

FHWA Asphalt Binder Expert Task Group Meeting

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 65 individuals attended the meeting (15 members and 50 visitors) excluding attendees via a webinar. The meeting was held in Raleigh, North Carolina.

ETG Members in Attendance:

Gaylon Baumgardner, Paragon Technical Services (Chairman)
Mike Anderson, Asphalt Institute (Co-Chairman)
John Bukowski, Federal Highway Administration (Secretary)
Chris Abadie, Louisiana Department of Transportation
Dave Anderson, Consultant
Mark Buncher (Liaison), Asphalt Institute
Audrey Copeland (Liaison), National Asphalt Pavement Association
John D'Angelo, Consultant
Darren Hazlett, Texas DOT
Bruce Morgenstern, Wyoming Department of Transportation
Ioan Negulescu, LSU
Jean-Pascal Planche, Western Research Institute
Gerald Reinke, Mathy Construction
Henry Romagosa, ICL Performance Products LP
Geoff Rowe, ABATECH

Meeting Coordinator: Lori Dalton (SME, Inc.)
Technical Report: Harold L. Von Quintus, (ARA, Inc.)

ETG Members Not in Attendance:

Georgene Geary, Georgia Department of Transportation
Edward Harrigan (Liaison), TRB
Gayle King, GHK, Inc.
Mihai Marasteanu, University of Minnesota
Bob McGennis, Holly Frontier Refining & Marketing
Eileen Sheehy, New Jersey DOT

Friends in Attendance:

Howard Anderson, Utah DOT
Tim Aschenbrenner, FHWA-Resource Center
Haleh Azari, AAPRL (AMRL)
Hussain Bahia, Univ. of Wisconsin-Madison
Jason Bausano, MWV
Satish Belagutti, ESC Inc.
Mark Blow, Asphalt Institute
Ramon Bonaquist, Advanced Asphalt Tech.
Ryan Boysen, WRI
Sandy Brown, Asphalt Institute
Steve Burhans, Paramount Petroleum
Matthew Corrigan, FHWA
Codrin Daranga, Blackledge Emulsions
Stacey Diefenderer, Virginia CTIR
Acedil Elwouwui, TA Instruments
Mike Farrar, WRI
Frank Fee, Frank Fee LLC
Lee Gallivan, FHWA
Tejash Gandhi, MWV
John Gilligan, Innophos, Inc.
Mike Harnsberger, WRI
Cassie Hintz, North Carolina State Univ.
Rick Holmgreen, Phillips 66
Bob Horan, Asphalt Institute
Ryan Kirkendall, Troxler

Robert Kluttz, Kraton Polymers
Maria Knake, AASHTO
Tim Kramer, Holly Frontier
Nash Larson, Anton-Paar, USA
Daryl MacLeod, Husky Energy
Ala Mohseni, Consultant
Marissa Mooney, NuStar Asphalt
Madhu Namani, TA Instruments
Chuck Paugh, ESC Inc.
Dan Quire, Wright Asphalt
Donald Siler, Marathon Petroleum Co.
Nilesh Surti, North Carolina DOT/Const.
Hassan Tabatabaee, Univ. Wisconsin-Mad.
Kevin VanFrank, CMETG
Scott Veglahn, Mathy Construction
George Way, RAF
Eric Weaver, FHWA
Pater Wheeler, Anton-Paar, USA
Todd Whittington, North Carolina DOT
Jeff Withee, FHWA
Ludo Zanzotto, Université of Calgary
Habtamu Zelecew, ESC Inc.
Doug Zuberer, Cox and Sons

[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 Task Group members].

DAY 1: Wednesday, 2 May 2013

- 1. Call to Order** – Gaylon Baumgardner (Paragon Technical Services) and Mike Anderson (Asphalt Institute) called the meeting to order at 8:00 AM.

Welcome and Introductions – Chairman Gaylon Baumgardner welcomed all participants to the meeting and noted two sign-in sheets are being distribute, one for the members and the other for friends of the ETG. Members were asked to check their information for accuracy and friends to note their information.

John Bukowski also welcomed all to the meeting, and noted the previous meeting report and agenda for this meeting were distributed to the members via e-mail prior to the meeting.

- 2. Review Agenda/Reports and Action Items from September 2012 Meeting and Technical Section 2b Actions**—John Bukowski (FHWA); Secretary

Review Agenda – Bukowski reviewed the meeting agenda, and asked if there were any changes. None were noted.

Approval of September 2012 Meeting Report – Bukowski commented that no changes or revisions have been received to the previous meeting report as submitted via e-mail to the members.

Review Action Items – Secretary Bukowski summarized the action items from the September 2012 Asphalt Binder ETG meeting. Bukowski also reported Chris Abadie is attending and will be giving a report on updates and results from the SoM meeting later today. The following is a listing and status of the action items from the September 2012 ETG meeting.

1. **ACTION ITEM:** The TP 44 task group will prepare written support and background for the recommended changes to the standard. This includes the rationale for those changes. Bukowski asked Hussain Bahia to produce some additional information on the use of toluene.
UPDATE: Bukowski reported this item is not included on the agenda. Hussain Bahia will be asked for an update on this topic.

2. **ACTION ITEM:** Mike Anderson will prepare a document on the rationale for changing Jnr to use with “S” grade binders. This document will summarize what has been done and what is recommended, which will be submitted to the full ETG for review and comment before the next ETG meeting and possible submission to the SoM for review. Anderson will write up the rationale as a stand-alone procedure for distribution to the ETG for review and comment. This item will be included on the agenda for the next ETG meeting prior to sending it to the SoM.
UPDATE: Action item is on the agenda.

3. **ACTION ITEM:** Mike Anderson will submit to the ETG a draft version of the MSCR recovery standard for evaluating the delayed elastic behavior of asphalt binders. All comments from the ETG will be discussed at the next meeting. Mike Anderson, Bob Kluttz, Gerald Reinke and Matt Corrigan will review the revisions prior to its submittal to the ETG.
UPDATE: Action item is on the agenda.

4. **ACTION ITEM:** The binder thermal cracking task group will review the testing protocol presented by Haifang Wen. Wen will submit it to the task group for review, which will be discussed at the next meeting.
UPDATE: Action item is on the agenda.

5. **ACTION ITEM:** Hussain Bahia will prepare a test protocol for the DSR yield energy test for submittal to the intermediate temperature task group for evaluation.
UPDATE: Action item is on the agenda.

6. ACTION ITEM: The ETG will review the recent TP 101 revisions and considerations given to forward recommended changes to SoM after the spring ETG meeting.
UPDATE: Action item is on the agenda, Hussain Bahia will be giving the report.
7. ACTION ITEM: Bukowski will forward any comments on AASHTO TP 92 ABCD to the ETG for review and information prior to the spring meeting to decide whether the ABCD re commendations should go forward to the SoM based on questions from the SoM regarding the last ballot.
UPDATE: This proposed TP 92 changes will be discussed.
8. ACTION ITEM: Dave Anderson will suggest a list of binders and test fluid to be used in the evaluation of the DSR temperature equilibrium. Potential test labs are from NEAUPG, SEAUPG, and WSTC. Frank Fee was an additional volunteer as well as some western states.
UPDATE: Action item is on the agenda.
9. ACTION ITEM: Dave Anderson will send the revised red-lines to Bukowski by early October. Bukowski will then forward to the ETG for comment. Comments on revised red-lines need to be sent back to Anderson by late October.
UPDATE: Action item is on the agenda. Bukowski reported while he has not received the red-lines, he understands that this work is nearing completion with the exception of a few edits, which will need to be sent out to the members for final review. Bukowski asked Dave Anderson to send him the final red-lines for ETG distribution.
10. ACTION ITEM: WRI asked for feedback from the ETG on information related to the DSR modification for the 4 mm plates in terms of emulsion residue recovery. Gerald Reinke and others asked that samples be provided to them for testing. Their results will be provided to WRI for review and discussion at the next ETG meeting.
UPDATE: Action item is not on the agenda. Bukowski reported work on this topic is continuing.
11. ACTION ITEM: Raul Velasquez will submit the SENB draft test standard to the ETG members for review. Members should review and provide input and comments on the procedure prior to the next meeting. Volunteers for ruggedness testing were requested and further action will be reported at the spring meeting.
UPDATE: Action item is on the agenda.
12. ACTION ITEM: John D'Angelo and Matt Corrigan will prepare the written rationale for proposed MSCR changes to be reviewed by the DSR manufacturers. After the DSR manufacturers review and provide comments, the revised document will then be sent to the entire ETG; specifically focusing on the current tolerances; perceived to be too tight.
UPDATE: Action item is on the agenda.

Bukowski reported another item related to rubber-modified materials is on the agenda. Information was sent to the SoM after the last meeting, and the 2b technical section requested

the ETG to re-consider adding additional wording/clarification. John D'Angelo will discuss the next steps for this topic.

3. Multiple Stress Creep Recovery (MSCR) Task Group Activities

Presentation #1: *Evaluation of Jnr Criteria for Unmodified Asphalt Binder—*
Mike Anderson (Asphalt Institute)

Summary of Presentation:

Mike Anderson reported that he sent the draft report to the ETG members just prior to the meeting. The draft report includes the data he will be reporting on today. He asked the ETG members to review the report and provide comments. Anderson thanked FHWA and others for their support in this effort, specifically: John Bukowski, Michael Arasteh, and the Technical Advisory Committee of the Asphalt Institute.

Anderson started his report with the background on this topic and noted this has been presented in earlier meetings – an evaluation of neat binders. The Jnr value has typically been used for modified mixtures, but is being looked at for use in testing or evaluating neat binders. Anderson summarized the binders that were selected for the study. He reported they were asked to look at adjusting the Jnr value of 4.0 kPa^{-1} . He showed data/analysis for an unmodified binder. He asked if problems would occur if this Jnr value of 4.0 kPa^{-1} criterion is applied to unmodified binders. Anderson discussed the Asphalt Institute MSCR database for unmodified binders. The Asphalt Institute also looked at SHRP binders and had the same results. This led to the purpose of the study, which was: (1) provide additional data to evaluate if the 4.0 kPa^{-1} criterion for unmodified asphalt binders and determine if a change is needed, and (2) evaluate if there is a bias in MSCR results dependent on DSR manufacturer's equipment. He reported 11 DSRs and the SHRP MRL asphalt binders were included in the study. Anderson thanked all labs for participating in the study: PRI Asphalt Technologies, Asphalt Technologies Group, Jebro, Flint Hills Resources, MTE, FHWA, and the Asphalt Institute.

Anderson summarized the testing of the SHRP MRL binders using AASHTO T315 and TP 70. He also explained the procedures used to handle and test the binders. Each lab received cans of RTFO-aged binder; one can was used for TP 70 at each temperature; and the other for T 315 at both temperatures followed by TP 70 at one temperature.

Anderson showed the table included in the draft report. He summarized the analysis, but all the data are included in the report. He started with the table for binder AAA, and explained the reproducibility of the tests. This included the d2s values for each test. Anderson reported they generated a number of graphs that showed the continuous grade temperatures, starting with AAA. He also showed a comparison of T 315 and TP 70 results. Anderson then showed the results for binder AAB. He went through a graphical presentation of the results for each binder, so the attendees could understand the results.

