strip additive. The MSCR test was used to evaluate aging with hydrated lime still in binder. The test results demonstrate that it appears PPA is stiffening the binder but not as high as without the lime; the hydrated lime is not going to neutralize the PPA.

In closing, the common opinion is that PPA chemically ages or accelerates oxidative aging of asphalt. Results reported in patents cited indicate that PPA actually has anti-oxidative characteristics in the asphalts studied. Other conclusions reported by D’Angelo include:

- Effects of PPA modification is crude source dependent; it improves the cross linking with SPS polymers and improves the elastomeric response.
- The effect of PPA on moisture damage is asphalt and aggregate dependent; but improves as long as you use anti-stripping additives (both lime and liquid anti-strips) – overall it can work.
- PPA is a valuable tool to binder suppliers necessary to provide binders that meet current specifications and provide the desired performance.

John D’Angelo then asked the ETG to comment on where do we go from here; do we ask for more studies?

ETG Discussion, Comments, and Questions:

Multiple ETG participants provided their opinions and asked for clarification on selected items presented. The following lists the topics and concerns raised from the ETG participants.

Asked that were there no bad results presented; in the past some projects failed prematurely, was this because of modification with PPA.

Noted that there are issues that we still do not understand when different materials are combined or modified. D'Angelo noted and emphasized that he is not saying everything is perfect; you must do your evaluation and understand what the impact is; moisture damage must be taken care of. Caution in terms of PPA use is still there.

Frank Fee asked whether we are thinking about putting together a white paper or just say that we are done. One suggestion is to compile documents and summarize all of the data and studies, and provide references regarding the findings. Gerald Reinke proposed that we need something more than just a white paper; we really need a synthesis document that does a forensic investigation to determine if the data is there to support the recommendations and conclusions. D'Angelo also stated that some of the early failures attributed to PPA were later found to not be the cause – something else caused the problem. D'Angelo commented that we need to be careful about some of the earlier studies and their findings. Jack Youtcheff and Bob McGennis reminded the group on how this started, that the focus of this effort was to get the word out from the earlier WRI work. As that work moved forward, we started adding other items. Suggestion was made for putting together an e-circular.

Baumgardner commented that a document is needed for the materials engineers and one for the users, so a combination of a synthesis and white paper would be good. He suggested that a group or task group be formed to write a white paper and e-circular. A lot of work has been completed to date and we need something to get the recommendations out from the ETG. This has been ongoing for some time and the ETG needs to start wrapping up this issue.

John D'Angelo was volunteered to lead a task group for drafting up a recommendation for a Best Practices manual for using Polyphosphoric Acid by the end of this year for submitting to the binder ETG for review. This draft should be done prior to TRB however Bukowski noted that is too short a time period and probably cannot be accomplished in that short a time period. Chairman Baumgardner requested that this be done by the end of the year – a target date of Dec. 15 was established.

Action Item:

John D'Angelo to lead the task group force to draft a test procedure for best practices for the use of poly phosphoric acid by December 15<sup>th</sup> 2009. The task group includes John D'Angelo, Gerry Reinke, Gayle King, Terry Arnold Henry Romagosa, Olga Puzic, Jean-Valery Martin, Fran Miknis and Mike Anderson.

## **9. TFHRC Fatigue Study – Jack Youtcheff (FHWA) and Terry Arnold (WRI)**

Presentation Title: *Detection of Phosphoric Acid and Trace Metals in Asphalt Binders*

### Summary of Presentation:

Jack Youtcheff made the presentation for Terry Arnold. This presentation was an update on the FHWA ALF activities for studying the embrittlement and durability of asphalt in related areas.

Youtcheff summarized the work that has been completed at TFHRC to detect if other materials were present in the asphalt, including PPA. Some of the results showed that they could identify which asphalt was supplied by different suppliers – this was basically to fingerprint the asphalt. For verification of the procedure, Youtcheff showed some of the results for testing the amount of metals in recovered engine oil for detecting differences. The conclusions made to-date from this work include:

- Phosphoric acid content of asphalt binders can be readily measured and detected using XRF spectroscopy. The method is well established, was developed by Puzic, Reinke and Glidden. However, not all the PPA is recovered from mixes.
- Presence of recycled engine oil bottoms (REOB) can be detected by measuring calcium and zinc levels. Confirmation of REOB by trace metals Cu, Mo, Sn, Ba and Pb.
- Measurement of vanadium levels shows promise as an asphalt fingerprint.
- BUT, more research is needed.

### ETG Discussion, Comments, and Questions:

Gerald Reinke asked whether the results on the vanadium slide had already been calibrated. Youtcheff replied it had. Has the sodium content ever been looked at within this study? Historically high sodium content has led to stripping in the past, and because it led to stripping, a limit on sodium content was used which eliminated the use of recycled engine oil in HMA.

