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 59 individuals attended the meeting (16 members and 43 visitors and two contract individuals). The meeting was held in Fall River, Massachusetts.

ETG Members in Attendance:
Gaylon Baumgardner, Paragon Technical Services (Chairman)
John Bukowski, Federal Highway Administration (Secretary)
Chris Abadie, Louisiana Department of Transportation
Dave Anderson, Consultant
John D'Angelo, Consultant
Heather Dylla, National Asphalt Pavement Association (attending for Audrey Copeland)
Gayle King, GHK, Inc.
Pamela Marks, Ontario Ministry of Transportation (Liaison)
Bob McGennis, Holly Frontier Refining & Marketing
Bruce Morgenstern, Wyoming Department of Transportation
Ioan Negulescu, LSU
Jean-Pascal Planche, Western Research Institute
Gerald Reinke, Mathy Construction
Geoff Rowe, ABATECH

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

ETG Members Not in Attendance:
Mike Anderson, Asphalt Institute (Co-Chairman)
Mark Buncher (Liaison), Asphalt Institute
Audrey Copeland (Liaison), National Asphalt Pavement Association
Georgene Geary, Georgia Department of Transportation
Edward Harrigan (Liaison), TRB
Darren Hazlett, Texas DOT
Mihai Marasteanu, University of Minnesota
Henry Romagosa, ICL Performance Products LP
Eileen Sheehy, New Jersey DOT

Friends in Attendance:
Howard Anderson, Utah DOT
Haleh Azari, AASHTO (AAPRL/AMRL)
John Barry, Crowley Chemical
Rod Birdsall, All States Materials Group
Sandy Brown, Asphalt Institute
John Casola, Malvern Instruments
Barry Catterton, Maryland DOT
Andrew Cooper, Cox Sons
Matthew Corrigan, FHWA
Aadil Elmoumni, TA Instruments
Mike Farrar, WRI
Frank Fee, Frank Fee LLC
Mark Gabriel, All States Materials Group
Lee Gallivan, FHWA
John Gilligan, Innophos, Inc.
Beth Griffin, DuPont Company
Matt Groh, Bituminous Technologies
Greg Harder, Asphalt Institute
Gerry Huber, Heritage Research
Brian Johnson, AASHTO (AMRL/AAPRL)
Robert Kluttz, Kraton Polymers
Daryl MacLeod, Husky Energy
Jean-Valery Martin, Innophos
Walaa Mogawer, HSRC/UMass
Ala Mohseni, Pavement Systems LLC
Marissa Mooney, Holly Frontier
Peter Moore, Pike Industries Inc.
Steven Muncy, BASF
Kevin Nelson, Seneca Petroleum
John North, All States Materials Group
Dan Quire, Wright Asphalt
Tom Snyder, Marathon Petroleum
Chris Strack, Sonneburn
Hassan Tabatabaee, Univ. Wisconsin-Mad.
Laci Tiarks-Martin, PRI Asphalt
Kevin VanFrank, CMETG
Scott Veglahn, Mathy Construction
Bob Voelkec, Maryland DOT
George Way, RAF
Eric Weaver, FHWA
Tim Yasika, Sonneborn
Jack Youtcheff, FHWA
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 Force members].

DAY 1: Tuesday, 17 September 2013

1. **Call to Order** – Gaylon Baumgardner (Paragon Technical Services) and John Bukowski (FHWA) called the meeting to order at 8:00 AM. Mike Anderson was unable to attend this meeting.

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

John Bukowski noted the meeting was not being webcast. The technical report from the last meeting was submitted via e-mail, and minutes from the AASHTO Subcommittee of Materials (SoM) were distributed to all members. He reported the technical report from the last Asphalt Binder ETG meeting was sent to Friends of the ETG. Gaylon Baumgardner thanked Walaa Mogawer for hosting the meeting.

2. **Review Agenda/Reports and Action Items from May 2013 Meeting and Technical Section 2b Actions—**John Bukowski (FHWA); Secretary

Bukowski started the meeting with a review of the AASHTO SoM standards update, and the 2014 AASHTO cycle. ETG recommendations were reviewed in mid-May 2013. Bukowski reported Mike Anderson could not attend the meeting, but is working on the Multiple Stress Creep Recovery (MSCR) draft for a potential AASHTO standard. He also reported Matt Corrigan is working with a group on grade bumping related to the intermediate test temperature. He noted Haifang Wen will not attend this meeting, so his presentation will be delayed until the next Binder ETG meeting.

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

Approval of May 2013 Meeting Report – Bukowski reported no changes or revisions to the May 2013 technical report sent via e-mail were received from the members. No revisions or changes to the May 2014 technical report were requested from the members in attendance.

Review Action Items – Bukowski summarized the Action Items from the May 2013 Asphalt Binder ETG meeting. The following is a listing and status of the Action Items from that meeting.

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}.
   UPDATE: Action item is on the agenda.

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.
   UPDATE: Action item is on the agenda and Anderson did submit the proposed changes to the draft procedure. Mike Anderson is not attending so Gerald Reinke will give the report.

3. Matt Corrigan (lead) and Task Force 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.
   UPDATE: Action item is on the agenda.

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.
   UPDATE: Action item was on the agenda, but Wen could not attend this meeting, so this item is postponed to the next ETG meeting.

5. Mike Anderson and Task Force on Intermediate Temperature will continue to evaluate older conventional binders, begin evaluating new conventional and unconventional binders and report on the analysis at the next meeting.
   UPDATE: Action item is on the agenda, but Gerald Reinke will make the report because Mike Anderson could not attend 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.
   UPDATE: Action item is on the agenda. This item was submitted to the SoM in 2012 and in 2013.

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.
   UPDATE: Action item is on the agenda.

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.
   UPDATE: Action item is on the agenda.

9. Hassan Tabatabaee will continue with the ruggedness of the LAS TP101 and provide potential revisions to be discussed at the next meeting.
   UPDATE: Action item is on the agenda.

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.
    UPDATE: Done.

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.
    UPDATE: Done.

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.
    UPDATE: Done.

Technical Section 2b Actions—John Bukowski overviewed results from the SoM meeting this past year, and reported recommendations were sent to Eileen Sheehy. He suggested the ETG spring meeting be held earlier next year to have more time before the SoM meeting, because the SoM deadlines. There was no separate tech section ballot this past year. The SoM met in August 2013 and the SoM ballot was issued in October 2013, so we will not know the results from the next ballot until sometime earlier next year. The SoM ballot items will be reviewed in the webinar meeting scheduled for February 2014. Bukowski will forward results from the ballot to members so they can be reviewed prior to the next meeting.

Bukowski overviewed the Tech section 2b actions. Concerning the recommendation of testing terminal blend ground tire rubber modified asphalt using a 2mm gap for the DSR (modifications made to M 320, MP 19, T 315, and T 44), Bukowski reported this

modification will be included on the full SoM December ballot. Bukowski noted Mike Anderson had a recommendation on increasing the maximum Jnr value from 3.2 to 4.5 kPa^{-1} relative to Table 1 in MP 19. This change will also be on the concurrent ballot. Another item on the concurrent ballot is TP 92 which includes revisions and modifications to the ABCD.

TP 70 and MP 19 are being balloted as full standards for this cycle. Chris Abadie reported there was a lot of discussion on moving these to full standards. The discussion focused on how long these were provisional standards. These were proposed to move to a full standard because they reached the maximum amount of time as provisional standards.

Bukowski reported Dave Anderson is working on the redline version for guidance on temperature selection for TP 70. Dave Anderson commented this will move to a full standard for ballot very shortly. Bukowski mentioned Dave Anderson has a webinar on this topic. Bukowski also noted a new task force was created on TP 70 to provide guidance in selecting the test temperature. Matt Corrigan will report on this new task force later in the meeting.

Bukowski reported the Tech Section 2b had discussed the DENT test as a possible new provisional standard. There has not been an ETG recommendation that this should be an AASHTO standard. The Tech Section decided to move this to a Tech Section ballot to determine the interest in the test method before moving it to a provisional standard in 2015. In addition, the Asphalt Research Consortium proposed two new standards that are on the Tech Section 2b ballot: (1) measuring the binder elastic recovery and ductility using the DSR and (2) measurement of the binder glass transition temperature. Bukowski also identified five other proposed new standards developed by the Asphalt Research Consortium. No action is required by the ETG on any of the five test methods at this time.

ETG Comments, Questions, and Discussion:
Abadie commented that the two proposed standards mentioned by Bukowski were not discussed in any detail at the SoM meeting but might be brought up during the February webinar. He noted the SoM minutes did state both will be sent to Tech Section ballot, as summarized by Bukowski. Bukowski noted that the Bitumen Bond Strength (BBS) and some of the others have yet to be discussed in detail by the ETG.

Dave Anderson commented on how quick some of these standards have been moved forward in AASHTO. In his opinion, they have moved too fast and it is a disservice to the community by moving these forward too quickly. Bukowski noted that this concern was brought up to AASHTO. Abadie was concerned that some method is needed to capture new potential standards so an available document is available for DOTs to try out. Dave Anderson referenced one standard that was proposed to AASHTO has yet to complete in depth studies on its use.

Dave Anderson maintains that if AASHTO publishes a provisional or research standard, it gives creditability to the standard which may not be warranted for use. In other words, it is perceived as being ready to use for testing and specifying materials. Gale King asked Abadie

if AASHTO is willing to sponsor a web site for these research test methods. Abadie commented that could be a possibility.