He then presented the results from all labs and MRL binders on one graph. It showed all of the T315 temperatures are lower than from TP 70 with the exception for one data point. Anderson presented a tabular summary of the test results relating to different comparisons.

A summary of the results generally confirmed earlier findings: the Jnr at 3.2 using T 315 = 4.65 kPa^{-1} and $G^*/\sin \delta = 2.52 \text{ kPa}$ using TP 70 where $\text{Jnr } 3.2 = 4.00 \text{ kPa}^{-1}$.

The recommendation based on this evaluation is that AASHTO MP 19 Jnr criterion for “S” graded asphalt binders can be increased to 4.5 kPa^{-1} . Anderson explained this was a mathematical exercise to allow unmodified asphalt binders graded by AASHTO M320 to link directly to MP 19 grading with no change in properties. Anderson explained the practical implication of this recommendation. If one assumes changing the Jnr – 3.2 value by a factor of two changes the rutting performance of the mix by a corresponding factor of two, then the ratio of 4.5 to 4.00 is 1.125 meaning that we can assume rutting will be 12.5 percent more. Anderson stated: in his opinion, this was an insignificant difference in predicted pavement performance.

Anderson then focused on reproducibility. He presented the d2s values; the values shown reflect that the d2s values are reasonable.

The next part of his report was on equipment bias. This was examined at the labs with multiple pieces of equipment. Anderson noted that they assumed all the equipment was properly calibrated and did not have any built in bias. He summarized the results from different labs with multiple DSRs. Their conclusion was that no bias or consistent difference was seen between different DSRs.

Anderson explained the reheat analysis, the effect of reheating the binders from AASHTO T 315 and TP 70. He showed the reheat analysis for the AAB binder. In summary, they found trends and he explained those trends through bar-graphs included in his report. The material does get stiffer as you reheat the sample, but the difference or increase in stiffness is small, so it is difficult to note any statistically difference. Overall, for the reheat analysis, it was concluded that the general trend to higher values of $G^*/\sin \delta$ and lower values for Jnr at 3.2 as samples are reheated.

Bukowski asked for the ETG for any comments or concerns on the recommendation for increasing the Jnr value from 4.0 to 4.5 kPa^{-1} .

Hussain Bahia noted that the master curve for the PG grading system was generated for modified asphalt. He agrees with the recommendation. But was cautious on the effects for moving the limit; will other limits be moved, or is it restricted to 4.5. Chris Abadie noted northeast states are developing information on the impact of this change. Abadie stated there is on-going discussion related to Bahia’s concern on this topic. He supports Bahia's caution, but reported states are moving forward with the change.

D’Angelo reminded the ETG that the effect of this change is small – less than a degree. He considers moving the Jnr limit is a minor correction. This change was more for getting a correlation between different neat asphalts. Darrin Hazlett commented about suppliers having higher values but does not see this as a problem. Mike Anderson and D’Angelo agreed: suppliers do not view this change as significant. Hazlett asked if this is changing the specification to meet production, or should we be changing production to meet the

specification. Bob Kluttz commented essentially you will be getting the same result, and agreed this is a minor correction.

Bukowski again asked if the ETG recommendation is to make a revision to MP 19 increasing the Jnr value for S graded (unmodified) binders from 4.0 to 4.5 kPa⁻¹. This approach received approval from the ETG. He noted that since the ETG agrees, this recommendation will go forward to the SoM.

ACTION ITEM #1: John Bukowski will forward the recommendations and rationale for the Jnr changes in MP19 for unmodified asphalts from 4.0 to 4.5 kPa⁻¹ to the SoM, technical section 2b.

Presentation #2: *MSCR Recovery Procedure: Draft AASHTO Procedure*—Mike Anderson (Asphalt Institute)

Summary of Presentation:

Mike Anderson then overviewed the draft standard practice for the MSCR. He used the red-lined version to overview the changes made. “Delayed” was removed and referred to as elastic behavior. These revisions were considered editorial. Anderson also reported they removed table 1 and explained the addition to section 7.3 was to provide test temperature guidance. Anderson discussed the recovery curve (Jnr at 3.2 versus recovery at 3.2) and explained the value of the curve was cut at 0.1. If you do get a Jnr value at 3.2 less than 0.1, the recovery at 3.2 can be assumed to be 55 percent.

ETG Comments, Questions, and Discussion:

Gaylon Baumgardner asked what reliability level was used? Anderson replied it was 98 percent. Baumgardner believes that should be specified in the standard. D’Angelo commented that typically the temperature for all binder testing is defined at a reliability of 98 percent. D’Angelo explained how the temperature values were determined based on the LTPPBind software. There was disagreement between what LTPPBind 2.1 and 3.1 versions. Sandy Brown’s noted LTPPBind version 3.1 shifts the grade for the entire country. D’Angelo explained what changed between versions 2.1 and 3.1 of LTPPBind. Version 2.1 was based on the average 7 day high temperatures, while version 3.1 is based on temperature degree days. There still was disagreement between how this will impact the binder grades.

Anderson again asked if the 98 percent reliability should be noted in the standard? Frank Fee made a suggestion for rewording the statement, which was to remove “in absence of” and replace with “or”. Baumgardner believes this is mainly an issue for some southeast states. Matt Corrigan explained what was done for determining the test temperature for the flow number test and noted this can affect other testing also that may need to be changed.

Corrigan disagreed with Fee’s suggestion to replace the words “in absence of” with “or” and agrees with the wording currently in the draft. He believes you do not want to give an option.

Bob Klutz is concerned about putting something forward that is different than TP 70; his opinion is the wording used here should be the same as the wording in TP 70. The ETG agreed this should be considered.

Don Siler noted when you look at the map and location using LTPPBind for the actual temperature, the result is a shift up to a different temperature which is an extremely large shift. This will have a significant impact on the asphalt grade. Corrigan's opinion was that while there may be a change that effects only a very few southern locations, this recommendation is needed for a national standard.

Baumgardner agreed with Corrigan's recommendation. In summary, there are three possibilities or test temperatures and unsure which one should be used. D'Angelo suggested that maybe we need to add a line that in some cases the 98 percent reliability throws you into a higher grade, so you might consider in those cases reducing the reliability. Brown believes that LTPPBind version 2.1 was used extensively, but not as much LTPPBind version 3.1. If it is used now, it will have a two grade bump in some areas. Reinke noted that there are implications here that need further discussion. He believes if not understood we could have some users specifying asphalt grades without knowing the effects and some of the standard grades will be erroneously eliminated.

Baumgardner suggested this issue go back to the task group. Ala Mohseni commented that LTPPBind version 3.1 was developed so the reliability could vary and was not fixed. He also noted that you can move the band by changing the rut depth as well as the reliability.

Baumgardner noted that based on the amount of debate and discussion, this issue is not ready to move forward to the SoM. He asked Mike Anderson to forward the revised standard to the ETG. The task group will review and define what are the implications, what additional changes are needed, and this will be discussed at the next meeting.

ACTION ITEM #2: Mike Anderson will circulate to the ETG for comment the proposed changes to the draft procedure for Evaluating the Elastic Recovery of Asphalt Binders Using the MSCR Test and discuss comments and revisions at the next ETG meeting.

4. PAV Aging Temperatures for PG 52-34 and 64-34—Gerald Reinke (Mathy Construction)

Presentation Title: *PAV Aging Temperatures*

Summary of Presentation:

Gerald Reinke gave a verbal report on this topic. Reinke asked what is the test temperature if one examines using between either a 52-34 or 64-34 in a PG 58 climate. He believes the answer to that question is something the ETG should consider. Should the test temperature be 90 or 100 °F. Dave Anderson replied that it should be should be 100 °F. Ludo Zanzotto agreed with Dave Anderson's comment. Remember PAV simulates aging, so there is no difference. Reinke's opinion is this needs further consideration. Reinke asked what in terms

of the MSCR evaluation is the appropriate test temperature for the binders in terms of where they are going to be used. Should we be testing these binders at the Jnr standard grade temperature or the climate in which they are being used.

ETG Comments, Questions, and Discussion:

Sandy Brown noted that the grade you want is at the master temperature, so the answer is test at the environmental temperature. Reinke believes that will not happen and again stated that if we are using PG52 asphalt in a PG58 climate and using the MSCR, the test temperature should not be the climate temperature.

Baumgardner recommended a task group look at MP 53 relative to bumping the grades. Corrigan commented that Eileen Sheehy (SoM technical section 2b chair) is moving the provisional standards to a full standard and is cleaning up some editorial information. We are discussing an additional issue of the standard, so he suggests removing the recommendation on temperature selection and only address the recovery process. The grade bumping and test temperature can then be discussed or included in a specific standard or document. The current ones only address the recovery process.

ACTION ITEM #3: Matt Corrigan (lead) and task group members (Gerald Reinke and Mike Anderson) will develop wording for grade bumping recommendations and associated PAV temperatures and distribute to the ETG for discussion at the next ETG meeting.

5. Task Group Recommendations; Binder Thermal Cracking Test—Haifang Wen
(Washington State University)

Presentation Title: *Updates on DSR Thermal Cracking Test (DTCT)*

Summary of Presentation:

Haifang Wen reported on the status of the DSR thermal cracking test protocol. He acknowledged the members of this task group, including: Mike Anderson, Dave Anderson, Gayle King, Ioan Negulescu, Jean-Pascal Planche, Geoff Rowe, and himself.

Wen presented an overview of the test protocol that was evaluated. He reported the time to reach temperature equilibrium was 5 °C and the duration of the test only takes a few minutes. He also referred back to what he had presented in previous meetings as a summary because it has been over a year since the last presentation of this topic. This included an overview of the draft test protocol.

The next part of Wen's report was to overview comments received on the test protocol and report on how those comments have been addressed.

- Comment on test temperature, selecting 5°C as the single measurement temperature might not be universally relevant, because different binders will be in different physical states, depending on how far 5°C is from T_g. Some binders will be very ductile, while others will be fragile. A single point measurement might not allow

- predicting the real thermal cracking behavior. Wen reported they changed the test temperature to be 5°C or lower.
- Comment on reproducibility/variability of the protocol. Wen reported the coefficient of variation (COV) of 5 percent or less. It is fairly repeatable assuming you are using the procedure outlined in the draft test protocol.
 - Comment on water bath, allow the use of any type of rheometer capable of adequate temperature control at 5°C or lower. This recommendation has now been added.
 - Comment, “trial and error” process should be used to select the shear rate and provide guidance on what to be used. Wen provided a table of shear strain rate ranges applicable for high temperatures of different binder grades. This table will be included in the standard.
 - Is the spindle stiff enough to neglect its compliance issue for testing at 5°C? Wen reported they made a recommendation in that the DSR can self-correct for compliance. However, the failure strain is substantially larger than steel compliance, and that could be an issue at much lower test temperatures. This needs further investigation; the lower the test temperature could increase the error.
 - Comment, effect of epoxy on stress/strain relationship. Wen showed the relationship between frequency and shear modulus for different epoxies, both with and without epoxy. The results show minimal effects of the epoxy. He reported there were no significant effects.
 - Comment, in test preparation, the sample is loaded and the gap is zeroed at 50°C, but the test is conducted at 5°C. So for the 50°C temperature, the gap needs to be corrected according to the thermal expansion coefficient of the spindle. Wen reported the gap is zeroed at the test temperature, and the normal force is checked.
 - Questions, why are we using the 4 mm plate, and can this test be run right after running the specification testing like for the MSCR? Wen does not see an issue with this comment. Wen noted the reason for the 4 mm plate is to reduce the torque needed and other tests can be run on this setup.
 - Question, why use the 1.75 mm gap and did the standard gap not work? Wen reported it possibly would work, but he had evaluated and selected the 1.75 mm gap.
 - Comment, epoxy is not defined in the procedure. Wen reported that it is now included in the test protocol.
 - Question, what is the purpose of the epoxy. Wen reported, for better adhesion.
 - Question, how thick should the layer be? Wen reported it is now defined in the test protocol.