D'Angelo believes that this topic was on the program because Ontario did a large study to determine why recycled engine oil affected the performance of binders. Different performance was found with the same asphalt binder grade (20 sections were included in the study). In the first part of the study, they found PPA and concluded that PPA damaged the low temperature properties. The asphalt suppliers, however, reported that they were not using PPA. Terry Arnold noted that maybe the phosphate was not coming from PPA, but instead from recycled engine oil bottoms. The question then is this more of a significant issue. One common comment was that this is a significant issue and needs to be looked at.

Gerald Reinke noted that even at low recycled engine oil concentrations, you end up with inferior low temperature properties. The problem is caused by the addition of these materials in the asphalt. Recycled oil is a good cutter to make the asphalt grade but performance of the road may be bad. Bob Kluttz opinion is that this is a good issue for the ETG to consider, but it should not be restricted to recycled engine oils; it should cover a lot of other materials. John Bukowski cautioned that the ETG needs to be careful about what materials are covered.

All of this discussion relates to forensic investigations in using vanadium to identify if the asphalt is coming from different crude sources and to determine if there is a problem

D'Angelo reminded the group that we need to get back to what the ETG can do as an ETG, how can we address this issue. There was a lot of discussion on what the problem is and if it needs to be looked at. As an ETG do we want to take this on?

Gayle King proposed that the ETG prepare a research needs statement on this topic of recycled engine oil bottoms. Gerald Reinke agreed, this becomes an issue about banning certain materials that are being introduced or blended into the asphalt, prior to having sufficient evidence that adding small percentages is a bad thing. We need to be looking at a much larger scope of the problem. Noted that need to define which one of the elements is the problem. Gayle King also stated that to evaluate performance, we need performance tests.

Baumgardner summarized that our action is to develop a research problem or needs statement for evaluating the effects of recycled engine oil bottoms or similar materials on asphalt binders and performance. John D'Angelo and Raj Dongre volunteered for this effort.

**Action Item:**

John D'Angelo & Raj Dongre will o prepare a research needs statement on the use of reclaimed/recycled motor oils and its effects on mixture performance and Olga Puzic will help provide the references by December 15<sup>th</sup> 2009.

**10. Low Temperature ABDC Task Group Report – Sang-Soo Kim (Ohio University)**

Presentation Title: *Asphalt Binder Cracking Device (ABDC): Update*

Presentation Summary:

This presentation given by Sang-Soo Kim and was an update on the Asphalt Binder Cracking Device (ABCD) and BBR interlaboratory study. Sang-Soo Kim provided a handout to the binder ETG on the Standard Test Method for the ABCD device. This was a draft standard test method that has been prepared for review.

Summary of Presentation:

Sang-Soo Kim first gave an overview of the ABCD concept or operating principle, and presented some test results in using the device to determine the polymer concentrations versus cracking temperatures.

He also provided an update on the ASTM C 802 and ILS Plan related to the ABCD & BBR test. Sang-Soo Kim reviewed the list of laboratories that participated in the study and provided a review on some of the test results. He also provided a status report on the ABCD interlaboratory study—the laboratories that have completed the testing, those that are in process of completing the tests, those labs that are waiting to do the testing, and those labs that have withdrawn from the study.

Sang-Soo Kim presented the results for the precision and accuracy of the ABCD and BBR devices that were included in the laboratory. Some of the variability was high. Thirteen laboratories were included in the initial study. A video was provided for demonstrating sample preparation. Sang-Soo Kim's opinion was that with time and experience the precision of the ABCD device will improve or get better. In some cases, it was the first time that these laboratories have used the device—the reason for preparing the video was to show how the sample is suppose to be prepared; thereby reducing variability.

Sang-Soo Kim identified some of the major sources of error that cause increased variability of the test. The current plan is to work on the no-trimming procedure and open ABCD ring. Input from the ETG on the working draft of the test procedure is also needed and requested.

ETG Discussion, Comments, and Questions:

Multiple questions were asked and comments provided during the discussion session. There was a lot of debate on what we need for the specification and how the test results are used.

Raj Dongre asked why are you looking at  $m = 0.4$  and the strength is not the failure strength. Dongre believes that the critical temperature is important, but the strength is simply a calculated property. Sang-Soo Kim agreed with the comment.

Mihai Marasteanu asked why did the micro-strains go up and then decrease with increasing test temperature. Some of this effect is related to calibration that has to do with the compression and tension results. This result or discrepancy should be taken out related to calibration – Sang-Soo Kim took out as much as they could, but with enhanced calibration it could be improved.

Dave Anderson asked why do we need this test. Sang-Soo Kim responded that the purpose of the test is to estimate the potential cracking value of the binder and for use in specifications. To calculate cracking temperatures you need to include the variation in strength. Dave Anderson's comment - No one is using the strength in the specification or very few are using strength. D'Angelo commented that this leads to an issue regarding the BBR which is also an empirical property. The relationship to cracking is what is empirical.