In summary many believe the word standard provides creditability and can create a confusing system. Chris Abadie will ask AASHTO SoM to consider establishing a category to cover experimental test methods that can be published on a website

ACTION ITEM #1: Abadie was asked to take the issue to AASHTO to see if they would sponsor a web site for making these research test methods available for trial use by industry. Abadie agreed to take this issue to AASHTO at the next meeting.

3. Multiple Stress Creep Recovery (MSCR) Task Group Activities
Bukowski reported Mike Anderson could not attend the meeting, so he will give a brief status report on this topic which relates to the binder plus specifications that agencies use. This is important issue which needs to be addressed. If the MSCR can be used, this could eliminate many of the binder plus specifications. He noted the report and discussion on the Tech Section 2b items just completed relates to this item. Bukowski reported Mike Anderson submitted a document to the ETG for review and asked everyone to give Mike Anderson their input regarding the MSCR test procedure.

4. Intermediate Temperature Task Group Activities—Mike Anderson (Asphalt Institute)
Bukowski reported Gerald Reinke will give this report in Mike Anderson's absence. Reinke acknowledged the members that participated in the conference call.

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

Summary of Presentation:
Reinke summarized previous meeting presentations. He showed some of the Linear Amplitude Sweep (LAS) test results for different asphalts and gave some observations relative to what had been presented in earlier meetings.

Geoff Rowe had been provided data for preparing the master curves for many of the binders included in the study. Reinke asked Geoff Rowe or Gayle King to comment on those test results and master curves. Gayle King commented using one of the master curves—showing good low temperature properties, but when the material crystallizes there is a change in the master curve. This change or deviation has caused previous problems in preparing the master curves by being overly shifted, which is similar to the shift in aging. This shift has a huge impact on cracking and changes the relationship between modulus and phase angle. Rowe explained the isotherms that develop and the separation occurs at temperatures higher than 25^{o}C. This occurred in 4 of the 5 base asphalts tested. No wax was in AAG sample, so without any wax there is no shifting. Reinke reported this was an important observation.

Reinke reported that binders were sent to different labs, including WRI, to examine various properties. The differential scanning calorimeter (DSC) was used to determine the glass-transition temperature and crystallization properties. The SAR-AD and DSC results were measured on a range of asphalts for three aged conditions: original or unaged, RTFO, and PAV aging. Jean-Pascal Planche commented testing continues, but the DSC is showing

response changes with temperature that need further analysis. In his opinion, we need more data on a larger range of binders. With more aging, there is a change in composition, but it is too early to make any comments regarding the DSC test results. Reinke presented a summary of the current test results. Planche noted that the AAG asphalt has a much higher glass transition temperature than any of the other binders tested thus far.

Reinke reported their lab utilized the torsion bar and did the 4-mm parallel plate DSR testing but the data are unavailable for presentation at this time. Rowe also commented that the data have been received but has not been evaluated for presentation purposes.

Reinke reported results from the PG grading of the new conventional binders. Reinke highlighted the phase angle at certain temperatures and the difference in values. If the difference is negative it is m-controlled but if the difference is positive it is s-controlled. Reinke then presented some plots of delta Tc (difference in cracking temperature) from the BBR and DSR tests for the new conventional binders. Reinke showed other correlations that were observed and noted the two parameters are tied together, which is reasonable. The important question however is whether there is anything in those relationships for use in specifications. Bob Kluttz commented on the 4 mm test temperature and asked if the phase angle was examined at the different temperatures. King noted that the test data is just beginning to be received, and this and other issues need to be examined.

Reinke showed some of the LAS test results from two intermediate grade test temperatures. This included a graphical comparison of results from NC-A in terms of the shear strain versus cycles to failure. Reinke noted there is a defined relationship between shear strain and cycles to failure which is dependent on aging but is unsure on the importance and meaning of these relationships. More importantly, the slope of the relationship between shear strain and cycles to failure is dependent on temperature and other parameters (delta Tc and phase angle).

Bob McGennis commented that the next portion of testing is planned on binders that have significant commercial user. McGennis presented a testing plan to Mike Anderson but Anderson will decide the materials to be tested and evaluated.

D'Angelo asked with this evaluation are we trying to find some type of test protocol that relates to binder use or the specifications. His opinion is that stiffness by itself is not the answer and neither is stiffness/phase angle. Rowe and King both commented that LAS captures damage. King added that this evaluation is focusing on two types of cracking: (1) low temperature and (2) block cracking which are related to the rheology of the material. In his opinion, the LAS capture's that effect. For fatigue cracking, however, there is a difference. It is a combination of rheology and mix properties. D'Angelo replied that temperature can be interpreted as a load just like fatigue from truck loads.

Dave Anderson opinion is that there is not one parameter to explain all of the different type of distresses. In his opinion, this current approach will not lead to a useful test standard.
D'Angelo agreed with Dave Anderson and noted that we should not be developing a lot of tests without knowing what they mean in terms of distress mechanisms. D'Angelo referred back to the problem with the use of master curves. Rowe commented that there are two types

of master curves and they are starting to look at this issue in a rational manner to see what it tells us in terms of what we see in the field or performance. He referred to the potential of trying to develop a material purchase specification and noted we are still a long ways from the answer. Rowe believes it will need more evaluation before it is known which tests have potential and which ones should be abandoned.

The next steps in the testing plan were discussed by Reinke. This includes continue evaluating the old conventional binders, continue evaluating new conventional binders, and selecting new unconventional binders. The final comment made by Reinke is that more than one parameter needs to be used at the intermediate temperature—it could be a strength or toughness test at the intermediate temperatures.

ETG Comments, Questions, and Discussion:
Ala Mohseni referenced a test they have been working on for the past couple of years. He reported they sent the test results to Mike Anderson. Mohseni believes the test provides the intermediate test temperature. Reinke noted the test and results have yet to be presented to the ETG, but should be presented sometime in the future before making any recommendations about the test.

ACTION ITEM #2: Intermediate temperature Task Force will proceed as instructed to provide an update to be presented at the next ETG meeting. Anyone interested in participating in this group should contact Mike Anderson.

5. Task Force for MSCR Temperature Selection—Matthew Corrigan (FHWA)
Corrigan reported he will be discussing the general direction of two items: (1) the PAV temperature selection from two task groups, and (2) the MSCR temperature selection relative to the climate effect.

Presentation Title #1: *PAV Temperature Selection*

Summary of Presentation:
Corrigan referenced Reinke's suggestion during his presentation at the May 2013 Binder ETG meeting that the PAV temperature be based on climate conditions. He focused on the AASHTO M320 footnote—the PAV aging temperature is based on simulated climatic conditions and is one of three temperatures: 90, 100, and 110°C. Corrigan showed Table 1 from AASHTO M320 and highlighted the specific item on Table 1. He noted there is no discussion in this standard for selecting the binder test temperature. He showed a summary of the requirements from Table 1, and summarized the history behind where the values in the current standard came from—SHRP-A-369 and SHRP-A-370 reports. These reports and historical information only address hot desert climates and not mountainous cold climates. Corrigan stated he is presenting this historical information as background for his Task Force's recommendations on this topic.

Corrigan showed an overview of the U.S. from LTPPBind as related to the PG grades being used. The question is, if you can go up in temperature in binder selection, why cannot we go down in temperature. He used an example for a PG46 or PG52 in a different climate and

asked, should the conditioning temperature be different for the two. How do we incorporate these "grade bumping" and "grade dumping" climatic considerations into the standard? This was the direction imposed on the Task Force, to provide an answer to that question for a recommendation to M320.

Corrigan's recommendation is a matrix for different approaches with restriction to grade bumps or dumps. He illustrated the recommendation in a table that was developed for discussion. He took Table 1 in M320 and showed the recommendations for using two temperatures at each condition because he did not want to stray too far from the original recommendations. The issue remains, that with these suggested changes, is the note in the standard regarding the climate effect still needed.

ETG Comments, Questions, and Discussion:
Bukowski commented that a thorough discussion/rationale is needed on any recommendation prior to moving this forward to the SoM. Gayle King strongly supports Corrigan's recommendation. He referred to the initial issue between versions 2 and 3 of LTPPBind. He believes, since we are using degree-days, we are in more of a reasonable format in deciding on what is to be used.

Bob Kluttz asked if it would be reasonable to go one step further and completely disengage the temperature issue from the grade bumping issue. He suggests the footnote for climatic temperatures—you test or age at the climate. Dave Anderson agrees with Kluttz; you age at the climate temperature and not bump or dump the grade. There was some disagreement between Corrigan's recommendation and how it was interpreted by King and Kluttz. Corrigan countered by only noting the climate temperature you have to explain a lot more. But if you use the two-grade bumping or dumping rule, it retains and simplifies the other notes.

Karissa Mooney asked if the test would still be performed at a specific temperature. Corrigan replied, no change is proposed on the testing temperature/grading, but suggesting a different aging temperature for the PAV.

Sandy Brown mentioned two issues. It is fine to refer to a climate temperature. The suggested verbiage in a standard, however, will not explain the issue of bumping. Corrigan noted that this is still a draft recommendation for discussion. Corrigan asked about the agreement on the two additional temperatures suggested as well as on the procedure of just using two additional temperatures. He identified the administrative issues this is going to create.

Gerry Huber commented about aging at three different temperatures under this suggestion. His asked how much of an impact will this have on the binder in terms of the variability of RAP from a qualitative standpoint. Baumgardner commented we are just clarifying what is already in the standard. Corrigan responded, this is only partly the situation. Table 1 only gives you one aging temperature and does not account for the original intent for it to be aged in terms of the climate where it will be used. He was unsure why that was changed during the standard development. Reinke answered Huber question, maintaining that this will be about a 2 to 3 degree impact, but is unsure about the performance question. Even the 2 to 3

degree temperature impact can be important. Hassan Tabatabaee asked if these also apply to the recommendations related to MP19 for the MSCR. Corrigan stated this will be part of the next presentation, but noted, yes since MP 19 does refer to M320.