- Question, how many data points, and what is the sampling interval needed to get a good result? Wen reported they looked at 2 points per second.

The last part of Wen's report was on the status of the test protocol. The protocol was revised based on the comments received and the protocol has been resubmitted back to the ETG. The future action items for the task group are to try to lower the test temperature to the T_g temperature, and find more binders that exhibit thermal and block cracking. Wen requested anyone wanting to work with them on this task group or if anyone has available materials used on pavements that exhibit thermal and block cracking to contact him.

ETG Comments, Questions, and Discussion:

D'Angelo asked what is the recommendation to run the test at a lower temperature, since in the test procedure this needs to be specified. Wen answered that they started at 5 °C, but cannot state a final value at this time.

Dave Anderson believes you have to use a rheometer that has an air bath and not a fluid. Wen agreed with that comment. Anderson noted the fluid affects the fracture properties of the binder so you cannot use a fluid. Wen agreed with Anderson but noted that requires a more costly equipment investment. Anderson suggested continuously monitoring the normal forces throughout the test and until you can do that, you cannot use this procedure. Anderson's opinion is just because the normal stress is zero does not imply that the stress in the specimen is zero. Vertical normal stress is the only value we can really measure, but stresses are 3 dimensional and the horizontal stress is important in the specimen. He believes that the only way this test is valid is to run it at a lower test temperature because you cannot extrapolate to lower temperatures unless you know the time-temperature shift or superposition. Wen explained the time-temperature superposition for this test did work. Anderson suggested Wen re-evaluate this finding.

Baumgardner agreed with Dave Anderson that more work needs to be done. Since the ETG just received the draft test protocol, he asked the ETG to review the protocol and provide comments back to Haifang Wen. This will be on the agenda for the next meeting.

ACTION ITEM #4: ETG members are asked to review the draft procedure for Binder Thermal Cracking and provide comments back to Haifang Wen prior to the next meeting.

6. Intermediate Temperature Task Group Activities—Mike Anderson (Asphalt Institute)

Presentation Title: *Intermediate Temperature Parameter for PG Asphalt Binders*

Summary of Presentation:

Mike Anderson updated on the intermediate temperature parameter task group activities. He started his report by acknowledging members of the task group. The individuals that participated in the testing included: Mike Anderson (the task group leader), Dave Anderson,

Hussain Bahia, Gaylon Baumgardner, Gayle King, Bob McGennis, Jean-Pascal Planche, Gerald Reinke, Geoff Rowe, and Hassan Tabatabaee.

The purpose of the task group is to evaluate the existing intermediate temperature parameter and criterion in AASHTO M320 and MP19, and if necessary, revise and/or develop one or more parameters that:

- Do not require more testing than the current intermediate temperature parameter $G^*\sin\delta$ determined using AASHTO T315.
- Have reproducibility at least comparable to but better than the d_2s values for the current intermediate temperature parameter.
- Are related to the rheological and failure properties of the asphalt binder at intermediate temperature.

Anderson overviewed the materials included in the test program, which were grouped into three areas: (1) the old conventional binders or the SHRP MRL binders that were used in developing the current PAV DSR parameters; (2) new conventional materials based on current production representing a cross section of binders in the U.S; and (3) new unconventional binders that were suggested and formulated by Bob McGennis to represent binder with unusual intermediate temperature responses. Anderson described the type of binders used within each of the three categories and the tests conducted on each of the binders. Not all testing has been completed. He focused his presentation more on explaining the new unconventional binders selected for the evaluation. There is a soft and hard component of the binder within this group. Anderson noted they wanted to look at binders that are “m” and “s” controlled and determine what impact that has on the final results.

Anderson provided a summary of the binder testing program and the organizations doing specific activities. These include the binder testing with aging and all aging via the PAV will be done at the Asphalt Institute; the chemical analysis will be completed by Gerald Reinke and WRI (Planche); the DSC test will also be done by WRI; and the BBR tests to determine a continuous grade of the binders will be performed by the Asphalt Institute; the Asphalt Institute will also do the DENT test. In terms of DSR testing; Baumgardner will perform the temperature-frequency sweep test from 5°C to the high PG temperature, Reinke and Planche will use the 4-mm parallel plates, Anderson and Bahia will do the LAS test, Baumgardner will base the continuous grade on $G^*\sin\delta$ using values from 2,000 to 8,000 kPa, Reinke will do the torsion bar testing, and Anderson and Wen will do the monotonic tests.

Anderson discussed the data collected to date. He started with a graphical presentation of the mix fatigue life as a function of binder property, including:

- Low strain, which is the LAS versus fatigue life at 4 percent air voids.
- $G^*\sin\delta$ versus fatigue life at 4 percent voids.

He also showed the data collected to date for the higher strain level, and mentioned whether the trend was in the right direction in terms of correlations between the test results. Most data comparisons exhibited a relationship in the “right” direction. Comparing different temperatures and aging conditions – the trend is in the right direction. Anderson reported the intercept and slope are both changing between the two conditions (temperature and aging).

He also mentioned some of the comparisons are more definitive with different asphalts. Anderson then focused his report on presenting the results for the different binders that have been tested to date.

Anderson summarized the results measured to date and provided his reasoning on why two parameters are needed. He presented two graphs comparing $G^*/\tan \delta$ and LAS results at PAV-15°C and PAV-25°C. He reported one of the data points was significantly different than the bulk of the data, so in his opinion, we might need two parameters to explain these results. Anderson showed a comparison between ΔT (temperature difference) versus the slope from the linear amplitude sweep test and reported the relationship is reasonable.

Anderson concluded his report by listing the next steps of the task group, which include; continuing to evaluate the old conventional binders for the 4 mm PP DSR, torsion bar, DSC and LAS, begin evaluation of new conventional binders, and selection of new unconventional binders for evaluation.

ETG Comments, Questions, and Discussion:

John D'Angelo noted his concern that most polymer modified asphalts (PMA) have a high ΔT , but we are not looking at that parameter. In addition, what do we do if PMA is shown to be bad in terms of the test results, when we know PMA binders can result in good performance. Mike Anderson agreed with that comment and explained they will be looking at PMA. D'Angelo commented that ΔT_c is okay, but in his opinion, the change in the ΔT_g rather than ΔT_c will be more important. Mike Anderson agreed, but in his opinion, it will be both. That is why more than one parameter needs to be considered in answering some of the questions about durability, cracking, and intermediate temperatures.

D'Angelo asked why the group is not evaluating some of the temperature-frequency parameters, not necessarily over the entire spectra, but just over a short range? Mike Anderson agreed with that comment about needing to look at some of the other temperature-frequency parameters, but right now they are need to focus on the current efforts.

ACTION ITEM #5: Mike Anderson and Task Group on Intermediate Temperature will continue to evaluate old conventional binders, begin evaluating new conventional and unconventional binders, and report on the analysis at the next meeting.

7. Asphalt Rubber Modifier Update—John D'Angelo (D'Angelo Consulting)

Presentation Title: *Asphalt Rubber Modifier Update – AASHTO Subcommittee on Materials*

Summary of Presentation:

John D'Angelo started his report by noting this presentation is based on comments from the AASHTO SoM meeting held on August 2012 in Biloxi, Mississippi. His report was to update the ETG on the results from the last ballot on this topic. He first identified the ballot negatives and the plan for moving the GTR specifications forward. The specification will need to be revised and resubmitted to the ETG. Also, under development is a new geometry

to test larger GTR size materials – work is continuing with the expected procedure in the near future.

- Implement PG GTR for fine mesh now with AASHTO specifications; D’Angelo reported that testing completed demonstrates that 30 mesh works in a 2 mm gap parallel plate. Thus, need to modify M320, MP 19 and T 315 to test 2 mm gap and GTR. For T 315 DSR adjustments, the only suggested change was to change the statement for the 25 mm plate with a 1 or 2 mm gap, and allow up to 600 micron particle size or a quarter of the gap size. There were five negative SoM votes so changes did not pass the SoM ballot. Reasons for the negatives were related to the gap size, and precision and bias of a 2 mm gap. One suggestion was to complete all 2 mm testing and rewrite as a separate test standard. D’Angelo’s opinion is that should be able to keep T 315 with changes to address the concerns from the ballot. Bukowski mentioned a SoM survey indicated that agencies were evenly divided whether to change the current standard to accommodate rubber modified binder or to create a separate specification. Chris Abadie asked if the ETG was going to resubmit a recommendation to the fall SoM. D’Angelo believes it can be resubmitted soon. Henry Romagosa asked about the 600 micron size in terms of particle size distribution and if that would be important. D’Angelo replied this can be tested with the 2 mm gap and Romagosa agreed with that response.
- Proposed changes for T 44-03 “Solubility of Bituminous Materials”; multiple changes were suggested in the test standard. However, none of the ETG recommended changes were discussed/approved by SoM. D’Angelo reported more discussion is needed in the technical section 2b for this to move forward in the SoM.
- Variability of Jnr cycle to cycle changed in TP 70; the recommended change was accepted and passed the December ballot, but other parts of TP 70 were not on the December ballot, so this will need to be resubmitted. The negative percent recovery statement was not included in the December ballot, as well as the stress sensitivity statement added to MP 19.

The next part of D’Angelo’s report focused on the Cup & Bob (CB). He showed some comparisons of geometries for the DSR high temperature grades using a PG64-22 and PG70-22 (PG64-22 plus PPA) binders. The continued work under this topic includes: testing 2 mm PP & CB for different sizes and percentages of mesh rubber particles, and mix testing to generate the master curves for slivers, three stresses for creep recovery testing, three stresses for fatigue testing at 10 Hz oscillatory, BBR mix slivers, and Hamburg rut testing. D’Angelo reported they started seeing significant differences at the intermediate temperatures between using the new and current equipment corrections. D’Angelo stated they are still waiting on some of the revised results. One issue is related to testing equipment compliance for adjusting the phase angle and in calibrating the machine results. Other issues identified that there is no approach for correcting phase angle due to compliance at the present time, and errors resulting from high variation in properties measured from high to low temperatures are likely due to other factors in addition to testing equipment compliance.

D'Angelo then discussed the difference between the PG and MSCR grading systems. He showed some examples which demonstrated that the binders grade the same under the PG system, but there is almost one full grade difference when using the MSCR system. Thus, there is a significant difference between the two grading systems.