Dave Anderson noted that the ABCD is also an empirical. This comment resulted in lots of discussion on the importance or need for this device and test. We need a test to capture the fracture temperature properties of the binder. The TSRST is also an empirical device and property. Gayle King's opinion was that if you recreate the actual temperature drop, then it is not empirical. Agreed that you do not get any fundamental properties from this test and other tests related to fracture and cracking, which is a problem. Raj Dongre commented that we are calculating the critical temperatures, they are not measured. Sang-Soo Kim agreed with Dave Anderson's comment that the ABCD does not provide mechanical properties for pavement or mixture design. This is the reason why he included the strain jump in the test.

Gerald Reinke commented that we need to determine if this device is telling us something about performance that we do not already know.



This is an 8-hour test, is it very practical use of the test during day to day production. Sang-Soo Kim replied that more samples can be tested and expanded to test more samples during the day. There was additional discussion of how often samples need to be tested, assuming the device is used.

Action Item:

There was no action item for this topic, however Chairman Baumgardner asked the members to review the document handed out by Sang Soo-Kim and provide any comments or corrections to him, as soon as they could. No deadline was given for returning any comments to Sang-Soo Kim.

**11. Warm Mix Asphalt Task Group Report** – Gaylon Baumgardner (Paragon Technical Services, Inc.); Geoff Rowe (ABATECH)

Presentation Title: *Evaluation of the BBR Test with Mixtures Containing Waxes – Proposed Work Item*

Summary of Presentation:

Gaylon Baumgardner introduced the topic or presentation and summarized some of the items that will need to be investigated further. Geoff Rowe made the presentation and overviewed the wax study.

Geoff Rowe started out acknowledging all of those that have been involved in this task effort or group. He first reviewed what has already been done to refresh memories, and then overviewed some of the tests and materials that were included in the test program.

The second part of presentation was to review some of the test data or results related to different wax percentages and type. Rowe acknowledged that some of the test results were difficult to understand and were not expected—no real form or relationship in the data. He then showed some of the test results in terms of wax type and number of temperature saturation days. A decision was made to retest some of the BBR beams, because of the unexpected results. These beams were tested before and after the annealing procedure (something like a healing of the beam).

There was some confusion on the presentation of the test results. Some of the confusion was related to how the data were being presented in terms of shift factors and isotherm plots in the interest of time. Rowe will put in the actual shift factors and isotherm plots into the presentation after the meeting to clarify what is being done and how the data are being compared between the different testing conditions – un-annealed and annealed data.

At the end of the presentation, Geoff Rowe asked the ETG; what needs to be done in the future. He provided some recommendations and asked for comment from the ETG. Chairman Baumgardner noted that the lower part of the BBR specification might be doing what we are asking it to do at least for binder used in the study. The reversal of the expected results is the issue and whether that is reality. In other words, what is causing the reversal of stiffness in the test results?

ETG Discussion, Comments, and Questions:

Gerald Reinke's opinion is that more materials need to be added to the test program.

Mihai Marasteanu reported that that one of his students obtained the same type of results and ran into some of the same issues. One comment is that once you go to lower temperatures, you start approaching the limits of the BBR. Maybe the test temperature is the issue; should we go to a larger loading frame at these lower temperatures and what load level should be applied to break the specimen. The 20% of the load to break the sample is low and should not damage the specimen, so Marasteanu does not believe that is the problem with inducing damage that is causing the reversal in stiffness. Raj Dongre stated that the BBR will tell you that you are approaching the breaking point. Mihai Marasteanu agreed with that comment.

Mike Anderson has three asphalts that have different m-values which could have to do with different amounts of wax that they are using for an FAA study. These binders should have significantly different cracking properties. Mike Anderson may be willing to share these materials for use on this study. Both studies will result in a lot of laboratory measured properties.

Mihai Marasteanu mentioned that MnRoads has a lot of asphalts stored that have been used for which performance data does exist. Thus, they know the performance between the asphalts is different. These asphalts would be available for use by the ETG. Gayle King agreed with that approach. The reversal in stiffness feature is only being observed at the longer temperature saturation times, exceeding 4 days. At the earlier part of the relationship, the reversal is not being observed in the test data. Gerald Reinke suggested that these asphalts be included in the test program.

Rowe will put in the actual shift factors and isotherm plots into the presentation to clarify what is being done and how the data are being compared between the different testing conditions – un-annealed and annealed data.

Action Item

Gerry Reinke and Geoff Rowe to prepare a proposal for continued BBR temperature saturation with Lion Oil asphalt as the control asphalt and include at least three additional asphalt binders sources to investigate micro cracking and healing based results from the wax study that was conducted from the previous ETG by December 15<sup>th</sup> 2009.