Corrigan identified the action item that will be taken to the next meeting. He asked for everyone's comments so that they can be considered and discussed at the next meeting. Corrigan asked for a maximum number of grade bumps to consider. King noted there are a maximum of 3 grade bumps. Corrigan noted he will increase his recommendations to account for 3 grade bumps.

ACTION ITEM #3: The recommendation is to amend Table 1 in M 320 to include a reference on the three test temperatures representing footnote f of the current method. The task group will be on the agenda for the next ETG meeting to make a possible recommendation to the SoM. Any comments on this topic should be sent to Matt Corrigan prior to next meeting for consideration.

Presentation Title #2: *MSCR Temperature Selection*

Summary of Presentation:
Corrigan overviewed the history behind this issue of selecting the MSCR test temperature and what is being done relative to the SoM Tech Section 2b on TP 70 and MP 19. He referred to Mike Anderson's recommendation and reported both provisional are moving forward to a concurrent ballot to become full standards. Corrigan also reported the revision to assess the elastic response is still being discussed in the Tech Section.

Corrigan noted there are many issues that must be considered under this item of MSCR temperature selection. He summarized the two common points which were reflected by the South Carolina and Texas DOT concerns with the method. He concluded from these concerns, more guidance is needed. Corrigan is the lead of the new Task Force to develop further guidance on temperature selection for TP 70.

Corrigan summarized the efforts from FHWA and Asphalt Institute with the MSCR implementation. He referred to two publications that are available on the web: a Technical Brief FHWA-HIF-11-038 (2011), www.fhwa.dot.gov/pavement/asphalt/index.cfm, and Asphalt Institute resources www.asphaltinstitute.org/public/engineering/mscr-information.dot.

Corrigan acknowledged Greg Harder and Bob Horan from the Asphalt Institute efforts in the implementation effort with the DOTs.

ETG Comments, Questions, and Discussion:
Bob Kluttz noted there was discussion on this issue a couple of years ago. As he recalls, it did move forward but was removed from SoM balloting.

ACTION ITEM #4: Matt Corrigan will report on activities and comments regarding the SoM Task Force on MSCR temperature selection.

6. Update on LAS TP 101 Testing Results—Hussain Bahia (University of Wisconsin at Madison)

Hassan Tabatabaee gave the report.

Presentation Title: *LAS Test, Binder Grading Specification and Failure Criteria*

Summary of Presentation:

Hassan Tabatabaee started with a brief overview of the presentations from previous ETG meetings and the Asphalt Research Consortium binder characterization methods. He will focus this report on the intermediate test temperature range. Specific items included in his report are: (1) a review of the LAS test procedure and ruggedness testing, (2) the LAS failure criterion, (3) use of the LAS as a performance based test, (4) study on applicable test temperatures, and (5) future work planned in this area.

Tabatabaee described the LAS test as having two parts. One portion describes the binder rheology which is a frequency sweep test, and the other describes the binder's damage resistance which is a continuous amplitude sweep test. As a reminder, he noted the recommendation from a previous meeting, the change in the test from a stepped to continuous strain sweep test. The reason for the continuous strain sweep is that it can be performed on more models of the DSR.

In terms of the LAS failure criterion, the critical crack length was proposed as a possible alternate but is no longer being considered because of a lack of correlation between Nf and performance or cracking. AASHTO TP 101-12 uses the visco-elastic continuum damage (VECD) concept to determine the number of cycles to 35% reduction in the initial modulus but determining failure damage based on peak stress relates the ultimate failure criteria to the material response. Tabatabaee reported they are not looking at a fixed failure point, but rather the peak stress so they are trying to determine the total response of material. This revised failure criterion does not change the test procedure; it is only the interpretation of the data collected in terms of how long the binder resists loading. So no fixed point is being used. This represents a minor change in the "c" point. Tabatabaee stated a significant advantage of using Nf as defined by the peak stress is that the failure damage level is material dependent, rather than definition dependent.

Tabatabaee provided their vision for grading binders with the LAS method. The method is based on converting the pavement strain to a binder strain value. He explained the procedure, and provided an illustration for incorporating the LAS in MP 19, Table 1. The advantages of the proposed specification are; it is simple, considers traffic levels and pavement thickness, and uses the existing framework of MP 19.

The last item Tabatabaee reviewed was the temperature study to define an applicable range of test temperatures for the LAS test. The objective of this study is to determine the temperature range for which damage in solely through cohesive fracture and crack propagation. He also provided a listing of the sections being used. Tabatabaee summarized the damage this torture test is capturing. A unique analysis technique being used in this study is the image analysis to study the effect of temperature on the failure mechanism.

Tabatabaee showed examples at different temperatures and reported the observed geometry changes during the testing at the extreme temperatures. This was noted as bulging but was identified well below 1 MPa. In summary, the difficulties related to bulging at the higher temperatures are well beyond how it would be used in a specification test.

Tabatabaee reported on findings from the LAS ruggedness tests. In summary, the LAS test was found to be rugged for loading temperature, strain amplitude, and sample type. Ruggedness data, however, will be reanalyzed using Nf at the peak stress criteria and presented at the next ETG meeting. In addition, data from two more labs will be gathered and added to ruggedness analysis. Thus, the next steps are to use the peak stress damage limit and reanalyze the ruggedness test results, and finalize the limits and strain values for the proposed LAS grading specification. The LTPP and MnROAD binder test sections will be used to further validate the test and its use.

In conclusion, Tabatabaee acknowledged the sponsors for this work. This study was sponsored by FHWA and WRI through the Asphalt Research Consortium. Laboratories that participated in the ruggedness study include: Asphalt Institute, FHWA Turner-Fairbanks, MTE Laboratories, North Carolina State University, and Utah DOT. He also mentioned the upcoming workshop on this topic which is scheduled for November 13 and 14, 2013.

ETG Comments, Questions, and Discussion:
Ala Mohseni referred to the "c" factor regarding NSCU approach and asked if it violates the basic assumption of viscoelasticity. In his opinion, this is over the linear range for the 0.35. Hasan Tabatabaee disagreed with the comment, because that was not the reason for selecting the values. He noted linearity was not the assumption used in calculating Nf. He did state it is an assumption in some of the calculations, but not in establishing the criteria.

Baumgartner requested all that have been involved in using the LAS test to provide comments back to Hasan Tabatabaee and Hussain Bahia in preparation for the next ETG meeting.

ACTION ITEM #5: A report will be made to the ETG at the next meeting, if necessary, on the SoM ballot on the Linear Amplitude Sweep test with respect to ruggedness testing.

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

Haifang Wen was not present, so this report was delayed until the next binder ETG meeting.

8. **Report on Rheology and its Use in Binder Specification—**Dave Anderson (Consultant) and Geoff Rowe (Abatech)

Dave Anderson gave the background for this report of how the binder specification developed. He referred to the critical distress mechanisms that were selected for the binder specification. He also noted this relates back to what Matt Corrigan stated earlier on selecting a temperature that is climate related in where the binder is being used. Dave

Anderson also summarized the objectives of today's report, which are: (1) to show how the R-value (Rheological Index) and w_c or the cross-over frequency are key parameters for defining binder performance; (2) to discuss the development of potential modifications to the M320 specification and the need to retain basic rheological concepts; and (3) to demonstrate the inadequacy of single-point measurements at arbitrary temperatures.

Anderson summarized the history and starting points pre-SHRP related to rheology. This included a listing of the different items being discussed prior to SHRP. He also overviewed the Heukelom 1966 graph from the AAPT paper.

Anderson explained the basis of the Christianson-Anderson (CA) model and discussed specific details of the model and mathematical relationships. He presented a series of equations of the CA model with an emphasis on the relaxation portion. He also explained the PG Specification measurements contain components of the equipment. He noted the BBR and DSR result in the same information, but just measure it in different ways. He noted Geoff Rowe will discuss the process for obtaining the output from one to the other, and present the relationship between the DSR and BBR; they are two rheological devices that measure the same thing.

Geoff Rowe started his report with the analysis of the data collected by Mike Anderson relative to M320. They are trying to update the analysis because there are now different analysis tools and techniques. He provided a summary of the materials and data in terms of what was used in the analysis. Rowe illustrated the conversion of S(t) = 300 to G* and m = 0.30 to δ. In his example, the red line and points were for G* while the blue line and points were for the phase angle. Rowe summarized how G* correlates to the other data items or elements. The blue line or relationship showed the correlation between G* and G* sin δ. Rowe reported that same correlation is not present for the phase angle which has considerable variability.

Rowe also stated the shape of master curve can be defined by two PAV data points and the slope of that line or relationship represents the R-value. He reviewed the original concept implemented in the AASHTO M320 specification between reduced frequency and G*. The R-value is linked to the PG range in the existing specification. Due to the method of computation of the intermediate grade temperature, this becomes a single relationship for all binder grades. A similar relationship exists between the cross over frequency and PG range. Rowe explained the current binder specification includes the rheology by default because of the R-value. In addition, the cross over frequency is being effectively controlled.

The next part of Rowe's report was to overview what the R-value and cross over frequency do as related to the binder specification. Regarding temperature susceptibility, Rowe showed some data illustrating a strong correlation between R-value and temperature susceptibility or the shape of the master curve, while cross over frequency shows the hardness of the binder.