The final part of D'Angelo's report listed the next steps for this task group. Those steps are to resubmit the specifications and complete a small round robin experiment to establish precision and bias for the 2 mm DSR gap.

ETG Comments, Questions, and Discussion:

Matt Corrigan commented that in his opinion and from the SoM discussions, the reason for the negatives is there was insufficient data and rationale to explain the changes and define why the change is needed. The SoM was asking for more guidance/rationale for using rubber and to know how these changes will affect other binder materials. Kevin VanFrank noted he would like to see a specification that is blind to modification. If rubber leads to a secondary specification, then an agency will need choose what binder modifier to specify.

Chris Abadie commented that they are testing rubber with the DSR and given the timing relative to the ballot, he suggests editing changes, but keeping within M 320, MP 19, and T 44, and resubmit to the technical section 2b ballot to keep things moving forward.

It was decided to move forward on the T44 solubility and modify the suggested wording relative to rubber in the current standards and submit to the SoM for their discussion/ballot. The results from this new SoM balloting will guide any further ETG action on this issue.

Hussain Bahia was asked to add additional rationale for changes to T 44. Bahia showed the language in the specification that is going forward to the SoM. D'Angelo disagreed and stated; that wording is what the SoM did not like – the use of “other” regarding ASTM D5546. Putting the word “other” without more clarification is what initiated the negative. Bahia commented this is not a specification it is only a test procedure that distinguishes between rubber asphalt binders. Dave Anderson asked when do you determine what the material is, before or after the test? Bahia replied after the solubility test. Anderson suggested the word “should” needs to be deleted, you cannot use conditional wording in a test procedure. It needs to state “shall.” Similarly, take the word “most” out of paragraph 1.3. Reinke noted this procedure only tells us how to test the material, not whether it is to be used or rejected. Bahia also referred to the section Bob McGennis revised in this same context, which was paragraph 4.1.6 regarding the filter paper. Baumgardner noted in paragraph 1.3, it should be “ground” tire rubber; remove word “grind. Bahia said he will make these modifications and send it back to Bukowski.

Matt Corrigan asked if we are adding a commentary to the test standard. Bukowski agreed with Corrigan about adding additional commentary when it is submitted.

ACTION ITEM #6: John D'Angelo will provide additional input/comments on the GTR related changes to M320, MP19, and T315. Hussain Bahia will edit T44 to incorporate changes in paragraphs 1.3 and 1.4 and provide to Bukowski for re-submission to the SoM 2b.

8. Single Edge Notched Beam Procedure—Hassan Tabatabaee (University of Wisconsin at Madison)

Presentation Title: *Single Edge Notched Bending Test for Binder Low Temperature Characterization*

Summary of Presentation:

Hassan Tabatabaee started his report by overviewing previously presented information. This was the draft test standard for the single edge notched beam (SENB) procedure for thermal cracking susceptibility of binders. Tabatabaee compared how the SENB fits in with the other binder tests. Thermal cracking of pavements remains one of the most challenging distresses in pavements to predict.

Tabatabaee reviewed the other PG testing methods for low temperature cracking, including the BBR (creep stiffness and relaxation parameter or m-value) and direct tension test (strain tolerance). Tabatabaee provided some background information on this topic in comparison to some of the other tests. This included an explanation of the mechanism for thermal cracking and how it is impacted by binders. He also reviewed the need for a system that is simple and effective in measuring fracture properties. Tabatabaee reviewed some of the other fracture tension tests, the research that has been completed, and identified some of the issues with each test. He noted there has been extensive research using the SENB, so it is not new. He also summarized the motivation for development of the BBR-SENB and identifying the advantages for combining these two test geometries.

Tabatabaee discussed the equipment changes for improving the test. As an example, they added a step motor and used a load cell with a higher load capacity. He emphasized they did not do anything really new to the test specimen, they just added notches to the specimens. Tabatabaee explained the different modification they made in creating the notches in the samples and in placing the test specimen in the device. He showed some examples of the test being able to differentiate between different binders.

The next part of Tabatabaee's report was on their verification study being planned and the materials that are currently included in the study. As part of this verification, he showed a comparison of the BBR and BBR-SENB. Tabatabaee reported they are not trying to replace the BBR, but only to compliment the BBR for evaluating modified asphalts. He presented multiple comparisons. The important point of the comparisons is the BBR m-value and s-value limits fail to distinguish between binders demonstrating low to high values of failure energy. Data for all of these comparisons were measured on PAV aged binders.

Tabatabaee then showed some comparisons between the binder and mixture test results: BBR-SENB versus mixture testing on materials used at MnRoads and included in the pool fund study. The specific comparison included in his report was between the SCB and BBR-SENB. Tabatabaee reported there was a good correlation between the two. The next comparison was between Gf of the binder and Gf of the mixture.

Tabatabaee then turned the focus of his report to field performance in comparison to the testing of binders under evaluation. Two binders used in Minnesota had similar Gf but much different deflection versus force, as compared to the amount of cracking. In addition, results from four LTPP test sections were used and compared in terms of deflection versus force for different amounts of cracking. A comparison of the actual cracking and tests showed promising results.

Tabatabaee then summarized the findings from his work:

- Binders of the same low PG can have significantly different failure energy and deflection at fracture values measured at the grade temperature.
- Fracture properties of asphalt mixtures are highly influenced by fracture properties of the binders.
- Binders with high strain tolerance perform better in the field.
- BBR-SENB is a good compliment to BBR as it can measure damage resistance behavior and strain tolerance of binders in brittle condition.
- BBR-SENB test is a relatively simple that can be carried out in a time frame similar to current BBR test.

Tabatabaee asked for comments back from the ETG on the draft test standard previously submitted. Tabatabaee summarized the proposed ruggedness testing plan, which included; deflection rate, notch depth, test temperature, and demolding temperature. The binder types will include neat RTFO, neat RTFO+PAV, polymer modified RTFO, and polymer modified RTFO+PAV. The ruggedness plan for the BBR setup remained unchanged from the previous plan. Tabatabaee acknowledged the efforts of the ARC, Dr. Raul Velasquez, Mihai Marasteanu, and others.

ETG Comments, Questions, and Discussion:

Kevin VanFrank asked what COV has been measured. Tabatabaee replied the COV values varied for different parameters, but in general they see very good repeatability with COV values less than 15 percent. VanFrank's commented that the direct tension test has been criticized because of large COV values. Tabatabaee believes with the ruggedness test, this will be better defined.

Dave Anderson asked what media was used; Tabatabaee answered ethanol. Anderson referred to past effort that Raj Dongre did many years ago regarding the use of ethanol. Tabatabaee commented they did not see a big difference in variability and the ranking did not change between the different media used in the test. Even if the data are shifted because of the fluid, the ranking will remain the same. Dave Anderson questioned the validity of this test procedure, and the assumption of linear viscoelasticity, which he maintains is being violated. Tabatabaee explained they are not calling this fracture energy; they are calling it failure energy and explained why that definition was important. Anderson asked at what temperature is the test performed. Tabatabaee responded the test is at the closest temperature to the glass transition temperature. Anderson suggested a need to review the fundamentals of the test procedure before it leaves the ETG. Anderson also suggested the resolution of the equipment be confirmed.

Sandy Brown asked how is the notch formed. Tabatabaee illustrated during his presentation how the notch is formed. The asphalt binder to be tested is poured around the notch. Brown suggested, that pouring the binder around a notch is in his opinion not a true notch.

D'Angelo commented while it is suggested that this is a compliment to the BBR test, he does not see how it will be used. D'Angelo suggested you need to consider how all of this ties together before it moves forward. Tabatabaee agreed that is a good question, and stated it will be taken into consideration.

Tabatabaee plans to continue with the ruggedness test, analysis the type of fluid and its effect on the test results, and examine the test in relation to the BBR. Volunteers for the review task group include Dave Anderson, John D'Angelo, and Sandy Brown.

ACTION ITEM #7: Hassan Tabatabaee will continue to analyze the SENB procedure and report at the next ETG meeting. Additionally, it is requested he provide information on how this procedure is intended to be used with the current binder grading specification and tests.

9. Task Group Report on Elastic Recovery/BYE—Hussain Habia (University of Wisconsin at Madison)

Presentation Title: *Elastic Recovery/BYE Procedure*

Summary of Presentation:

Hussain Bahia reported on the yield energy test and Hassan Tabatabaee will report on the LAS test, as part of the next topic. Bahia's report focused on both extensional and non-extensional tests. Extensional tests include the ductility and forced ductility tests, while the non-extensional tests include the BBR, SENB and Torsional DSR tests. The focus of his report is to define the differences and how they apply to the specifications. He reviewed the failure mechanics of both types of tests and gave his opinions on why we are discussing these differences. Measuring asphalt binder yield energy and elastic recovery can provide more fundamental properties in evaluating fracture or failure in terms of cracking. Bahia noted that Tabatabaee just explained what they are doing for the BBR-SENB and he will discuss what they are doing for the yield energy test.

Bahia summarized some of the reasons why we should be moving away from the extensional rheology tests for measuring failure. He referred to necking and its importance in the extensional tests because of the change in cross sectional area and geometry during the test. Bahia noted the correlation between the test results and performance tests. Bahia summarized his conclusions for this part of the report:

- Testing asphalt at 4 to 15°C does not cause fracture.
- Asphalt extensional testing does not satisfy requirements well known to make tests meaningful.
- Special conditions are needed to perform meaningful extensional tests and taking into account the necking during testing.

Bahia's opinion to resolve the above and in getting the real ductility is the binder yield energy test (BYET), which started the second part of his report.

The next part of Bahia's report was on the revised draft procedure for the BYET. He reported two procedures are described in the document, but noted we need to look at what we are doing so that we do not end up with another so called ductility test that will not correlate to field performance. Bahia reported on the interpretation of the test data and in showing the difference in the results from the BYET for significantly different binders – neat versus modified binders. Two energy parameters are calculated from the BYET: yield work which is the area under the shear strain versus shear stress relationship up to peak shear stress, and total work which is the area under peak load up to equivalent maximum ductility stroke.

The next part of this report was a review of the stress state of binder in the pavement and how that relates to the multi-axial stress state in the BYET sample. Bahia reported the BYET provides multi axial stress state and has normal and shear stress components which are believed to more realistic to the stresses that occur in the pavement. He defined why a normal force is formed in the sample and that the BYET can differentiate between different binders through modification and cross-linking.

Bahia's report then focused on the difference in results between the ductility bath versus BYET test. Bahia acknowledged some of the testing was done in Mathy Construction's laboratory and thanked them for their participation and support. There are mixed results but he believes the BYET clearly distinguished between the materials, unlike the ductility results. From these results and comparisons, Bahia reported the BYET results are more closely related to field performance. However, Bahia also reported the comparisons were done with very limited data and there is scatter in the data.

Bahia's concluding remarks were focused in three areas, in summary: (1) there are serious problems with the extensional tests including the ductility, force ductility, and DENT; (2) the serious problems can be overcome using the BYET to replace ductility – constant strain rate is used, much better repeatability is obtained, good discrimination between binder in terms of performance, simpler and available device with better control of the test conditions; but (3) challenges do exist that need to be overcome; as an example – correlation to performance needs to be improved and specification for test limits need to be developed.