**12. Added Item to the Agenda—Negatives from the AASHTO SOM Ballot**

At the AASHTO Subcommittee on Materials meeting in Anchorage, Alaska earlier this year there was a recommendation for changing the time of retention of the sample in silicone mold to two hours in AASHTO T-315 test method and it was objected by two states that need to be addressed (T-315 DSR) by the binder ETG. Eileen Sheehy noted that they could not agree on the change. The 2 hours was the original recommendation from this ETG, but that was changed to 8 hours. The 8 hours was changed back to 2 hours, and this change resulted in an objection or negative from Utah and Arizona.

ETG Discussion, Comments, and Questions:

Kevin VanFrank asked why set the time to 2 hours and noted that he has never seen the data for the 2 versus 8 hours; he has not seen any data to indicate difference between 2 hours and 8 hours. He has data that he can present to the ETG to demonstrate that 8 hours is appropriate. Bob McGennis reminded everyone that there was no original recommendation, that the 2 hours came from this ETG as a suggestion just to give advice or guidance to technicians.

There was a lot of discussion and debate on what the actual recommendation was from the ETG and the data used to make the recommendation or suggestion. It was brought to the ETG about 2 years ago. Bukowski reminded the binder ETG that AASHTO (Eileen Sheehy) is looking for a reaffirmation that ETG still maintains 2 hours retention time. And that the ETG to resolve this issue. There is now a maximum time of 2 hours limit in the test standard. Kevin VanFrank gave an overview of the test data from WRI and his laboratory. Kevin VanFrank showed G\* versus aging time for different conditions of the asphalt. Dave Anderson asked how this test is being done. Kevin VanFrank noted that the test is using the DSR and storing the asphalt at different times. Dave Anderson asked what about the intermediate test temperature. Kevin VanFrank noted that his lab is always testing at the higher temperature for grade. Dave Anderson noted the issue is not with the intermediate or test temperature, the issue is with the plates. Lots of debate on what is the real question or problem is related to 2 versus 8 hours. Absorption of the lighter end oils into the rubber for the BBR and silicone using the DSR.

Suggested that Matt Corrigan's and the FHWA laboratory do testing on the DSR specimens retention in molds at different holding times. This data will be collected and provided for review at the next ETG meeting. John D'Angelo recommended that the PAV also be included.

Bob McGennis reminded the ETG that there is data that did justify or support the 2 hours, and asked if that data had ever been presented to the ETG. Kevin VanFrank replied that it had not—it was asked for but not provided. This is some of the same discussion between the technicians that occurred years ago in looking at reasonable times for the test.

David Anderson noted this is not an issue at the higher test temperatures, the issue is at the intermediate test temperature, it is not heated. Steric hardening is not destroyed at the intermediate test temperatures but is destroyed at the high temperatures because of the heating. His opinion is that you only need to look at high temperatures.

Action Item:

FHWA will report data for DSR mold testing at the next ETG meeting. DSR test results will be from the binders from the molds with retention time of 0, 0.5, 1, 2, 4, and 8 hours on RTFO and PAV aged conditions.

**13. Temperature Equilibrium** – Dave Anderson (Retired, Consultant) & John Casola (Malvern Instruments). John Casola participated in the discussions via the webinar.

Presentation Title:     *Thermal Equilibrium in the DSR*

Summary of Presentation:

Dave Anderson initially went over the two questions or areas that were previously asked about this topic. These two questions are just a review to remind the group of the issues:

- How long does it take to reach thermal equilibrium in the DSR and is the current test method adequate?
- Anecdotal evidence suggests that current specification may be inadequate.

These two issues need to be resolved and then summarized from an analysis of the experimental test results. His focus is that two times are needed; one for temperature and one for  $G^*$  so that temperature and  $G^*$  are constant with number of loading cycles, but his recommendation is to use  $G^*$  to know when you are at thermal equilibrium.

The next issue, based on the above assumption, is how do you know that  $G^*$  is a constant. Dave Anderson gave his proposed definition for determining when you have a constant  $G^*$ , as well as for that a constant temperature condition has been reached. Both are listed below:

- Constant Temperature is the time when two consecutive values from the instrument are within 0.1C of the target temperature.
- Constant  $G^*$  is the 1<sup>st</sup> of three consecutive times in which the corresponding values of  $G^*$  are within 1 percent of the 15-30 minute average value for  $G^*$ .

His definition does not mean or include a systematic change in  $G^*$  over time (continuously increasing over time). Dave Anderson summarized the recommended protocol for determining when the device and materials are at thermal equilibrium. He noted that you do not have to do this every day.

ETG Discussion, Comments, and Questions:

How do you determine that the sample is at an equilibrium temperature? The plates will come to equilibrium before the test sample. The sample is at thermal equilibrium condition when the  $G^*$  modulus does not change over time. Opinion is that this process may not work in all cases. Dave Anderson's opinion is that the data is too noisy to compare consecutive test points. D'Angelo's opinion was that  $G^*$  is changing even over 40 minutes for some devices based on Dave Anderson's data, and when that happens his procedure will not compensate for those conditions. Dave Anderson disagreed – you can use the slope as part of the criteria in deciding when we are at thermal equilibrium. Darrin Hunter requested to make a presentation at the next ETG meeting on this topic. His request was approved, if it is found to be an issue.