In closing Dave Anderson emphasized some cautions about the specifications. One part should not change without the other, it is a system and integrated approach. Anderson summarized the rationale used in the SHRP original specification development. He referred to D'Angelo's point about just developing a correlation test—we need to use fundamental

tests independent of sample size. We will be unable to run a single test to explain all performance observations or material responses. Attention must be given to aging in relation to the test we are using. Define the problem and then develop the test for measuring the property. Anderson showed an illustration tying test method development to rheological behavior.

In closing, Anderson emphasized the need for rheology as the basis for: specification parameters, relating binder and mixture properties to pavement performance, allowance for time-temperature dependency of rheological and ultimate properties to be characterized and accounted, ensuring values retain existing links to the development of continuous functions. However, replacing well-defined rheological parameters with empirical parameters is a negative development to the rheology captured in the original SHRP developed specifications, and empirical measurements do not integrate well with pavement design and provide a poor basis for future development.

ETG Comments, Questions, and Discussion:
Bob Kluttz asked if all of this is predicated on the CA model. Rowe replied the CA model fit well up to the intermediate test temperature.

Gayle King noted he does not understand how the R-value compares to the Glover-Rowe parameter. Rowe replied it is not just the R-value but R-value and stiffness. King asked if Glover correct in terms of the R-value as a failure strain. Rowe replied this is a ductility issue. D'Angelo pointed out for a certain range of materials, these mathematical models fit very well, but we need to understand how and where these fall apart for different materials. The rheological part is good for a narrow range of materials. The key issue is the rheological basis has changed over time. King noted the value of this presentation because of what he did in trying to relate cracking to the R-value for some of their work. He did not understand the issue of cross over frequency adjustments on the R-value initially. His opinion this is important to understand.

9. Rubber Modification Testing Results—John D'Angelo (D'Angelo Consulting)

Presentation Title: *Asphalt Rubber Modifier Update*

Summary of Presentation:
John D'Angelo overviewed the issue that some agencies are using the binder specifications M 320 and MP 19 with recycled tire rubber (RTR) binders. So the question being asked, do the specifications provide equivalent results for RTR binders. D'Angelo acknowledged the agencies (Paragon Technical Services and MTE Laboratories) that are involved in the testing trying to answer that question on this topic.

This study is using an SPS typical PG 76-22 grade that is modified with a RTR using different amounts of rubber and ground to various mesh sizes. D'Angelo explained the experimental design for this study. He reported the cup and bob tests have yet to be completed. The RTR size selected for use in this study was to ensure the mesh sized rubber particles were the same for the parallel plates and cup and bob tests. Four different gradations or mesh sizes were used in testing program.

D'Angelo presented the test results relative to the PG 76 for the high temperature binder properties. For the stiffer materials, the data were not included in the graph because those would grade out to a different temperature grade. In terms of M 320 most of the binders are PG 76. However, there is a wide range in G*/sin δ from the low end of the grade to the top end. In fact, the MSCR indicates that the binder vary over three grades from a 64V to a 64E+. M 320 showed equivalent properties, while MP 19 indicates variations in properties.

Polymers like SBS set up networks in the binder to improve elasticity and toughness to reduce cracking. RTR may provide some networking but primarily provide elastomeric filler which also improves elasticity and toughness to reduce cracking. D'Angelo showed images of the polymer structure, and reported the rubber particles act like steel in PCC to change or alter the direction of the crack and its properties. Rubber has shown good performance in resisting cracking, but may not provide adequate percent recovery responses using current testing methods.

D'Angelo included some illustrations in his report to demonstrate RTR does not provide equal percent recovery to polymer modified binders (PMB). One illustration included Jnr versus percent Recovery for PMB and rubber blends and showed the elastic response in comparison to the measured response to the different binders. Another illustration showed some of the cup and bob data. These results showed the Jnr changes with percentage of RTR and its geometry (percent rubber versus Jnr at 3.2 kPa). D'Angelo noted with the percent recovery you start to see differences with the cup and bob compared to the parallel plate. This has to do with the illustration showing the change in percent recovery with percent RTR and geometry. Results indicated that we need to be careful with parallel plate testing.

D'Angelo referred to previous studies which indicated the cup & bob geometry had compliance issues with intermediate DSR testing and larger gap sizes may be needed for larger mesh size rubber. He also reported the larger gap sizes at high temps resulted in sagging of sample, but at intermediate temperatures it may be workable. D'Angelo included photos of the 8 mm plates with 4 mm gap at intermediate temperatures to illustrate probably need to go to a large plate size. If particle size is an issue with test results, the question becomes how to develop control to validate gap size results. D'Angelo noted torsion bar testing at low and intermediate testing has been used historically because its geometry reduces or eliminates particle interaction issues. This could be used as a control to compare to parallel plate testing.

D'Angelo showed results from the torsion bar tests to those from the 2 mm gap parallel plate tests. The torsion bar test provides higher modulus results than the 2 mm gap parallel plate, even for the 30 mesh rubber at a 15% concentration level. At higher rubber concentration levels, a larger gap may be needed. D'Angelo described the 30 mesh results as compared to the 20 mesh results—the results were very similar to what was presented for the 20 mesh size results.

In summary, D'Angelo reported the smaller mesh RTR reduced the intermediate temperature modulus of binders, while increased RTR percentage increases that reduction but larger RTR particles did not show the same reduction. In addition, at high temperatures M 320 and

MSCR do not provide equivalent results for the rubber and PMB binders. MSCR has been verified to more closely relate to high temp performance of binders. The MSCR percent recovery is different for PMB and RTR binders (the percent recovery relates to internal structure not directly to performance) and there may be a need to develop a new relationship for RTR binders. In addition, RTR binders can be produced to be equivalent to PMB binders; the MSCR is more discriminatory than the M 320 specification, but more work is needed to determine internal structure of the RTR binders and its relationship to performance. RTR improves intermediate DSR properties, but its affect is size dependent.

ETG Comments, Questions, and Discussion:
Chris Abadie asked if the intermediate temperature continues to increase or change with the finer the mesh size. D'Angelo noted the larger mesh size the more issues with sample size.

Bob Kluttz asked if we know for a fact that the homogeneity will be the same between the parallel and cup and bob test. D'Angelo replied that was confirmed before anything else was done.

Bob McGennis asked how to include rubber in binders relative to the time issue. D'Angelo explained the process used: mixing, let cool, reheat and test; and noted everything was tested at the same time. He noted as the rubber reacts with asphalt the properties do change and noted time will make a difference. McGennis asked if the rubber from the same source. D'Angelo replied it was not from the same source, but in his opinion, this was not an issue. D'Angelo did comment however, they may need to look at different sources regarding the results. Kluttz noted that need to be careful about the equilibrium issue the end will not always be the same. D'Angelo agreed with the comment. He noted the materials were produced and mixed at the same high temperature. The temperature was held constant and that is why they used the same time. One sample was produced and then broken down into smaller sample sizes for testing.

Ala Mohseni commented that he believes the difference between the cup and bob and parallel plates is related to the total strain. D'Angelo noted the recovered strain was a little higher. Mohseni commented it appears the difference is related to confinement, in other words the cup and bob has more confinement and could be the reason for the higher values. D'Angelo disagreed with that comment; in his opinion the cup and bob has less confinement. Mohseni referred to Hussain Bahia's suggestion in a paper that the cup and bob has more confinement which could be the reason for the difference. D'Angelo stated the cup and bob results in higher modulus values, and the recovery was higher than for the parallel plates.

Baumgardner noted no ETG action is required for this item until after the SoM/Tech Section ballot. An update on this issue will be made at the next ETG meeting.

10. Update on the 4mm-DSR Spinoffs—Mike Farrar (Western Research Institute)

Presentation: *Recent Developments at WRI on the 4 mm DSR Status and Spin-Offs*

Summary of Presentation:

Mike Farrar reported this is a status on the development and use of the 4-mm DSR and review of the spin-offs from this device. He noted the 4-mm sample is an extremely small size sample, but the DSR is a more precise piece of equipment so if it is applicable, it should be used. Farrar reported that the 4-mm plate option is in the redlined version of the AASHTO T 315 that Dave Anderson prepared. In addition, a final report has been submitted to FHWA on the development of this device, as well as a Tech Brief. Both are currently under review by FHWA.

A number of peer reviewed products and spin offs have occurred from this work. Farrar showed a summary of recent developments and publications using the 4-mm plates.

Farrar acknowledged the research conducted at WRI and the sponsorship from FHWA on this topic. He noted the manufacturers are onboard with this device and are looking at the theoretical components.

Farrar identified some of the spin offs from this work and equipment. He started with the rheology, specifications, USAT and field sampling. In his opinion, the USAT can and will eventually replace the RTFO. Farrar stated the USAT does work for modified asphalt and it does not creep off the plate. He noted the testing of modified asphalts is explained in an ISAP paper that was recently completed. He does not believe turning the temperature down for WMA is an option for aging, and stated you can age the binder in about 8 hours.

Farrar reported the emulsion residue recovery and aging was just published. It is simpler as compared to AASHTO TP 71-11, Method B. Farrar also showed a draft method in AASHTO format for sampling and extraction. He reported this draft is available for others to use. He showed a schematic of the process, and asked if anyone has an interest in a super micro-extraction method. He noted 50 grams of mix yields about 3 grams of asphalt and showed a schematic of the process.

In conclusion, the 4-mm DSR has resulted in a number of new, innovative technologies that may be adopted by the asphalt paving community for application.