ETG Comments, Questions, and Discussion:

Reinke asked did you hold the normal force constant, and if so, what happens to the shear stress. Bahia replied it was not held constant, because it will vary with materials.

Ala Mohseni asked, what is the purpose of the test, why is it being used? Bahia commented that the ductility, forced ductility, and DENT tests are not correct and there are specifications based on these tests. Hopefully, the BYET test will replace those tests.

Dave Anderson asked if it is assumed that the cross section does not change in the test; Bahia replied the cross section remains the same.

Bahia would like to move this procedure to the SoM. D'Angelo commented there are still a lot of issues in terms of what temperatures that should be used and other items. While this standard can be sent directly to the SoM without an ETG recommendation, based on these discussions the ETG does not have a recommendation at this time.

Frank Fee asked if any other lab has performed this test. Reinke commented that he has performed the test, and believes it is ready for SoM consideration.

Mike Anderson noted the ETG members need to provide written comments to Bahia regarding their concerns. Bahia closed the discussion by noting that this is an ARC contract objective and deliverable; he is required to deliver an AASHTO type draft standard to the ETG. Bahia's opinion, the data clearly show that the draft test standard being recommended is much better than what we have today in terms of the ductility and forced ductility tests.

ACTION ITEM #8: ETG members are requested to review and provide additional comments to Hussain Bahia on the draft BYE/Elastic Recovery procedure, and particularly how it is intended to be used to evaluate binders. This item will be discussed at the next ETG meeting and any potential recommendations to the SoM.

10. Summary of LAS Test TP 101 Proposed Changes—Hussain Bahia and Hassan Tabatabaee (University of Wisconsin at Madison)

Presentation Title: *LAS Multi-Laboratory Ruggedness Testing Results and Review of Proposed Changes to TP 101*

Summary of Presentation:

Hassan Tabatabaee reported on the changes made to the LAS test procedure or TP 101. These changes were based on feedback from the ETG users.

- Delamination of stiff binders from spindle plates. Tabatabaee reported they increased the recommended sample loading temperature.
- Difficulty achieving target step strain value. The “stepped” strain sweep was changed to a continuous strain sweep.
- Simpler failure index or damage tolerance. The crack based failure index was defined and there are two options that can be used: (1) the terms A and B and the VECD are used to calculate N_f or (2) the damage tolerance index is used.

Tabatabaee reviewed the test procedures and discussed how the test results are used. The test is a two part procedure: the first part is rheology as measured through the frequency sweep and the second part is damage resistance as measured by a continuous amplitude sweep. The LAS damage tolerance index is based on a minimum value preceding rapid crack growth (the rapid increase in crack propagation).

The second part of Tabatabaee's report was a summary of the multi-laboratory ruggedness test program for the LAS test. He acknowledged the laboratories participating in the ruggedness, including: the Asphalt Institute, FHWA Turner-Fairbanks, MTE Laboratories,

North Carolina State University, University of Wisconsin, and Utah DOT. Four rheometers are being used in the ruggedness test plan: Anton Paar Smartpave, TA ARES, TA Discovery Hybrid 3, and Malvern Kinexus. Data from five of the six laboratories has been received and analyzed.

Tabatabaee reported the previous round of ruggedness testing showed test procedure to be rugged regarding effect of temperature fluctuation and frequency sweep strain. Thus, the current ruggedness plan includes the following factors: sample loading temperatures, strain amplitude, frequency accuracy, and sample placement method (pallet and pour). Tabatabaee overviewed the procedures used, the design of the ruggedness, and an analysis of the results submitted to date. All labs received three binder conditions for a total of 24 conditions for each binder. The ruggedness test plan was designed and the analysis performed in accordance with ASTM E 1169-12a. Factors with p-values more than 0.05 or 95 percent reliability was found to be rugged. The repeatability of the test was good, as well as the overall reproducibility. They showed good comparison between the COV values to those from the $G^*/\sin \delta$ COV. Tabatabaee summarized the results for each binder. Frequency was the only factor found to be non-rugged, so they revised the procedure to make sure the frequency is held very close to the target value.

The final part of Tabatabaee's report was to present their observations on test quality and the next steps to be completed. The conclusions were; (1) LAS is rugged for loading temperature, strain amplitude, and sample type, (2) Nf was not rugged for 5 percent variation of frequency, (3) a minimum value preceding rapid crack growth was found to be very consistent, repeatable, and rugged; and is the most sensitive to variation of the experimental factors.

Tabatabaee listed the next steps to be taken; (1) decide on analysis procedure to use for the final specification, (2) finalize method for determination of a minimum value preceding rapid crack growth, and (3) finalize TP 101 with any modifications. Tabatabaee ended his report by thanking the sponsors for this work. The ARC sponsored the work, which was funded by FHWA through WRI. He again acknowledged the participating laboratories in the ruggedness test plan.

ETG Comments, Questions, and Discussion:

Dave Anderson asked at what stiffness value is the test run to get G^* . Tabatabaee noted most were at an idle stiffness value, but they do not have any recommendation right now. Anderson suggestion is the need to consider what value is used as this test is improved. Anderson also suggested to determine whether the test is valid at much lower temperatures; and the allowable range for running the test needs to be validated. Tabatabaee agreed with the comment and suggestions.

ACTION ITEM #9: Hassan Tabatabaee will continue with the ruggedness of the LAS TP101 and provide potential revisions to be discussed at the next meeting.

11. Update on Asphalt Miniature Testing—Mike Farrar (Western Research Institute)

Presentation Title: *4-mm DSR Ruggedness Testing*

Summary of Presentation:

Mike Farrar reported on the ruggedness test plan that has been prepared for the 4-mm DSR. He overviewed the 4-mm DSR test. He acknowledged the current 4-mm DSR technical working group (Dave Anderson, Mike Anderson, Gerald Reinke, Geoff Rowe, Jean-Pascal Planche, and Qian Qin), and identified new members of the groups consisting of rheometer manufacturers (Malvern Instruments, TA Instruments, and Anton Paar), as well as two State DOT representatives. Farrar reported one of the items excluded from consideration in the past effort was machine compliance. However, they now have a method that corrects for machine compliance, so it is being included in the current ruggedness plan.

D'Angelo asked whether the sample is bonded to the plate. Farrar replied, yes and explained how it becomes bonded to the plate. This bond relates to the adhesion, which will be explained later on in the presentation.

Farrar reported the draft method was completed in December 2012, and is now being used in Europe, Canada, China, and other areas. The next steps in the process for gaining acceptance are to execute the ruggedness and round-robin testing.

As part of his report, Farrar reviewed the ruggedness testing plan that was prepared in accordance with ASTM E 1169. The test variables include: loading and trimming, high trimming temperature, roughened plate surface, cooling rate, temperature, normal force, and order of the frequency sweeps. Farrar mentioned when you drop the temperature below 0° C, the normal force becomes very high and can tear the sample from the platen, so the procedure includes a method for keeping the normal force near 0° C. Farrar stated a description of the test method is included in a technician manual as well as in a training video. Equipment effects between different rheometers, as well as a round robin pilot study consisting using three to four laboratories and one material will be initially completed. In addition, the instrument compliance measurement including the normal force, glue versus ice, glue versus solid rod, and aluminum versus steel will be considered as part of the testing plan. The last items mentioned that will have an impact on the test standard were the time to equilibrium and physical hardening.

Farrar reiterated the time to reach temperature equilibrium is really important to reduce the time to run the test between frequencies; any reduction in time to reach equilibrium will be a tremendous time savings.

Farrar continued his report by explaining some of the reasons for expediting this work in terms of 4-mm DSR spin-offs. The ruggedness testing will probably start in the summer of 2013 and is designed as a one year study.

The next part of Farrar's report was on low and intermediate test temperatures for asphalt, modified binder, emulsion residue, and crack sealant. He reviewed the specifications of AASHTO T 313, R 49-09, emulsion residue, and crack sealant for measuring the properties using the 4-mm DSR. He also mentioned the test method can be used for measuring the in place properties of other materials. Farrar then explained and reviewed the equipment used

for sampling the material - hammer drill for rapid sampling and recovery and micro-extraction. He identified the main advantage of the 4-mm DSR is an alternative to the BBR. Farrar also reviewed the universal simple aging test (USAT) which is being used for emulsion residue recovery and aging.

In conclusion, Farrar maintains the 4-mm DSR is a breakthrough technology – it is an alternative to the BBR, and has numerous applications. Applications for its use include; low and intermediate temperature rheology, micro-sampling and extraction, universal simple aging test, critical cracking temperature in accordance with AASHTO R49-09, and crack sealant.

12. Presentation of SAR-AD—Ryan Boysen, John Schabron, & Jean-Pascal Planche (WRI)

Presentation Title: *Automated Combined Saturates, Aromatics, Resins and Asphaltene Determinator (SAR-AD) Separation and Applications*

Summary of Presentation:

Ryan Boysen acknowledged the individuals and sponsors of the work which included: the Department of Energy, oil companies, and the FHWA – the sponsor for the SAR-AD development. Jack Youtcheff was the lead from FHWA.

Boysen gave the background on this topic in terms of asphalt – oil chemical complexity. SARA separation in generic fractions is based on solubility and chromatography, but there are shortcomings of SARA separation and includes: it is arbitrary, lengthy, has poor reproducibility, and poor correlations with other asphalt properties. Boysen noted there is a need for a relevant, quick, and reproducible method. The majority of Boysen's report was on the development and use of the SAR-AD.

The next part of his report was on the WRI Asphaltene Determinator development and was noted as Phase 1. AD is a solubility based separator and Boysen explained the process. He also showed a typical output from the test. The Asphaltene is separated into 3 fractions and the area under the peaks is equivalent to the amount of material. There are two calculated parameters, ADAIR (aromatization of naphthenes) and TPA (total pericondensed aromatics). Boysen showed the results from the accelerated load facility sample in terms of area percent AD heptane insoluble. He reported they found lab PAV aging does not appear as the aged material, so PAV does not predict field aging.

The next part of the report was on Phase II or the combined SAR-AD separation. This is a rapid evaluation of asphalts and heavy oils. It evaluates materials and changes in those materials with aging and processing. Boysen explained the process consisting of whole oil injected with repeat injections that are possible in using four columns: ground PTFE, glass beads, aminopropyl silica, and activated silica. About 4 to 5 samples can be run in a day. Boysen showed and explained some SAR-AD output. The percentage of area under each peak is related to the percent of total amount of material within the binder. Boysen showed the SAR-AD data from FHWA ALF original binders and from core slices. He reported this is a powerful tool to track oxidative aging binder changes. The next summary of data

showed how the material changes with aging. Boysen presented data related to the automated SAR-AD aging index as a predictor of the master curve parameters for the binder. Aging ratios of oven aged binders were also discussed. The aging index can be used as a predictor of the cross over frequency, but the slope and intercept are not universal.