Dave Anderson noted that he has sent this procedure to few members of ETG asking them to review and send the response back, and may be this time I will have some response back.

John Casola Comment – This procedure needs to be done only once for each instrument and environmental cabinet.

Action Item:

David Anderson and Darin Hunter will work together to discuss the DSR temperature equilibrium issues and the discussions will be continued at the next meeting.

**14. Low Temperature Pooled Fund** – Mihai Marasteanu (University of Minnesota)

Presentation Title: *Investigation of Low Temperature Cracking In Asphalt Pavements, Phase II, National Pooled Fund Study 776*

Summary of Presentation:

Mihai Marasteanu overviewed the phase II plan and identified members of the task group or pooled fund study. The purpose of this presentation was to review the materials and test procedures being used to study the asphalt binders that are being used on the next round of testing at MnRoads. Marasteanu overviewed the tasks and provided a status on each task. The tasks of the study are listed below.

- Task 1 was the literature review or update on the low temperature cracking research.
- Task 2 was to expand the phase I test matrix with additional field samples. Task 2 includes a subtask on physical hardening
- Task 3 is to develop a low temperature cracking specification for asphalt mixtures.
- Task 4 is to develop an improved TCMODEL for predicting thermal cracking.
- Task 5 is the modeling of asphalt mixtures contraction and expansion or volume change potential with thermal cycling.
- Task 6 is the validation of the new specification.
- Task 7 is the development of the draft AASHTO Standards and final report.

Mihai Marasteanu also overviewed reconstruction of the MnRoads phase II reconstruction program and the different agencies involved with the reconstruction program. He also provided an overview of the different asphalt materials that are being used within the test sections and identified the types of asphalts being used. Marasteanu then overviewed the mixture and binder fracture testing that is being completed on the 2008 MnRoads reconstruction.

Mihai Marasteanu then gave some of the reasons why the system works or has worked to date, and asked the ETG for comments and suggestions regarding the proposed AASHTO test method.

ETG Discussion, Comments, and Questions:

Gayle King asked how long it will take to complete the proposed test for characterizing the mixtures in terms of fracture. Mihai Marasteanu noted that it can be much shorter.

Sang-Soo Kim asked how thermal fatigue will be performed. Mihai Marasteanu noted that they are not doing any repeated load testing. Everything is a single load test by changing the temperature during the test. They are not using any thermal cycling tests.

These were some comments about using stiffness as a predictor for thermal cracking in asphalt mixtures. Mihai Marasteanu's opinion was that you cannot use stiffness as a surrogate for predicting thermal cracking or fracture.

Action Item Summary:

No formal action item needed or required for this topic.

**15. Fatigue Task Group Report** – Hussain Bahia (University of Wisconsin at Madison)

Presentation Title: *ARC Update – Binder Fatigue*

Summary of Presentation:

Hussain Bahia presented an overview of the Binder Yield Energy (BYE) test being used to evaluate binders. Bahia overviewed the table of the proposed BYE limits for the specifications that was presented at the last meeting.. No cross linking accounted for in the material in generating or estimating the strain versus stress for the undamaged binder (AAPT 2009 paper). This was discussed with Ray Bonaquist and Richard Kim based on the behavior they observed in testing mixtures – both recommended a much faster rate. Bahia decided to use a faster rate to eliminate the hardening that has been reported and that they observed in their binder testing.

Effect of loading rate on the monotonic test – the faster rate did not eliminate that effect in testing the binder. Faster rates also started causing slippage of the binder between the plates. Result was that this test could not or should not be used as a specification test.

The test results measured to date were presented in an interim report or findings document. Bahia's opinion is that the test is practical and repeatable and can easily identify modification and possibly cross linking but cannot be used for damage analysis.

Bahia presented the procedure or process that they are investigating—using results from the strain sweep DSR data to estimate the A and B terms for calculating the fatigue life or properties of the mixture. The tests and specification type protocol were summarized as follows:

- Perform  $G^*$  versus frequency tests to determine alpha value.
- Perform the amplitude sweep at IT grade temperature.
- Calculate the following parameters.
- Damage intensity to build VECD curve.
- Determine curve fit coefficients to calculate A and B.
- Predict number of cycles to failure using appropriate strain level based on pavement structure and traffic loading.

Hussain Bahia then provided a listing of the next steps to be taken, which are listed below.