ETG Comments, Questions, and Discussion:
It was asked how the 2-mm results compare to 8-mm sample size relative to the problems that occurred for trimming the 8-mm plates. Farrar replied that with the frequency sweep and their 4 rheometers they get the same result. So it appears to have good repeatability between the instruments. Farrar stated trimming is an issue, but their technicians believe the trimming of the 4-mm plates is easier than for the 8-mm plates. Training for specimen trimming is important to get consistency in the test specimen. He also explained that adhesion is important and that is the reason they warm the plates—primarily from an adhesion standpoint. Farrar noted in the final report and Tech Brief, they show how to manually correct for machine compliance to verify the manufacturer's machine compliance correction. Farrar stated all of this is in their final report.

Dave Anderson asked if diffusion was examined and whether it is still diffusion controlled. Farrar replied it is in their final report but in limited detail. Diffusion was not explained very well in the report and they have yet to thoroughly look into diffusion regarding any thickness

effect. Anderson noted that need to eliminate the effect of the pavement conditions to relate performance to properties. Farrar agreed with that comment. He also noted the TSRT was evaluated by Elie Hajj and they have compared their results to those from Hajj. Farrar reported their results compared very well. Farrar noted there is some steric hardening that occurs in the TSRST specimen because of the cooling effect.

11. CAS Fracture Toughness – Chip Seal Binders—Mike Farrar (Western Research Institute)

Presentation Title: *Concept for a New Chip Seal Emulsion Test—Chip Adherence Stability (CAS) Test*

Summary of Presentation:
Mike Farrar reviewed Wyoming's experience with chip seals. On one project, one lane exhibited snow plow damage while in other areas little snow plow damage was observed. Farrar reported they collected material from this project to determine the reason for extension snow plow damage in selected areas along the project. Wyoming's opinion was that the development of a test that can help predict chip seal performance would be invaluable. In other words, a test that can show how a particular product can be expected to perform in a particular service environment over the performance period could benefit manufacturers, contractors, and end users.

Farrar discussed the Chip Adherence Stability (CAS) test. It is an adhesion test with tensile and shear loading components. It uses variable controlled stress rate and test temperatures, and has stress or strain controlled capabilities. It can measure creep compliance and various modulus values, as well as adhesion. Multiple measurements are made simultaneously to provide statistically significant data. The film thickness of the test is relevant to field conditions. The CAS test basic concept is to prepare test adhesive joints, age the joints in a prescribed manner, and measure the strength of the aged joints. Farrar showed the prototype design of the CAS test and a schematic of the test apparatus.

In conclusion, Farrar stated the CAS test is a promising new concept regarding laboratory chip seal testing. WRI is currently developing a prototype test.

ETG Comments, Questions, and Discussion:
Geoff Rowe mentioned the pendulum test from Europe as something very similar to this test. But the proposed standard is much more detailed than the European test. Rowe commented he has some data that he will share with Farrar on this topic.

Gaylon Baumgardner asked Farrar to search TRB for a paper from Isaac Howard describing the Faust marble test, which was presented a few years ago. The test used by Howard is very similar to what he was proposing.

12. Single Edge Notched Bean Procedure—Hassan Tabatabaee (University of Wisconsin at Madison)

Presentation Title: *Draft Standard for Single Edge Notched Bending (SENB) Test for Binder Low Temperature Test*

Summary of Presentation:
Tabatabaee presented an update to the draft standard based on recommendations made by the ETG in previous meetings. The items included in this report are an overview on the background and significance of the Bending Beam Rheometer (BBR)-SENB test, and how previous ETG concerns or action items were resolved.

The overview report given by Tabatabaee included the following items:

- The problem statement and motivation which lead to the development of the BBR-SENB test. In summary, modifying the BBR and test specimen to measure fracture properties and strain tolerances. The purpose of BBR-SENB is to rank binder resistance to thermal cracking damage.
- Modifications made to the BBR equipment and test specimens. Tabatabaee reported a more recent change was going to a stepped motor for a displacement controlled mode.
- A summary of the BBR-SENB analysis method including the pseudo (elastic)-deformation analysis to determine the contribution of non-elastic and viscous deformation. This portion of the report included the fracture energy definition and concept. This concept or method is only valid for elastic failure conditions – the classical stress concentrations in fracture mechanics.
- The pseudo-deformation analysis is the ratio of elastic to total energy which was compared relative to the binder glass transition and the ratio varies with binder type and temperature. Both viscous and fracture energy resist damage. By using a temperature below the glass transition temperature nearly all of the energy is elastic. The BBR-SENB total and elastic failure energy correlated very well, which implies components do not need to separated. Separating elastic fracture energy from BBR-SENB total energy is unnecessary in terms of how they are using the results from a ranking standpoint.
- Effect of loading rate or cooling rate on results. The question is what loading rate corresponds to what happens on the roadway, which is the rate that should be used in the laboratory. The strain-rate in thermal cracking is dependent on pavement cooling rate and the coefficient of thermal expansion.
- Multi-scale analysis of thermal contraction: the analysis was completed in four phases. The first was to use finite element multi-scale micromechanical modeling used to measure binder strain-rate in constrained pavements. The other phases were related to simulating the aggregate particles, the asphalt binder, and the mastic. Results show considerable strain distribution in continuous phases, even though the bulk mixture is constrained against thermal contraction. Tabatabaee reported the BBR-SEENB rate can simulate pavement contraction conditions and can be used to set up the binder grading framework.
- The ETG expressed concerns on the cooling fluid. In reply to this concern, a new effort is underway and they are working on this. Beams float to the surface of the potassium acetate which is not useful to the test.

Tabatabaee recommended the BBR-SENB test be forwarded to AASHTO for the following reasons; industry does not have an accepted fracture test, using ductility and forced-ductility

is misleading, an EN standard already exists, the direct tension device is no longer produced or available, and compared to the ABCD test, the BBR-SENB can be run using the BBR device and provides failure properties rather than Tc. He also commented further recommendations from ETG were probably not needed.

In conclusion Tabatabaee acknowledged agencies and individuals that have contributed to the development of the BBR-SENB test. He also announced an upcoming workshop on this topic which will be delivered on November 13 and 14, 2013. The last item Tabatabaee reported on was the stress state of the binder in the pavement. They are evaluating this condition to try and determine what stress states should be used in the test. Tabatabaee emphasized stress state is a critical item of the test because the results are used to rank the binders or materials, so the stress conditions need to represent the same stress conditions in the pavement. Tabatabaee showed a comparison of the torque predicted and measured crack length. They are also looking at the raw data of strain versus time in the revised LAS test.

ETG Comments, Questions, and Discussion:
John Bukowski reminded the group that the AASHTO SoM wants comments from the group and not just one view point. John D'Angelo asked how you control the rate. Tabatabaee replied this is the reason they went to a stepped motor. Beth Griffin asked if cyclic loading could be used. Tabatabaee replied that they currently do not do cyclic loading, but the equipment could be modified to do cyclic loading.

Pamela Marks asked why is the information from Ontario no longer used. D'Angelo replied that it was related to the equipment. Tabatabaee also noted there were problems with sampling and practical implications of the equipment. Tabatabaee also mentioned their samples/beams are about double the size from the ones that were used in Ontario. He also noted metal beam extensions are used. Marks requested details on the sample size. Tabatabaee agreed to send them.

13. Mortar Binder Grading Procedure—Andrew Hanz (University of Wisconsin at Madison)

Andrew Hanz not attending the meeting, so Hassan Tabatabaee gave the report for Hanz.

Presentation Title: *Draft AASHTO Test Procedure for RAP Mortar Grading Procedure*

Summary of Presentation:
Hassan Tabatabaee overviewed current practice in this area. The limits are based on percent recycled material or percent binder replacement. AASHTO M323 assumes 100% blending of the recycled and virgin binders but there are different limits for RAS and RAP and all RAS and RAP sources are treated as equal. Tabatabaee identified the two technical issues: (1) the assumption of 100% blending is not correct and the extent of blending is temperature and time dependent; and (2) chemical extraction has technical and practical issues in that it does not consider the effect of time and temperature and the chemicals may have an effect on the measured properties.

Tabatabaee summarized the procedure which is based on composite theory for estimation of RAP binder performance grade. This procedure results in two benefits, which are:

incorporates the effects of blending time and temperature in the sample preparation procedure, and chemical extraction is not necessary.

Tabatabaee showed an example to determine the effect of aggregates on the m-value. He reported there is a spreadsheet available to accommodate the computations, which is much simpler than running an extraction test. Tabatabaee included a schematic for determining the blended binder continuous grade. Tabatabaee reported they have an independent verification part of the blending study which is an UNR study objective. UNR compared methods for estimating the effects of RAP on the low temperature grade of the binder and then compared the binder grade results to mixture performance using the TSRST test.

To estimate the degree of blending, the process must be understood. Blending is a diffusion based process that depends on conditions (time and temperature) and material properties, as well as the concentrations of the virgin and aged binder. The softer material dominates the response. The next item discussed was the proof of concept for blending results. Tabatabaee included illustrations and graphs showing conditioning time and G*. The degree of blending is influenced by production temperature, but no blending occurs at the service temperatures. Blending proof was also done for RAP mortars, and Tabatabaee included illustrations and graphs showing conditioning time versus G* for RAP mixed materials.

Some observations related to effects of RAP on blending: selection of time and temperature to achieve blending are dependent on the RAP binder source, and the results are consistent with the diffusion concept. A similar study is needed for RAS.

Tabatabaee overviewed the test procedure which was a summary of the spreadsheet that is available for the evaluation. For mortar evaluations, the inputs are the test measurements and the output is the binder grade. The reported values are the virgin binder properties and mortar properties. Tabatabaee's recommendation is to move the procedure forward to AASHTO for consideration.