Boysen also showed SAR-AD data for the FHWA ALF PG70-22 and concluded the system shows significant changes in composition due to process and modification. His opinion is that this also can be used on modified asphalts. He also showed data for PPA modified binders and reported the resins become toluene asphaltenes after PPA modification.

The last part of Boysen's report was a summary of results and what are some of the potential applications of this technology. In summary, WRI has developed a series of new separation techniques (asphaltene determinator and SAR-AD, separation of asphaltenes into good versus bad actors, it is small-fast-reproducible, and it is already in use at some refineries); the aging index predicts master curve parameters; the process has the ability to differentiate different asphalts in terms of composition, oxidation state, and modification process. Some of the potential or future applications include: asphalt fraction characterization and selection, monitoring asphalt oxidation aging; asphalt binder performance predictability; study modified asphalts; and use in forensic studies for fouling and failure.

ETG Comments, Questions, and Discussion:

John D'Angelo asked if the three different asphaltene groups were evaluated, and if so, what impact might that have about grouping the results into the different groups. D'Angelo noted, with PPA you get a stiffening effect but less aging. Even though the percentage is small, its effect is really large because they may make the binder become very brittle. Boysen agreed with D'Angelo's comments. Jean-Pascal Planche noted WRI is nearing the end of this project and wants to use it in other areas but does not have a lot of time to demonstrate its use.

Dave Anderson noted that need to start thinking beyond what has been thought of in the past, which is leading to a lot of false ideas and conclusions. D'Angelo commented this process might explain how the three groups come together. He referred this discussion back to what Elie Hajj is doing in measuring the temperature inside the specimens and using that value to calculate the built up of thermal stress. Anderson reported Hajj was able to explain some observations with RAP mixtures using that concept, and demonstrated the importance of the brittleness of the material.

Baumgardner adjourned the meeting at 5:00 PM.

DAY 2: Friday, 3 May 2013

Call to Order – Co-Chairman Mike Anderson called the meeting to order at 8:00 am. Anderson noted the next meeting is being planned for the week of September 16, 2013. The Binder ETG will be held first at the next meeting. Bukowski noted Phoenix, Louisville, Austin and others are possible locations for the meeting. They will be working on the finalizing the time and place and let everyone know later.

13. ABCD Test TP 92 Proposed Changes—Sang Soo Kim (Ohio University)
Sang Soo Kim was unable to attend the meeting, so Nelson Gibson delivered the report.

Presentation Title: *Proposed Changes to TP 92 – ABCD Test Device*

Summary of Presentation:

Nelson Gibson started the report by stating Sang Soo Kim was unable to attend. Gibson is participating in a task group with Tim Ramirez to evaluate the ABCD. Gibson reported he believes the changes are straightforward and ready to go back to the SoM for balloting.

Gibson overviewed the changes that were made to the test protocol. These changes included revisions to the test procedure, sampling preparation and handling, and precision of the test. Gibson noted the concern with the ABCD is the trimming and pouring, especially for newer technicians. A pouring device with a calibrated syringe is now being used for pouring the material out which has been added to TP 92. Kim has prepared a written procedure for new laboratory technicians as an aid to preparing test specimens. Gibson reported using an ABCD device in his lab. He also noted that the precision of the test was developed with trimmed specimens during an inter-laboratory study. He recommended the ETG consider a study to check the precision statement on using un-trimmed specimens.

Gibson reported four binders were tested at FHWA in 2012. The four individual replicate cracking temperatures are saved on the device, but the average cracking temperatures are available. The difference in average cracking temperature for trimmed and untrimmed was (no trim - trim) 1.8, 0.5, -0.9, and -0.5 °C which are smaller than a single operator d2s of 2.69.

The second part of Gibson's report was on a new inter-laboratory study. Gibson overviewed the details of the proposed ILS, which include 4 unaged binders, 3 replicates, and 3 types of specimen preparation. Gibson asked for volunteers to participate in the ILS.

ETG Comments, Questions, and Discussion:

Dave Anderson asked what initiated this initial study. Matt Corrigan answered that a Highway for Life grant was issued to develop this device as an alternative to the direct tension test because of the difficulty with the direct tension test equipment as being serviceable and reported through the suppliers. Dave Anderson noted that this test gives you the same ranking as the BBR and others, so it is redundant. It is an empirical test and we need to ask if we really need more empirical tests. Gibson commented that we need to develop new tests that give better results. Anderson agreed, we should develop new tests, but only if they really are an improvement on existing procedures. He believes the ETG needs to do better in guiding the technical community so that we just don't proliferate redundant test procedures. Especially ones that are not fully evaluated and are not really any improvement over current practices.

D'Angelo agreed with Anderson's point about the appropriateness and background behind the test, in that it needs to be evaluated very carefully and you do not know the exact temperature of the test specimens and agrees all of those issues need to be resolved before going to the SoM. Reinke commented while a good effort he is unsure it is a good device.

Reinke summarized his background with the test. It is probably a little more complicated than the direct tension test but the direct tension test was validated with field data. He is unsure that this empirical test can survive and does not seem to have any support by the binder suppliers. Dave Anderson recommended that these questions need to be answered before we continue to volunteer for a ILS. Gibson replied that this is still a very preliminary plan and Sang Soo Kim is trying to compare the ABCD with TSRST data.

Mike Anderson reminded the ETG this was an update to the proposed changes to the already existing provisional standard. He is unsure how much the test is being used. The purpose of this report was simply to update the group with its current status. He suggested the action for this topic be a report at the next meeting for further discussion.

ACTION ITEM #10: Sang Soo Kim's suggestions for changes to the ABCD test TP92 and comments from the ETG will be forwarded to the SoM 2b.

14. Development of a Laser Test for Binder QC/QA—Raj Dongre (Dongre Laboratory Services)

Presentation Title: *Field QC/QA Test for Asphalt Binder*

Summary of Presentation:

Raj Dongre gave the report on this topic. He started with acknowledging other members of this group: Jack Youtcheff with FHWA and John Newman with LTI. Dongre introduced John Newman as the expert in laser technology.

Dongre overviewed the background behind this test and defined the test's use as a quick pass/fail method for characterizing asphalt binder, as well as quality control. Dongre explained; we are using a laser but other loading techniques can be easily adapted to the equipment for other things.

Dongre also acknowledged the individuals that have been involved in the development and use of this equipment, which include: John Newman, Lakesha Perry (FHWA), Mary Cris (DLSI), and Kevin VanFrank (UDOT). The group now has almost a 1,000 data samples because the test is so quick and easy to use. Dongre noted the report today includes a demonstration of the equipment.

Dongre and VanFrank agreed about trying to get something quick in verifying the asphalt grade during construction. Dongre explained the basis of the test which is based on a column of air that is pushed through the system. He showed an illustration of the equipment and how it operates and is used in testing a binder.

John Newman demonstrated the equipment and showed the actual real time test results starting with a PG58-28. As the demonstration started, Newman provided the discussion on what was happening and then discussed the resulting plots they were creating in real time. The next asphalt used in the demonstration was a polymer modified PG76-22. Newman

explained the equipment is a prototype and is being used to demonstrate the test. The equipment can be made a lot smaller in the future. After demonstrating the test for two significantly different binders, Dongre and Newman compared the two results together on the same plot in real time.

Geoff Rowe stated they had been using the micro-pen test and this is much better because of the speed of the test. Dongre agreed with that comment. Henry Ramogosa asked about what response is being measured. Dongre replied all that is being recorded now is deflection and not stress. However, he did indicate that stress could be added later. Dongre explained how the test response could be analyzed.

Dave Anderson commented this test appears to be simply an indentation test. Another comment made was that it appears just to be a sophisticated version of the old penetration test. Newman commented they are building a unit that has a load cell for measuring load. The pressure that applies the air pressure has to be very accurate. Anderson commented that the air pressure is a good idea and you do not have the friction issue from previous indentation tests.

Reinke noted that there is no way this is telling us anything about the low temperature properties. Dongre agreed with that comment and noted that it is not telling us that much about the high temperature properties either.

Dongre then moved forward or back to the presentation. He showed comparisons or correlations with the DSR. Dongre overviewed the approach and test procedure as well as different parameters that have been compared. He identified the binders selected and used in the comparison. He also showed a comparison of the MSCR and laser method in terms of percent recovery. The trend was in the right direction. The same was true for polymer modified asphalt. He also showed comparisons between the phase angle and results from the laser method.

The last part of Dongre's report was on the future steps using the method. He discussed how this could be used in the future in terms of shearography. Dongre illustrated shearography images showing the deformation in 2 seconds at 30 second intervals. Other specific items to be done include: develop and standardize a test protocol, explore a research instrument based on shearography for pavement measurements such as test pads, and make a more portable version of the equipment. Reinke asked about the possibility of cooling the air through the air jet for looking at different temperatures. Newman explained the shearography for looking at how a sample's geometry is changing over time under certain loads.

Mike Anderson requested that the group keep the ETG advised on updates on this topic in the future.

15. Discussion of TP 70 – Addition of Recording Time Variation (Ex. From a 1.0 second value to 1.0 seconds -0.0 Sec. to +0.05 Sec.)—Matthew Corrigan (FHWA)

Presentation Title: *Discussion of TP 70 Recording Time Variation*

Summary of Presentation:

Corrigan provided an update on the TP 70, MSCR Test of Asphalt Binder Using a DSR, which was recently balloted by the SoM regarding the suggestions made by the ETG under section 7.3. Corrigan mentioned AASHTO wanted more information to move this forward.

Corrigan started his report with the background on this topic and acknowledged others involved in this effort, including: Chuck Paugh, Satish Belagutti, and Habtamu Zelelew. Corrigan showed examples or observations related to this issue on the sampling rate and times. He noted DSR #1 was an Anton Paar Smartpave MCR 300, and stated what comes out of the machine is fairly consistent based on his experience. DSR #2 is a TA Instruments AR-G2, while DSR #3 is TA Instruments AR-2000. He identified the biggest challenge relative to section 7.3 in terms of the sampling rate. Corrigan noted this issue led to the changes to section 7.3 – AASHTO SoM TS 2b (from the 2012 meeting) and showed the recommended changes to that section. Corrigan also reported on note 2 under that section of TP 70. He reported note 2 was removed from the concurrent ballot. Note 2 will be addressed on future technical section ballot.

The second of the proposed five changes recommended by the Binder ETG was to add a tolerance for the timing of the cycles. Corrigan showed the redlined version in the presentation. Under TP 70 – section 7.3, the ETG recommended changes provided to the SoM. He summarized what is being proposed is to concentrate on the data and illustrated what was suggested by the ETG at the spring 2012 meeting. He showed what was balloted and what will be printed in the next version of the standards. He reported the time tolerance was removed for the concurrent ballot. The standard and items included on the ballot were approved. This will be in the AASHTO publication in 2013. The time tolerance will be addressed in a future technical section ballot.

Corrigan reviewed what the Binder ETG recommended to the SoM. These were the TP 70 section 7.3 recommend changes from D’Angelo and Corrigan to simplify and clarify, remove equipment specific control/timing elements, focus attention to data needed/required at end of creep and end of recovery for each cycle, and provide standard extrapolation procedure if these data points are not explicitly recorded, and adjust requirements for measured data tolerance for last data point to extrapolate. Corrigan showed the redlined version.