- Draft an AASHTO Procedure for linear amplitude sweep and VECD modeling.
- Draft an AASHTO Procedure for the BYE test.
- Continue testing for validation
- Work with the TFHRC Group

ETG Discussion, Comments, and Questions:

Previous individuals have been promoting the use of a fracture test or one that initiates fracture within the test specimen. How was it determined that fracture tests for the binder are now not needed or recommended. Hussain Bahia commented that melt fracture is what happens in the

binder; actual cracking does not occur. Fatigue happens in the intermediate temperatures and not in the brittle condition.

Bob Kluttz commented that he does not have a problem with using the yield behavior for the binder and mix and the other tests that Bahia has recommended for use. Nelson Gibson commented that we should not forget about the lower temperature range that can be used to estimate what happens in the intermediate temperature range. John D'Angelo does not believe that low temperature characterization needs to be done in the low temperature range. Gayle King mentioned that block cracking estimates may have to come from the low temperature range. John D'Angelo agreed, but that is another issue.

Kevin VanFrank asked how can these three micro strain categories be looked at on a continuum basis. Hussain Bahia replied; we are going to very high strain levels in cross linked materials. There is no way we will get to those high strain levels, in the field, cracking will have already occurred. These stain levels are from plastic flow condition, which will not occur within the fatigue area. The VECD procedure is not developed to account for these high strain levels; this is for the new parameters for the monotonic test. Bahia noted that he does not know which one is better; he knows that they cannot use the BYE test because of the damaged condition. A couple of these tests are purely empirical that can be used but they will not provide fundamental properties.

Raj Dongre opinion was that the purpose was not to damage the specimen when using oscillation tests. Why use oscillation tests if you are allowing damage. Hussain Bahia said that there is no permanent deformation, but there is damage to the test specimens.

Bob Kluttz replied to Dongre's opinion in that we cannot assume that the material is visco-elastic and that we are not damaging the material. Bob Kluttz opinion is that we are damaging the materials. Dongre opinion is that the damage noted by Kluttz and Bahia may be relaxation and not fatigue damage. Kluttz disagreed with Dongre; it is damage and not relaxation. Bob Kluttz's opinion is that what Hussain Bahia has proposed appears to be the best by subtracting the visco-elasticity from the analysis so what is left is the damage in the binder.

Considerable discussion among the ETG on what is fatigue damage and what is not fatigue damage. D'Angelo commented that if these are just correlations, then we will end up with correlations. Hussain Bahia's reply back to Dongre is that the pseudo-strain is used that takes all of the visco-elastic and nonlinearity out of the analysis. Again considerable ETG debate on what is really being measured and how it will be used or considered for looking at fatigue from a binder standpoint but still being consistent with how the mixtures are being handled.

Dave Anderson opinion is that we do not understand fatigue and where fatigue damage occurs. Hussain Bahia stated that when he sees good relationships between classical damage equations for many other materials – there is nothing to convince him that there is a anomaly related to the binders for fatigue. D'Angelo noted that if Dongre is right, no good correlations will occur or be found. If Bahia finds good correlations, then it would appear that the procedure is reasonable. Is it damage or viscous flow – that is the debate? ).

As the debate continued, Bob Kluttz asked how is cracking measured. Nelson Gibson replied that cracking is defined as a reduction in modulus of the material, which made Bob Kluttz's point – it is not really cracking, only a reduction in modulus. Much discussion occurred here on what is cracking, damage, etc. Discussion in the ETG focused on fatigue and how it is measured in the laboratory.

**Action Item:**

Hussain Bahia will prepare a draft AASHTO procedure for the linear amplitude sweep test in the binder yield energy test and will be distributed to the ETG members for review and comments by January 15, 2010.

**16. WRI Fundamental Properties – Fred Turner (WRI)**

Presentation Title: *ASTM D 4124-09: Standard Test Method for Separation of Asphalt into Four Fractions*

Fred Turner introduced the topic regarding determining the asphalt properties regarding the aging gradient. Troy Pauli made the presentation (Co-author was James Beiswenger).

Summary of Presentation:

Troy Pauli went discussed the testing to show the effect of waxes and other materials of the asphalt properties. These devices included the liquid chromatography and SARA chromatography.

This was a detailed presentation on the fractionation and average molecular structure maps for asphalts under different conditions. Pauli presented results from the chromatographs for different samples. He also presented the detailed results from the SARA fractionation and average molecular structure maps, SARA fractionation and asphalt oxidation, SARA fractionation and AFM imaging of comparative test site asphalts. The conclusions from this work included:

- ASTM D 4124-86 was reviewed and revised resulting in the following significant changes:
  - Iso-octane used to precipitate asphaltenes
  - Is-octane maltenes used to prepare samples for SARA chromatography.
  - Temperature control of column
  - Self-contained LC-column (eluting solvents pumped through column to separate fractions)
  - Elution solvent volumes increased
  - Sample loading concentration decreased
  - Spectrophotometric detection of fractions.
- Consequences of the modifications made to the procedure:
  - Increased resolution of separated species.
  - Scalable separation
  - Cleaner (better chemically defined) fractions



- Faster, cleaner method.