ETG Comments, Questions, and Discussion:
Gayle King asked about the blending of soft and hard asphalt to get a different G*. His issue is that we restore the G* as it originally was, but we are designing it to crack because of the m-controlled, rather than the s-controlled binders. The criteria need to be finalized so the manufacturers can program the equipment software.

Ioan Negulescu referred to the amount of organics and molecular weight of materials. He questions the validity of this approach. Tabatabaee agreed with the difficulty

John D'Angelo voiced his concern in trying to calculate the m-value by using mastic beams. Tabatabaee believes that has been addressed because of the older asphalt being used. Reinke opinion is that the interaction of the aggregate should not be a problem because of the amount of asphalt used in the beam. Tabatabaee stated there is a lot of asphalt in the mortar which is predominately fresh or new asphalt. D'Angelo referred to what Bahia had presented in previous meetings in that they needed to be around 2 percent air voids. Tabatabaee noted their binder replacement is around 25 to 30%. Reinke and Dave Anderson both agreed that the calculated m-values should be fairly representative to the measured values.

Sandy Brown referred to a study presented at the TAC this year on the use of Teflon between a hard and soft asphalt to determine diffusion rates. He reported based on the mixing time, silo storage time, and time prior to completing compaction, there was time to have completed blending or diffusion between 2 ½ mm layers. Brown commented that does not appear to be the conclusions with this approach. Tabatabaee replied the temperatures are different. Brown suggested that Tabatabaee or Hanz read this publication because of the different conclusions being reached. Tabatabaee noted this was just to determine the impact of time and temperature. Brown understood that focus but noted the heat profile going through a plant, blending by diffusion was complete prior to compaction. Tabatabaee agreed with that comment and noted their data also shows this but just with different temperatures and conditions. Brown noted the results of this approach suggests the black rock theory still exists as with blending charts, but the other data suggests they do blend. Data shows that it is not black rock.

Bob Kluttz asked are the materials continuously oscillated. Tabatabaee stated they are not continuously oscillated. Brown also noted from the other work that the material was held in the DSR and then oscillated. D'Angelo commented Tabatabaee's data is basically showing the same thing.

Baumgardner adjourned the meeting for the first day at 4:30 pm.

DAY 2: Wednesday, 18 September 2013

Call to Order – Gaylon Baumgardner called the meeting to order at 8:00 am.

Bukowski made an announcement that there is a continuation of the LAS test in a Wisconsin led pooled fund study. The solicitation is available at the FHWA pooled fund site and asked ETG members for comments.

ACTION ITEM #6: Review and comment on Wisconsin DOT pool fund request for solicitation. Comments to be sent back to John Bukowski. The results or comments of which will be reported at the ETG meeting.

14. Recovered Engine Oil Modifier-Update—John D'Angelo (D'Angelo Consulting)

Summary of Presentation:
John D'Angelo reported this is a follow up to the presentation made last spring on refined engine oils—a re-refined product. D'Angelo explained that in the refinery process, light ends are removed and significant amount of oil remains. This is referred to as the bottoms which are very close to the asphalt product.

D'Angelo overviewed the previous work that has been completed under this topic. He also listed the binder and mixture tests that have been used to evaluate these materials and determine how they will perform. The tests and their results discussed in more detail were:

moisture sensitivity, strength, rut resistance, and fatigue cracking tests. As an example, D'Angelo showed some results from the Texas Overlay Tester. Increasing the amount of the materials as an additive to the binder, they saw an increase in resistance to cracking. Reinke asked what was the original binder grade for this example. D'Angelo replied they were a PG 64-22 and as the amount of additive was increased, the grade went to a PG 64-28. Rowe asked how failure was defined or designated, based on the earlier comment about not failing. D'Angelo replied the failure is the number at the end of the test.

D'Angelo explained the experimental design plan and how samples were prepared and aged, as well as monitored regarding the aging and moisture conditioning. After the explanation of conditioning, D'Angelo listed the tests being used to evaluate the materials. These include: AASHTO T 283 (moisture damage; Illinois Modified), AASHTO TP 79 (dynamic modulus and flow number), AASHTO T 324 (Hamburg Loaded Wheel; Illinois Modified), ASTM D 7313 (fracture energy), and ASTM D 7460 (flexural beam fatigue). D'Angelo provided and overviewed a tabulation summary of the test results. A summary of the findings identified by D'Angelo are:

- Moisture Damage in accordance with AASHTO T 283 – an improvement in the test results after being repeatedly subjected to water. They saw no deterioration in the samples. There was a huge improvement in TSR ratios.
- Dynamic Modulus in accordance with AASHTO TP 79 – Focused on the initial part of the master curve. They saw a difference in stiffness which was not seen in other tests.
- Flow Number in Accordance with AASHTO TP 79 – Flow number was conducted at 47.5°C. D'Angelo pointed out that one of the specimens was significantly softer and different from the other results, so they concluded it was damaged.
- Fracture energy tests – showed no difference. After aging no difference, but prior to aging material was softer compared to conventional binder.
- Hamburg Loaded wheel tests – no difference in results.
- Beam Fatigue – results presented in terms of a graph comparing the micro-strain versus cycles to failure. D'Angelo reported the micro-strain was changed prior to and after aging which was illustrated on graph. The material had a better or at least equal resistance to cracking relative to the conventional materials.

D'Angelo summarized overall findings from this work with EcoAddz. In summary, EcoAddz blended well with asphalt and was not prone to separation; did not increase aging of the binder, its effect is controlled by the base asphalt; reduces both the high and low temperature properties of the binder; did not increase moisture damage potential; improved the fatigue response of mixes; and improved fracture energy properties of the mix. The fracture energy properties of mixes with the 6% EcoAddz and the 6% control showed similar aging in the accelerated weathering study. Overall the 6% EcoAddz mix does not show any increase in negative performance with aging over the 6% control mixes in the accelerated weathering device.

ETG Comments, Questions, and Discussion:
In reply to a question, D'Angelo answered the material contained no naphthenic aromatics or waxes. They fit into the soft end of the binder.

Reinke asked why did you blend the 64 to get the 68-20. D'Angelo replied this was to match the modulus of the materials as closely as possible. D'Angelo noted they blended with a flux oil from the refinery to match the grades almost exactly on the low and high end of the temperatures. Reinke would not really call it a flux, but a very soft material. D'Angelo noted that in the direct tensile test there was no loss of strength and the strain at failure went up. They saw improvements in fatigue life and direct tensile test, but not in the BBR test. King thought he would have expected more s-controlled rather than m-controlled materials. D'Angelo agreed, and noted it is a very soft material.

Bob Kluttz recommended the chemical composition of the materials be evaluated because of those observations. King mentioned this is an important source for recycling for the materials, so this is really important. D'Angelo agreed, and noted it blends almost immediately and they purposely used aggregates from Illinois because they were identified as problem aggregates.

McGennis noted there are other things that come with this material like metals that really do bad things. D'Angelo agreed and noted that item was discussed in a previous AAPT paper. McGennis noted the materials do vary, they are not all the same and that not all are napthene free.

15. BBR Binder Strength and the Ethanol Effect—Mihai Marasteanu (University of Minnesota)

Baumgardner reported Mihai Marasteanu was unable to attend so Ioan Negulescu will make the presentation.

Presentation Title: *Ethanol Effect on BBR Binder Strength*

Summary of Presentation:

Ioan Negulescu noted he will present the chemical part of this report in answering various questions and/or concerns from the ETG ; Marasteanu will address any questions on a non-chemical issue.

Negulescu stated low temperature cracking is the dominant failure mode in asphalt pavements built in cold regions. Currently, asphalt binder low temperature behavior is characterized using the BBR and the DTT. BBR is used to perform low temperature creep tests on beams of asphalt binders conditioned at the desired temperature for 1 hour in ethanol. The DDT is used to perform low temperature uniaxial tension tests at a constant strain rate on asphalt binders conditioned at the desired temperature for 1 hour in potassium acetate. The main difference in conditioning between the two is ethanol versus potassium acetate. Negulescu stated the objective of the work is the possibility of obtaining bending beam strength of the asphalt binder using a modified BBR device. This would allow performing both creep and strength tests using one device and using the same beam specimen – similar to the IDT.

Negulescu overviewed the BBR and DTT tests and equipment. BBR strength tests in three cooling media and the conditions were set to have the same strength value to DTT. The three

cooling media were ethanol, aqueous cooling fluid containing 42 percent potassium acetate, and sodium fluorescein being added to these two cooling media. A key concern with using these media is the potential diffusion of the cooling media in the BBR samples which could change the binder behavior and/or grading.

The evaluation procedure included testing BBR samples cut from original BBR samples. The samples were prepared with a PG 64-22 binder and immersed in a glass vial containing the two cooling media with sodium fluorescein for 75 minutes. Tetrahydrofuran solutions of the washed samples were made and the fluorescing characteristics measured and compared between the different samples. Negulescu maintained 75 minutes was sufficient to define any diffusion prior to conducting the tests. A fluorescence spectrum of sodium fluorescein was used to determine if any diffusion had occurred in the test specimen. Negulescu showed an example of the fluorescence spectrum and explained the results from the diffusion of the cooling media into asphalt which might act as a softening plasticizer that will lower the strength of the binder and affect the grading process.

The binder mean strength was measured on the different samples and Negulescu reported the results suggest that the strength in air and potassium acetate is similar for the same type of test. He also reported the DTT strength values were different from the BBR values, but in order to compare apples to apples, you need to take into account two things: (1) the DDT specimen size is different compared to the BBR, and (2) the stress state is different in DDT compared to the BBR. Thus, the comparison between the BBR and DTT mean strength values is dependent on structural strength on the structure size, geometry, and stress field.