Corrigan thanked Reinke and his staff in evaluating whether the sampling rate requirements can be meet. Corrigan identified the equipment used to confirm the sampling rates: TA Instruments, Anton Paar, and Malvern; which has yet to be confirmed.

ETG Comments, Questions, and Discussion:

Corrigan asked for comments and discussion on this topic. He noted to move this specification forward we probably need additional discussion.

Chris Abadie asked whether results from the precision work were available, and if available, how that data was used to judge the importance of these changes. John D’Angelo replied, the changes are more related to control and data acquisition. Haleh Azari noted no precision data

was measured after the changes were made to the standard, so she does not know how these changes affect the precision of the equipment or test procedure. Corrigan commented the tissue is with extrapolation. We can continue standardizing the extrapolation procedure, or just move forward with changing the times and not require the extrapolation procedure by leaving it up to the user. He would like the ETG to suggest which way we go forward.

D'Angelo suggested that for now leave it as is in moving the standard forward. He believes the effect is minimal. Reinke noted that what we have done with the change is to ask the user to write a macro to do the extrapolation procedure, and is that sufficient. Corrigan believes the users will want the macros or extrapolation procedure built into the equipment. Reinke noted, so the guidance should be to the manufacturers, rather than to the testing community.

D'Angelo noted we can request a measurement at a specific point in time (1 and 10 seconds), so this is a matter of dealing with the transition between how DSR manufacturers will do this. But you are going to be close regardless of what is done in terms of reporting the response at specific times. D'Angelo's opinion is if we specify a way to report the response, we might go in the wrong direction in terms of repeatability, because it relates to the speed of the software and data acquisition. He suggested you have to give the manufacturers some flexibility.

Corrigan believes we are ready to move this to the SoM unless we want to further examine how the extrapolation procedure is performed. As it is written now, we will never get the exact data at 1 and 10 seconds. Reinke asked if you are using a script in the machine, will the script do the extrapolation? Madhu Namani answered yes. John Casola answered no because window drives the priority. Reinke concluded from these conflicting responses we need an extrapolation procedure. The ETG will need to address this issue in future discussions.

ACTION ITEM #11: Comments for the timing cycles of data acquisition on the MSCR DSR TP70 and note 2 on negative Jnr will be re-submitted to the SoM 2b for consideration.

16. Update of Cooling Medium Effects on BBR Results—Mihai Marasteanu (University of Minnesota) and Raj Dongre (Dongre Laboratory Services)

Presentation Title: *Cooling Medium Effect on Asphalt Materials Bending Strength at Low Temperature*

Summary of Presentation:

Raj Dongre made the presentation and noted Mihai Marasteanu could not attend.

Dongre referred to the original NCHRP Idea 151 project which was completed in 2012. He identified the initial goals for the study which included: testing relatively small specimens of binder and mixture at low temperatures to obtain bending strengths for use in material selection, pavement design, and to potentially replace the indirect tensile test. The work under the NCHRP Idea project resulted in a new testing device called the BBR Pro. Dongre

explained the equipment and its capability. The test is stress controlled rather than strain controlled and is a modified BBR frame to allow a larger load cell for mixture three point bending strength determination.

Dongre overviewed some previous results in testing in different cooling medium. He reported an increase in binder strength moving from the tests being performed in ethanol, to potassium acetate, and air. He also reported slightly more dispersion of results in potassium acetate. In addition, higher strength values were obtained in potassium acetate and air in comparison to ethanol. Dongre presented the conclusions from the study.

- The DTT binder strength values are much higher than the BBR binder strength but the two are related.
- The cooling medium has a significant effect on the binder strength and BBR tests performed in ethanol result in lower strength values. The BBR binder strength values from potassium acetate and air are comparable.
- The mixture strength values are also cooling medium dependent, but the effect is much less significant.
- The asphalt binder creep test is affected by cooling medium, while asphalt mixture creep results are not affected by cooling medium. This observation needs to be further investigated, but in the interim use air as a cooling medium to avoid this issue.

Dongre reported Marasteanu asked Ioan Negulescu to run some tests as part of this study. Negulescu gave a report on the test results in terms of mix beam sample and AC64-22 BBR sample. The purpose of this auxiliary study was to independently identify the effect of cooling medium on the strengths.

Negulescu began by describing the samples Marasteanu provided. The samples included beams (binder and mixture) for testing to determine how the cooling medium affected the results. Negulescu identified the different medium that was used in the test: (1) potassium acetate; CFL/water plus fluorescein, (2) ethanol plus fluorescein, and (3) methanol plus fluorescein. They used the fluorescence spectra to evaluate and explain the results. Negulescu included some slides that illustrated the concept of using this method and then showed the results. He provided an explanation for each set of test results. Negulescu provided his preliminary conclusions from the test data:

- The presence of fluorescein in the THF extract of the BBR asphalt sample immersed in ethyl alcohol containing fluorescein for 75 minutes at -12°C indicates that ethyl alcohol diffuses in the test sample.
- The THF extract of samples immersed in methanol also tested positive for fluorescein.
- The THF extract of samples immersed in aqueous potassium acetate 42 percent solution did not seem to contain positive for fluorescein.

Negulescu reported an analysis of THF extracts after precipitation of asphalt with methanol has yet to be done, but will be completed prior to the next ETG meeting.

The last part of the report was on future work being planned under this topic. Dongre listed two areas recommended by Marasteanu: (1) use the BBR strength at room temperature for mixture TSR testing, and (2) develop a binder specification based on bending strength.

ETG Comments, Questions, and Discussion:

Hussain Bahia commented this is very good work, but he has a concern about the solvent being used because it is very corrosive. We need to be using solvents that are not corrosive. Dongre agreed with the comment and suggestion. He mentioned there is a way to use alcohol, but suggested when you run your tests need to also use a little potassium acetate. Dave Anderson believes a strength test should never be performed in methanol and ethanol.

After the discussion on the cooling medium, Dongre reported Marasteanu sent him information to provide clarification on the cooling medium used in the test because of similar discussions during the mixture ETG meeting. Dongre reported the UMN research team has worked on developing tests for creep compliance and bending strength of asphalt mixtures and binders as part of the two IDEA projects. The second project focused on fracture properties and it was observed that bending strength of both asphalt and mixtures were affected by the cooling medium. However, the results from both projects also showed the mixture creep results were not affected by the cooling medium, so there should be no problem with using ethanol used in the AASHTO BBR test for measuring the creep compliance of mixtures.

The draft AASHTO BBR creep compliance testing method of mixtures has been reviewed multiple times by the ETG and the method has been used over the years by a number of laboratories. Thus, Dongre suggested for Marasteanu that the method be moved forward to the SoM. Bukowski requested the suggested wording be provided to the ETG.

17. Recorded Engine Oil Modifier-Update—John D’Angelo (D’Angelo Consulting)

Presentation Title: *Asphalt Binder Modification with Re-Refined Heavy Vacuum Distillate Bottoms*

Summary of Presentation:

John D’Angelo started his report by defining re-refined heavy vacuum distillate bottoms (RHVDB) and noted this report is about the 12% residual that can be used in asphalt binder. He also noted there is an increased demand to use softer binders because of higher reclaimed asphalt pavement (RAP) percentages that are being used, as well as recycled asphalt shingles. Use of RHVDB is a way to get softer binders.

D’Angelo summarized some of the concerns with using RHVDB: (1) does its use negatively affect binder aging – but discounted this concern because of the blending process for the oil; (2) does it affect moisture sensitivity; and (3) does it have separation issues? Some studies have been done to provide answers to these concerns. D’Angelo started by reviewing the results from one such study. He listed the binders and RHVDB’s that were included in the study. D’Angelo identified the components of RHVDB, which are high in polar aromatics. The basic make-up is saturates and polar aromatics; it contains no wax and no naphthene

aromatics. D'Angelo reported the metals are so fine that the particles go through the solubility filters.

D'Angelo presented the results of AASHTO Table 1 continuous grades for base asphalts with various RHVDB blends. He noted the values along the top of the table are the percentages of the RHVDB. He also presented the AASHTO Table 2 continuous grades for the same conditions. D'Angelo continued with showing the results of using RHVDB #1 on different properties of the binder.

- The low temperature continuous grade continues to get lower with increasing percentages of RHVDB.
- The results suggest the m-value is not affected by increasing RHVDB.
- Stiffness and strain at failure for the Marathon and BP binders used in the study were measured for different percentages of RHVDB #1 blends. The blends were tested at -18°C after 20 and 35 hours PAV aging. They observed a large increase in strain. They also saw some relaxation because failure strains or strengths were going up.
- DDT strength was not affected.
- DDT strain at failure increased.
- Extended PAV conditioning caused little change in the low temperature properties.
- The intermediate continuous grade decreased with increasing RHVDB #1 percentage, however RHVDB does not increase aging.
- SARA fractions were measured on the asphalt-RHVDB blends: minor reduction in asphaltenes with larger increases in saturates and polar aromatics, and change in fractions were controlled by the base binder.

D'Angelo presented the results of mix testing of RHVDB modified material. Two mixtures from the University of Illinois moisture damage study N70 and N90 mixtures were used. D'Angelo summarized the binders developed for the mix testing program. The results of the mixture tests were summarized in terms of how different percentages of the RHVDB changed the properties.

- T 283 test results on the N70 mixture (none of these had anti-strip, except for one of the mixes) and the N 90 mixtures showed none of the blends with the RHVDB had any indication that moisture damage increased. Gerald Reinke pointed out the strengths are low for the PG 58-28 material. D'Angelo agreed with that observation.
- Hamburg loaded wheel tracking tests run at 50°C for the N70 mixture. D'Angelo pointed out the results are the same with and without the RHVDB. The controls were made to be the same in terms of grading as for the RHVDB version. In summary, all mixes meet the rutting criteria for both binder requirements; the RHVDB mixes typically performed better than the equivalent PG control mixes; and none of the mixes indicated any stripping inflection point except the 10 percent blend – which was likely due to a very soft binder rather than stripping.
- Comparison of master curves showed no distinct change with RHVDB: the master curve data matches the binder PG grade and the lower dynamic modulus data was measured on the mixes with the softer binder.

- Fatigue testing comparisons: The four point bending beam data clearly showed the mixes produced with RHHVDB have better fatigue response than the control binder.

ETG Comments, Questions, and Discussion:

Henry Romagosa asked if mass change of the material a problem. D'Angelo noted no known issue with mass change. Romagosa asked if any health issue with the material and D'Angelo commented none that could be identified to date. Ioan Negulescu asked if methanol present, D'Angelo commented, yes there is some in the material.

Rick Holmgren mentioned some of the refining processes are different. Motor oil generally has detergents put in the oil, so you need to be careful. The detergents are still there and do not go away. He recommended the percentages in the material need to be monitored and stress the percentages that D'Angelo presented be clearly identified. D'Angelo agreed that too much can cause problems.