ETG Discussion, Comments, and Questions:

Shauna Teclé Mariana asked to explain why you selected heptain (octaine) versus hyoctane. Pauli replied that he can predict the phase angle of the binder just by knowing the ratio between the asphaltenes and maltenes.

–Asked if there is anyone using this specification and if they are using it, should they change their specification after these results? The asphaltenes part is what will be affected. Pauli was not sure about the answer to this question.

Action Item Summary:

Fred Turner asked for time at the next ETG binder meeting to discuss the 4 mm plate DSR.

**17. Summary of Action Items – John Bukowski (FHWA)**

John Bukowski summarized the action items that were identified from this meeting, which are:

1. John D'Angelo to prepare a draft stand alone specifications for the MSCR test method including precision and bias statements and submittal to the ETG by December 15<sup>th</sup> 2009.
2. Mike Anderson will submit the implementation recommendations of the Asphalt Institute for MSCR test method to the ETG for review for the next ETG meeting by December 15<sup>th</sup> 2009.
3. John D'Angelo will prepare a proposed study of cylindrical mix DSR fatigue vs. conventional mixture fatigue testing such as trapezoidal or four point bending beam fatigue and any other commonly used mix fatigue tests and forward to the ETG Chair for distribution to the members.
4. Gerry Reinke will draft procedures concerning PAV degassing (Method A and Method B) and will send out the proposed procedures to the ETG members for review and comments by December 15<sup>th</sup> 2009 for the next ETG meeting.
5. John D'Angelo to lead the task group force to draft a test procedure for best practices for the use of poly phosphoric acid by December 15<sup>th</sup> 2009. The task group includes John D'Angelo, Gerry Reinke, Gayle King , Terry Arnold Henry Ramogosa, Olga Puzic, Jean-Valery Martin, Fran Miknis and Mike Anderson.
6. John D'Angelo & Raj Dongre to prepare a research needs statement on the use of reclaimed/recycled motor oils and its effects on mixture performance and Olga Puzic will help provide the references by December 15<sup>th</sup> 2009.
7. Gerry Reinke and Geoff Rowe to prepare a proposal for continued BBR temperature saturation with Lion Oil asphalt as the control asphalt and include at least three additional

asphalt binders sources to investigate micro cracking and healing based results from the wax study that was conducted from the previous ETG by December 15<sup>th</sup> 2009.

8. FHWA will report data for DSR mold testing at the next ETG meeting. DSR test results will be from the binders from the molds with retention time of 0, 0.5, 1, 2, 4, and 8 hours on RTFO and PAV aged conditions.
9. David Anderson and Darin Hunter will work together to discuss the DSR temperature equilibrium issues and the discussions will be continued at the next meeting.
10. Hussain Bahia will prepare a draft AASHTO procedure for the linear amplitude sweep test in the binder yield energy test and will be distributed to the ETG members for review and comments by January 15, 2010.
11. WRI – will make a presentation on DSR testing using smaller samples 4 mm plates at the next ETG meeting.

**18. Conclusion and Location of Next Meeting** – Gaylon Baumgardner (Paragon Technical Services)

The next meeting will be held in Irvine, CA during the week of February 22-26, 2010. The specific two days for the binder ETG meeting during this week will be decided later this year and provided to the ETG members/friends via e-mail communication.

Gaylon Baumgardner again thanked NuStar and John Casola for the web access for allowing those that could not physically attend the meeting to participate via the internet.

**19. Meeting Was Adjourned at 4:35 PM by Chairman Baumgardner.**

## ATTACHMENT A

### FHWA Binder ETG Meeting Agenda Sept. 15<sup>th</sup> & 16<sup>th</sup> San Antonio, TX

#### Sept. 15<sup>th</sup>

1:00 pm	Welcome and Introductions	Baumgardner
1:15 pm	Action Items from last meeting	Bukowski
1:30 pm	High Temperature Task Group	D'Angelo/ M. Anderson
2:30 pm	Break	
3:00 pm	Fatigue task group report	Bahia, Wen
4:00 pm	High endurance polymer	Kluttz
4:30 pm	Adjourn	

#### Sept. 16<sup>th</sup>

8:00 am	Acid Modification	D'Angelo
9:00 am	FHWA Recovered Motor Oil	Arnold
9:30 am	Update on ABCD Device & BBR Interlab Study	S. Kim
10:00 am	Break	
10:30 am	Warm Mix Asphalt	Baumgardner
11:30 am	Temperature Equilibrium	Anderson
12:00 noon	Lunch	
1:00 pm	PAV-Degassing	Reinke

AGENDA  
FHWA Binder ETG  
Sept. 15<sup>th</sup> & 16<sup>th</sup>  
San Antonio, TX

1:00 pm	Low Temperature Pooled Fund	Marasteanu
2:30 pm	Break	
3:00 pm	WRI Fundamental Properties	TBD
4:00 pm	Rap-Up	
4:30 pm	Adjourn	