Negulescu suggested using the size effect theory to account for these differences. Negulescu overviewed the analyses completed and the approach used in comparing the strength values between two different tests. Negulescu overviewed and explained the conversion of BBR strength values to DTT strength values. Using the conversion theory to account for specimen size effects, the DTT values were similar to the BBR strength values.

In summary, the size effect of binders was investigated and the possibility of obtaining three point bending strength by testing small beam specimens with the BBR was evaluated. The conclusion was that cooling medium has a strong effect on BBR binder strength. Based on sodium fluorescein tests, ethanol diffuses in asphalt while potassium acetate solution does not. In addition, the use of potassium acetate and air result in similar binder strength values, while strength measurements in ethanol are much lower. The corrosive nature of potassium acetate makes the use of air as cooling medium an attractive option.

Accurate comparison of BBR and DTT strength values can be performed only if the differences in stress field, volume, and geometry between the two types of tests are taken into account. Based on size effect analysis, the converted BBR strength values match closely the corresponding DDT strength values.

ETG Comments, Questions, and Discussion:
Bob Kluttz asked why use florene, and Negulescu replied because it was available. Kluttz noted an issue with the DTT is the temperature calibration using an air system and how well

can you control temperature accurately. Negulescu replied you can control it within the limits of the tests.

King asked how long it takes to reach equilibrium using air. Negulescu commented it takes more than an hour. King replied then could have an issue with physical hardening. Negulescu showed the results comparing different hardening effect which was presented in the report – asphalt binder mean strength. Kluttz noted, as far as temperature control, strengths do not vary that much, but stiffness does and the slope seen in the slide presented is a concern regarding the difference between the materials. Dave Anderson noted air systems are unreliable, all of the original SHRP work was done in air controlled systems.

16. "Redlines" AASHTO Binder Procedure Standards—Dave Anderson (Consultant)

Report/Presentation: *Update*
Dave Anderson asked John Bukowski if the ETG received the redlined versions. Bukowski replied yes, based on what was submitted after the webinar. Bukowski acknowledged Maria Knake's effort on this task, and stated the goal was to streamline the test methods and make them more applicable regarding the "right way" to do the test. Dave Anderson reported the redlined versions are the result of many individuals and agencies, like the Asphalt Institute, in providing recommendations. He also stated the redlined versions were not intended for equipment revisions but were intended to assist anyone doing the test or interpretation of the test results; as an example, generation of the master curve.

Dave Anderson requested feedback as soon as possible for the ASTM and AASHTO ballots. He needs any input/comments within the next few weeks. Anderson also acknowledged Maria Knake's effort relative to the webinar on this topic. Bukowski asked if this will this be an AASHTO SoM Tech Section ballot or full ballot? Anderson was unsure since he had not yet confirmed with Eileen Sheehy. Chris Abadie thought this would be a full ballot. Bukowski reported he sent the redlined versions to the Binder ETG, but anyone else (Friends of the ETG and others) can provide comments. Bukowski mentioned that anyone wanting the redlined versions to give him their contact information and he will send them the redlined versions.

17. Pavement Preservation ETG – Emulsion Task Force Update—Lee Gallivan (FHWA)

Presentation: *Update*
Lee Gallivan gave the report and acknowledged members of the Task Force.

Summary of Presentation:
Lee Gallivan started with the background on why this Task Force was created. He noted the workshop arranged by Gayle King and titled: Progress Towards Performance-Graded Emulsion Specifications. King reported there is a circular available from that workshop.

Gallivan overviewed the recent meetings and status of the task group. The intent of the task group is to provide asphalt binder material/testing related input regarding any changes to the emulsified asphalt standards. Information will be provided to Tom Van, FHWA as the lead for the Emulsified Asphalt TWG.

The Emulsified Asphalt TWG members include representatives from industry groups (AEMA, ARRA, ISSA), academia or universities (Colorado State, Texas A&M, University of Wisconsin, Cal. State, North Carolina State), State DOTs (California, Louisiana, Indiana, Iowa, Rhode Island, Texas, Utah), FHWA and the National Center for Pavement Preservation.

Gallivan summarized AASHTO specifications: TP 91 – Determining Asphalt Binder Bond Strength by Means of the Binder Bond Strength Test; PP 71 – Certifying Suppliers of Emulsified Asphalt; and PP 72 – Recovering Residue from Emulsified Asphalt Using Low-Temperature Evaporative Techniques. Gallivan also identified additional standards that are now being developed.

ETG Comment, Questions, and Discussion:
Gayle King discussed the process about separating test procedures; those that are being evaluated versus those we want to use in the future. King mentioned Abadie can help distinguish between the two groups from AASHTO's perspective. Bob Kluttz noted the problem is that the title is wrong regarding the standard. He suggested the title include experimental method – something that states this method is not ready for "prime time" needs to be in the scope or definition at the beginning. King agreed with the comment, and noted we just need a way for people to work with the method prior to it being a standard.

Reinke noted there is a need to identify which standards/changes should move forward.
Bukowski noted this Task Force with a cross section of members with binder expertise can provide valuable input for any standard changes related to asphalt binder properties and testing. Reinke viewed this Task Force as providing information specific to emulsion testing and agreed with forming a group under the binder ETG. The ETG members that initially volunteered include: Reinke, Rowe, McGennis, Morgenstern, Abadie, Howard Anderson, King, Baumgardner, Planche, and Gallivan. Some members also suggested that Darren Hazlett be a member of this task group. King requested the pavement preservation group be kept knowledgeable on the activities of this group so there is coordination. Bukowski agreed with that request.

ACTION ITEM #7: Form a Task Force on asphalt emulsions. The Task Force was asked to report back to the group at the next meeting on activities. Task Force members include (see Appendix C): Chris Abadie, Howard Anderson, Gaylon Baumgardner, Lee Gallivan, Darren Hazlett (suggested that Hazlett participate even though he was not in attendance), Gayle King, Bob McGennis, Bruce Morgenstern, Jean-Paul Planche, Gerald Reinke, and Geoff Rowe.

18. Continuation of Discussion on MSCR Recovery Procedure—Matt Corrigan (FHWA)

Corrigan wanted to review some of the MSCR activities from the previous discussions.

Corrigan noted this relates to moving the MSCR from a provisional standard to a full standard. He stated that one item that did not pass on the SoM ballot was "Evaluating the

Elastic Behavior of Asphalt Binders Using the MSCR Test." Comments from the ballot were received, but Mike Anderson was unable to report on those comments because he was not able to attend the SoM meeting.

Corrigan noted a revised draft standard was prepared and Bukowski sent it out for comment prior to this meeting. Corrigan asked for comments on this draft, and referred the ETG to Figure 1 in the standard. Corrigan noted to move forward, we need comments so this can be moved through AASHTO. He asked all ETG members to review the revised standard and provide comments back so AASHTO can move it along for balloting. Corrigan reported this would be an option in the MSCR protocol, and stated some agencies in the Northeast want to use it in their specifications.

Rowe asked if this should the log scale be used. D'Angelo replied for comparing the Jnr 3.2 versus the recovery, a linear versus linear plot is acceptable because comparing one point, not multiple points. He noted, however, a log scale could be used. Rowe stated; he prefers to use the log scale. Reinke agreed with D'Angelo's comment for this use.

Pamela Marks asked about truncating the values. This question and comment was under section 7.4.2 or note 1. D'Angelo noted you can have numbers around 1.1 or in that region but normally you would never get materials in that range, because with very low values, the variability goes up. Corrigan summarized the discussion in referring to Note 1 under section 7.4.2 and summarized the recommendation from the Note. He pointed out that the graphic (Figure 1) is to reflect that note and recommendation.

Corrigan noted the intent of this continued discussion is to move it onto AASHTO. He replied; if you do not get the comments quickly, the SoM will assume there is no more interest by the ETG. All comments on the document should be sent to Mike Anderson.

ACTION ITEM #8: Review proposal for use of MSCR as a replacement for elastic recovery; comments to be submitted to Mike Anderson no later than October 31.

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

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

1. Chris Abadie was asked to take the issue to AASHTO to see if they would sponsor a web site for making these research test methods available for trial use by industry. Abadie agreed to take this issue to AASHTO at the next meeting.

2. Intermediate temperature Task Force will proceed as instructed to provide an update to be presented at the next ETG meeting. Anyone interested in participating in this group should contact Mike Anderson.

3. The recommendation is to amend Table 1 in M 320 to include a reference on the three test temperatures representing footnote f of the current method. The task group will be

on the agenda for the next ETG meeting to make a possible recommendation to the SoM. Any comments on this topic should be sent to Matt Corrigan prior to next meeting for consideration.

4. Matt Corrigan will report on activities and comments regarding the SoM Task Force on MSCR temperature selection.

5. A report will be made to the ETG at the next meeting, if necessary, on the SoM ballot on the Linear Amplitude Sweep test with respect to ruggedness testing.

6. Review and comment on Wisconsin DOT pool fund request for solicitation. Comments to be sent back to John Bukowski. The results or comments of which will be reported at the ETG meeting.

7. Form a Task Force on asphalt emulsions. The Task Force was asked to report back to the group at the next meeting on activities. Task Force members include (see Appendix C): Chris Abadie, Howard Anderson, Gaylon Baumgardner, Lee Gallivan, Darren Hazlett (suggested that Hazlett participate even though he was not in attendance), Gayle King, Bob McGennis, Bruce Morgenstern, Jean-Paul Planche, Gerald Reinke, and Geoff Rowe.