Reinke commented his company has done a lot of testing on mixtures containing this material. Fatigue is negatively affected based on their test results. He is unclear on what is being proposed to the ETG. Dave Anderson suggested looking at long term aging of mixtures containing this material. Reinke commented that while the binder may appear fine, need to evaluate mixture effects. He suggested additional research is needed because these materials are continually being used. Corrigan asked if a research needs statement had been prepared on this topic. Bukowski replied, yes but it did not make it through the AASHTO/TRB review process.

18. “Redlines” AASHTO Binder Procedure Standards—Dave Anderson (Consultant)

Dave Anderson mentioned two items to be covered in this report. The first is an update on the thermal equilibrium, and the second is on the redlined version of two AASHTO tests – T 313 (Flexural Creep Stiffness of Asphalt Binder using the BBR) and T 315 (Rheological Properties of Asphalt Binder Using a DSR).

Presentation #1: *Thermal Equilibrium Update*

Summary of Presentation:

Dave Anderson provided an update to the DSR temperature issue that has been ongoing. He identified the question at hand: does current test method gives us an appropriate time to allow test specimen to attain thermal equilibrium? The current procedure requires a 10 minute wait period once DSR indicates the target test temperature has been obtained. If this time can be reduced, that will increase productivity.

Anderson started with a review of definitions, assumptions, relevant information, and some observations from previous analyses. Most of the first part of Anderson's report was simply a repeat of previous ETG reports on this topic. Anderson did identify and present some definition updates. These updates include some slight revisions for simplification that need to be in the test standard.

Another item covered in the review was the criterion to establish a constant G^* . Anderson defined the criterion and then illustrated the criterion in a series of graphs. The graphs showed the results from using the new proposed and the existing requirements. He summarized the variables that have potential for affecting specimen thermal equilibrium time, which include: design of instrument, design of temperature control system, difference between mounting temperature and test temperature, plate size, and time-dependent changes in the binder properties. Anderson also emphasized there are many temperature control systems. His point, you cannot talk about comparing manufacture's devices, rather you need to compare the temperature control systems. The point of these different items is leading up to the recommended protocol and round robin program recommended. Anderson summarized, three questions need to be answered as part of the current round robin program; (1) how do we determine thermal equilibrium, (2) is the current wait time universally acceptable, and (3) can a reference fluid be used for determining the thermal equilibrium time.

Anderson reviewed the recommended protocol in terms of six steps; (1) mount unmodified binder sample in the DSR and trim in the usual manner, (2) create a bulge and set test temperature, (3) initiate loading at 10 rad per second, (4) continue the loading for 30 seconds, and (5) move to second temperature if testing at multiple temperatures is needed. He discussed the proposed change to the test method; to replace current procedure with new procedure that has been proposed and retain the current 10 minute wait time as a default value.

Anderson explained the current round robin program and its objectives; (1) include more robust set of rheometers and temperature control systems, (2) use more uniform script for making measurements that are contributed by each manufacturer, (3) include fluid as one of test materials, and (4) include more binders. The round robin program using the proposed test protocol includes: the test temperature (original at two test upper temperatures, PAV at two intermediate temperatures, and PAV at two low temperatures), materials including the fluid and different binders selected, and multiple rheometer/temperature control systems.

Anderson concluded his report by providing a status on the analysis that has been partially completed to date. He listed the questions to be answered by the analysis; what is the criterion for establishing the equilibrium time, is fluid the preferable medium, what is the cushion time after the equilibrium time is reached, and an appropriate time length.

Presentation #2: *Redlined Version of AASHTO T 313 – Determining the Flexural Creep Stiffness of Asphalt Binders Using the Bending Beam Rheometer (BBR)*

Summary of Presentation:

Dave Anderson acknowledged many individuals have worked on this specific standard. He reminded the ETG on the intent of this review of test standards related to the binder tests – it was to make them all as uniform as possible between different data usages. Anderson also reported that much wording has been revised and he provided examples of those –

calibration, aging, etc. Anderson reviewed and highlighted some of the changes and revisions that were made to this specific test method.

- The scope was changed to use generic wording.
- References were added to section 2.
- Descriptions of the test were revised to include a better wording of what is being done. Anderson mentioned three things need to be checked on the load cell prior to the test which relates back to nulling the load cell.
- Buttering was added to the description of the test method.
- Section 5.3: the old one was moved to a new location in the document.
- Apparatus, under section 7: not a lot of new information, other than figures are being redone.
- Section 6.1.10: very specific to the three thermometers being used.
- Anderson mentioned about an option for section 6.3.5, which originally did not include an option. He asked for any comments or questions on this item. No one made a comment.
- Anderson focused on note 6 and mentioned unless someone objects to note 6, it will be in the standard. There was no objection.
- Specimen preparation overview: Anderson mentioned the issue or question of mass change samples being stored in bottles need to be answered. He does not know the answer today, but it needs to be discussed and resolved at future meetings.

Presentation #3: *Redlined Version of AASHTO T 315 – Determining the Rheological Properties of Asphalt Binders Using a Dynamic Shear Rheometer (DSR)*

Summary of Presentation:

Dave Anderson reported the procedure Mike Farrar developed will go into an Appendix of this procedure – T 315. He is unsure, however, what to do about the equilibrium procedure. He asked about putting the equilibrium procedure in as a recommended version because the one currently included in the standard needs to be removed. Maria Knake mentioned that decision or revision will need to go to a technical section ballot. Chris Abadie thought the time table discussed was aggressive.

Dave Anderson requested everyone to review these suggestions. Any comments should be sent to him. Mike Anderson thanked Dave Anderson and Maria Knake for their efforts. Mike Anderson requested any changes or comments on the two AASHTO test methods be sent to Dave Anderson with a copy to Maria Knake.

ACTION ITEM #12: Chris Abadie will have the “redline” revisions on T313 and T315 prepared by Dave Anderson reviewed by SoM 2b. ETG members are requested to provide any further comments on this effort to Dave Anderson prior to the next ETG meeting.

19. Action Items/Next Meeting—Gaylon Baumgardner (Paragon Technical Services) and John Bukowski (FHWA)

Next ETG Meeting: John Bukowski reported they are looking at the week of September 16, 2013 for the next ETG meeting. The Binder ETG will be held first, with the Mix ETG to follow. Bukowski asked if there were any known conflicts.

Action Items: Bukowski summarized the action items from this meeting, which are:

1. John Bukowski will forward to the SoM 2b the recommendations and rationale for the Jnr changes in MP19 for unmodified asphalts from 4.0 to 4.5 kPa⁻¹.
2. Mike Anderson will circulate to the ETG for comment the proposed changes to the draft procedure for Evaluating the Elastic Recovery of Asphalt Binders Using the MSCR Test and discuss at the next ETG meeting.
3. Matt Corrigan (lead) and task group members (Gerald Reinke and Mike Anderson) will develop wording for grade bumping recommendations and associated PAV temperatures and distribute to the ETG for discussion at the next meeting.
4. ETG members are asked to review the draft procedure for Binder Thermal Cracking and provide comments back to Haifang Wen prior to the next meeting.
5. Mike Anderson and Task Group on Intermediate Temperature will continue to evaluate old conventional binders, begin evaluating new conventional and unconventional binders and report on the analysis at the next meeting.
6. John D'Angelo will provide additional input/comments on the GTR related changes to M320, MP19, and T315. Hussain Bahia will edit T44 to incorporate changes in paragraphs 1.3 and 1.4 and provide to Bukowski for re-submission to the SoM 2b.
7. Hassan Tabatabaee will continue to analyze the SENB procedure and report at the next ETG meeting. Additionally, it is requested he provide information on how this procedure is intended to be used with the current binder grading specification and tests.
8. ETG members are requested to review and provide additional comments to Hussain Bahia on the draft BYE/Elastic Recovery procedure, and particularly how it is intended to be used to evaluate binders. This item will be discussed at the next ETG meeting and any potential recommendations to the SoM.
9. Hassan Tabatabaee will continue with the ruggedness of the LAS TP101 and provide potential revisions to be discussed at the next meeting.
10. Sang Soo Kim's suggestions for changes to the ABCD test TP92 and comments from the ETG will be forwarded to the SoM 2b.

11. Comments for the timing cycles of data acquisition on the MSCR DSR TP70 and note 2 on negative Jnr will be re-submitted to the SOM 2b for consideration.
12. Chris Abadie will have the “redline” revisions from Dave Anderson on T313 and T315 reviewed by SOM 2b. ETG members are requested to provide any further comments on this effort to Dave Anderson prior to the next ETG meeting.

20. Wrap-Up and Meeting Adjournment

Mike Anderson thanked everyone for attending and participating in the meeting.

The meeting was adjourned at 11:50 PM.

ATTACHMENT A

Asphalt Binder Expert Task Group

Raleigh, North Carolina

May 2 & 3, 2013

Meeting Agenda

Day 1 – May 2, 2013

8:00 am	Welcome and Introductions	Baumgardner/M. Anderson
8:15 am	Review Agenda/Minutes Approval & Action Items September ETG Meeting and Technical Section 2b Actions	Bukowski
8:45 am	Rationale of Jnr Criteria for Unmodified Asphalt Binder	M. Anderson
9:15 am	MSCR Recovery Procedure: Draft AASHTO Procedure	M. Anderson
9:45 am	Break	
10:00 am	PAV Aging Temperatures for PG 52-34 & 64-34	Reinke
10:30 am	Missouri Implementation of MSCR Specification	Schroer
11:00 am	Task Group Recommendations Binder Thermal Cracking Test	Wen
11:30 am	Intermediate Temperature Task Group Activities	M. Anderson
Noon	Lunch Break	
1:00 pm	Asphalt Rubber Modifier Update	D'Angelo
1:30 pm	Single Edge Notched Beam Procedure	Tabatabaee
2:00 pm	Task Group Report on Elastic Recovery/BYE	Bahia
2:30 pm	Summary of LAS Test TP101 Proposed Changes	Bahia
3:00 pm	Break	
3:30 pm	Update on Asphalt Miniature Testing	Farrar
4:30 pm	Presentation of SAR-AD	Boysen
5:00 pm	Adjourn for the Day	

Day 2 – May 3, 2013

8:00 am	ABCD Test TP 92 Proposed Changes	Sang Soo Kim
8:30 am	Development of a Laser Test for Binder QC/QA	Raj Dongre
9:00 am	Discussion of TP70 addition of recording time variation (ex. from a 1.0 seconds value to 1.0 seconds -0.0s +0.05s)	Corrigan
9:30 am	Break	
9:45 am	Update of Cooling Medium Effects on BBR Results	Marasteanu/Dongre
10:15 am	Recovered Engine Oil Modifier-Update	D'Angelo
10:45 am	“Redlines” AASHTO Binder Procedure Standards	D. Anderson
11:30 am	Summary of Action Items	
11:45 pm	Adjourn	

ATTACHMENT B

ASPHALT BINDER EXPERT TASK GROUP MEMBERS

<p><u>Chairman:</u> Gaylon Baumgardner 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 Gaylon.baumgardner@ptsilab.com</p>	<p><u>Co-chairman:</u> R. Michael Anderson Director of Research & Lab Services Asphalt Institute 2696 Research Park Drive Lexington, KY 40511-8480 Phone: 859-288-4984 Fax: 859-422-1301 manderson@asphaltinstitute.org</p>
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ATTACHMENT C

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