ATTACHMENT B

ASPHALT BINDER EXPERT TASK GROUP MEMBERS

<p><u>Chairman:</u>  <b>Gaylon Baumgardner</b>          Executive Vice President          Paragon Technical Services, Inc.          2829 Lakeland Drive, Suite 2000          Jackson, MS 39232-7611          Phone: 601-933-3217          Cell: 601-842-3743          Fax: 601-933-3363  <a href="mailto:Gaylon.baumgardner@ptsilab.com">Gaylon.baumgardner@ptsilab.com</a></p>	<p><u>Cochairman:</u>          Vacant</p>
<p><u>Secretary:</u>  <b>John Bukowski</b>          FHWA          Deputy Director HIPT          Federal Highway Administration          400 7<sup>th</sup> Street, SW.          Washington, D.C. 20590          Phone: 202 366-1287          Fax 202-493-2070  <a href="mailto:John.Bukowski@fhwa.dot.gov">John.Bukowski@fhwa.dot.gov</a></p>	
<p><u>Members :</u></p>	
<p><b>Christopher Abadie</b>          Materials Research Engineer          Louisiana DOTD          4101 Gourrier Avenue          Baton Rouge, LA 70808          Phone: 225-767-9109  <a href="mailto:cabadie@dotd.louisiana.gov">cabadie@dotd.louisiana.gov</a></p>	<p><b>Dr. David A. Anderson</b>          Professor Emeritus of Civil Engineering          736 Cornwall Rd.          State College, PA 16803          Phone: 814-237-8585  <a href="mailto:daa@psu.edu">daa@psu.edu</a> or  <a href="mailto:DA.SC@COMCAST.NET">DA.SC@COMCAST.NET</a></p>
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<p><b>Kevin VanFrank</b> Utah Central Labs Utah Department of Transportation Salt Lake City, Utah Phone: 801-633-6264 Fax: 801-964-4417 <a href="mailto:kvanfrank@utah.gov">kvanfrank@utah.gov</a></p>	<p><b>Ludo Zanzotto</b> University of Calgary Faculty of Engineering ENF 262, 2500 Univ. Drive NW Calgary, Alberta AV &amp;2N-1N4 Canada Phone: 403-220-8918 Fax: 403-282-7026 <a href="mailto:zanzotto@ucalgary.ca">zanzotto@ucalgary.ca</a></p>
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<p><b>Edward Harrigan</b> Transportation Research Board 500 5<sup>TH</sup> Street, NW NA 487 Washington, D.C. 20001 202-334-3232 Fax: 334-2006 <a href="mailto:eharrigan@nas.edu">eharrigan@nas.edu</a></p>	<p><b>David E. Newcomb</b> Vice President-Research and Technology National Asphalt Pavement Association 5100 Forbes Boulevard Lanham, MD 20706-4413 301-731-4748 Fax: 731-4621 <a href="mailto:dnewcomb@hotmix.org">dnewcomb@hotmix.org</a></p>

ATTACHMENT C

**ASPHALT BINDER ETG WORKING COMMITTEE MEMBERS**

<b><u>Aging Task Group:</u></b> <ul style="list-style-type: none"><li>• Gayle King</li><li>• Jan Negulescu</li><li>• Gerald Reinke</li><li>• Laurand Lewandowski</li><li>• Jim Barnett</li></ul>	<b><u>Moisture Damage Task Group:</u></b> <ul style="list-style-type: none"><li>• Bob McGennis</li><li>• Ken Gryzbowski</li><li>• Chris Abadie</li><li>• Dean Weitzel</li></ul>
<b><u>Low Temperature Task Group:</u></b> <ul style="list-style-type: none"><li>• Mihai Marasteanu</li><li>• Bob Kluttz</li><li>• Gerald Reinke</li><li>• Jim Barnett</li><li>• Raj Dongre</li><li>• Sang-Soo Kim</li></ul>	<b><u>Modification Task Group:</u></b> <ul style="list-style-type: none"><li>• Laurand Lewandowski</li><li>• Carissa Mooney</li><li>• Mihai Marasteanu</li><li>• Henry Romagosa</li><li>• Mark Buncher</li></ul>
<b><u>Validation Task Group:</u></b> <ul style="list-style-type: none"><li>• Gerald Reinke</li><li>• Mihai Marasteanu</li><li>• Gayle King</li><li>• Henry Romagosa</li><li>• Mark Buncher</li></ul>	<b><u>PPA Best Practice Task Group:</u></b> <ul style="list-style-type: none"><li>• John D'Angelo</li><li>• Terry Arnold</li><li>• Mike Anderson</li><li>• Gayle King</li><li>• Jean-Valery Martin</li><li>• Fran Miknis</li><li>• Olga Puzic</li><li>• Gerald Reinke</li><li>• Henry Romagosa</li></ul>