8. Review proposal for use of MSCR as a replacement for elastic recovery; comments to be submitted to Mike Anderson no later than October 31.

A final action item from the May 2013 meeting was postponed until the next ETG meeting because Haifang Wen could not attend this meeting. 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.

Bukowski again thanked Walaa Mogawer for hosting the meeting. Potential meeting locations include: Austin and Utah DOT through the University of Utah (Pedro Ramero). He reported they are trying to get a location through a university or agency to reduce meeting location funds.

20. Wrap-Up and Meeting Adjournment

Baumgardner asked for any other comments or business.

- Dave Anderson stated he and Geoff Rowe are doing a workshop through the Asphalt Institute and there are still openings to attend that workshop.
- Bukowski welcomed Pamela Marks (Ministry of Transportation, Ontario) as the liaison from Canada.

No other comments or announcements were made. Both Baumgardner and Bukowski thanked everyone for attending and adjourned the meeting.

The meeting was adjourned at 10:30 AM.

ATTACHMENT A

Asphalt Binder Expert Task Group
Fall River, MA
September 17-18, 2013
Meeting Agenda – Draft

Day 1 – September 17, 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**
8:30 am	MSCR Recovery Procedure: Draft AASHTO Procedure	**M. Anderson**
9:00 am	Intermediate Temperature Task Group Activities	**M. Anderson**
9:30 am	Break	
10:00 am	Task Force for MSCR Temperature Selection	**Corrigan**
11:00 am	Update on LAS TP101 Testing Results	**Bahia**
11:30 am	Task Group Recommendations Binder Thermal Cracking Test	**Wen**
Noon	**Lunch Break**	
1:00 pm	Rubber Modification Testing Results	**D'Angelo**
1:30 pm	Update on the 4mm-DSR Spinoffs	**Farrar**
2:00 pm	CAS Fracture Toughness - Chip Seal Binders	**Farrar**
2:30 pm	Single Edge Notched Beam Procedure	**Tabatabaee**
3:00 pm	**Break**	
3:30 pm	Mortar Binder Grading Procedure	**Hanz**
4:30 pm		

Adjourn for the Day

Day 2 – September 18, 2013

8:00 am	Recovered Engine Oil Modifier-Update	**D'Angelo**
8:30 am	BRR Binder Strength and the Ethanol Effect	**Marasteanu**
9:00 am	**Break**	
9:30 am	"Redlines" AASHTO Binder Procedure Standards	**D. Anderson**
10:30 am	Pavement Preservation ETG – Emulsion Task Force Update	
11:00 am	Summary of Action Items	
11:30 am	Adjourn	

ATTACHMENT B

ASPHALT BINDER EXPERT TASK GROUP MEMBERS

Chairman: **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	Co-chairman: **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
Secretary: **John Bukowski** FHWA Deputy Director HIPT Federal Highway Administration 1200 New Jersey Avenue, SE Washington, D.C. 20590 Phone: 202 366-1287 Fax 202-493-2070 John.Bukowski@dot.gov	
Members :	
Christopher Abadie Materials Engineer Louisiana DOTD 5080 Florida Blvd. Baton Rouge, LA 70806 Phone: 225-248-4131 cabadie@dotd.louisiana.gov	**Dr. David A. Anderson** Professor Emeritus of Civil Engineering Penn State University Penn Transportation Institute 201 Transportation Research Board University Park, PA 16802-2321 Phone: 814-237-8585 daa@psu.edu or DA.SC@COMCAST.NET
John D'Angelo Consultant 8528 Canterbury Drive Annandale, Virginia 22003 Phone: 571-218-9733 Johndangelo@dangeloconsultingllc.com	**Georgene Geary** Georgia Department of Transportation State Research Engineer Forest Part, Georgia Phone: 404-608-4712 ggeary@dot.ga.gov

Darren G. Hazlett Deputy Director Construction Division Texas Department of Transportation 125 E. 11th Street Austin, TX 78701-2483 Phone : 512-416-2456 Fax: 512-506-5825 darren.hazlett@txdot.gov	**Gayle King** GHK, Inc. 15 Quick Stream Pl. The Woodlands, TX 77381 Phone: 281-576-9534 Cell: 832 741-2815 gking@asphaltscience.com
Mihai Marasteanu Professor University of Minnesota 164 Civil Engineering Bldg. 500 Pillsbury Drive, S.E. Minneapolis, MN 55455 Phone: 612-625-5558 Fax: 612-626-7750 maras002@umn.edu	**Bob McGennis** Technical Manager Holly Frontier Companies 20860 N. Tatum Blvd, #150 Phoenix, Arizona 85050 Cell: 602-315-6904 Robert.McGennis@Hollyfrontier.com
Bruce Morgenstern Materials Lab Wyoming DOT 5300 Bishop Blvd Cheyenne, WY 82009-3340 Phone: 307-777-4271 Bruce.morgenstern@wyo.gov	**Ioan I. Negulescu** Professor, Human Ecology Louisiana State University 232 Human Ecology Baton Rouge, LA 70803 Phone: 225-578-1684 inegule@lsu.edu and ioannegulescua@yahoo.com
Jean-Pascal Planche Vice President Transportation Technology Western Research Institute 365 N. 9th Street Laramie, Wyoming 82672 Phone: 307-721-2325 jpkanch@uwyo.edu	**Gerald Reinke** Mathy Construction 915 Commercial Ct. P.O. Box 563 Onalaska, WI 54650 Phone: 608-779-6304 Fax: 608-781-4694 gerald.reinke@mteservices.com
Henry Romagosa ICL Performance Products LP P.O. Box 171167 Holladay, UT 84117 Phone: 801-274 0955 Cell: 801-245 0429 henry.romagosa@icl-pplp.com	**Dr. Geoff Rowe** Abatech, Inc. P.O. Box 356 Blooming Glen, Pennsylvania 18911 Phone: 215-258-3640 Cell: 267-772-0096 Fax: 772-679-2464 growe@abatech.com

Eileen C. Sheehy Manager, Bureau of Materials New Jersey DOT P.O. Box 607 Trenton, NJ 08625-0607 Phone: 609-530-2307 Eileen.sheehy@dot.state.nj.us	
Liaison Members:	
Mark S. Buncher Director of Technical Services Asphalt Institute 2696 Research Park Drive Lexington, KY 40511-8480 Phone: 859-288-4972 Fax: 288-4999 Mbuncher@asphaltinstitute.org	**Audrey Copeland** Vice President-Research and Technology National Asphalt Pavement Association 5100 Forbes Boulevard Lanham, MD 20706-4413 Phone: 301-731-4748 Fax: 301-731-4621 Audrey@asphaltpavement.org
Edward Harrigan Transportation Research Board 500 5TH Street, NW NA 487 Washington, D.C. 20001 Phone: 202-334-3232 Fax: 334-2006 eharrigan@nas.edu	**Pamela Marks** Head Bituminous Section Materials Eng. & Research Office Ministry of Transportation Building C, Room 238 1201 Wilson Avenue Downsview, Ontario M3M1J8 Phone: 416-779-3724 Pamela.Marks@ontario.ca

ATTACHMENT C

ASPHALT BINDER ETG WORKING COMMITTEE MEMBERS

<table>
<tr>
<td><u>Aging Task Force:</u>
Gayle King
Jim Barnett
Laurand Lewandowski
Jan Negulescu
Gerald Reinke</td>
<td colspan="2"><u>Moisture Damage Task Force:</u>
Bob McGennis
Chris Abadie
Ken Gryzbowski
Dean Weitzel</td>
</tr>
<tr>
<td><u>Low Temperature Task Force:</u>
Mihai Marasteanu
Jim Barnett
Raj Dongre
Bob Kluttz
Gerald Reinke
Sang-Soo Kim</td>
<td colspan="2"><u>Modification Task Force:</u>
Laurand Lewandowski
Mark Buncher
Carissa Mooney
Mihai Marasteanu
Henry Romagosa</td>
</tr>
<tr>
<td rowspan="2"><u>Validation Task Force:</u>
Gerald Reinke
Mark Buncher
Gayle King
Mihai Marasteanu
Henry Romagosa</td>
<td colspan="2"><u>PPA Best Practice Task Force:</u></td>
</tr>
<tr>
<td>John D’Angelo
Terry Arnold
Mike Anderson
Gayle King
Jean-Valery Martin</td>
<td>Fran Miknis
Olga Puzic
Gerald Reinke
Henry Romagosa</td>
</tr>
<tr>
<td><u>GTR Modified Asphalt Task Force:</u>
Gaylon Baumgardner, Lead
Chris Abadie
Audrey Copeland
John D’Angelo
Darin Hazlett
Matt Corrigan</td>
<td colspan="2"><u>GTR P& B Round Robin Precision & Bias Group:</u>
Matt Corrigan, Lead
Chris Abadie
Gaylon Baumgardner
Tom Bennert
Bob McGennis
Randy West</td>
</tr>
</table>

MSCR Task Force:
John D'Angelo, Lead
Matt Corrigan
Haleh Azari
Raj Dongre (laboratory participation)
Edgard Hitti
Karissa Mooney
Ioan Negulesce (laboratory participation)
Gerald Reinke (experimental plan)
Geoff Rowe (experimental plan)
Chris Williams (lab participation; experiment plan)
Jack Youtcheff (laboratory participation)

Linear Strain Amplitude Test Force:
Hussain Bahia, Co-Lead
Gerald Reinke, Co-Lead
Chris Abadie
Haleh Azari
Jim Barnet
Audrey Copeland
Mike Farrar
Leonard Lewandowski
Karissa Mooney
Kevin VanFrank

Mixing & Compaction Temperatures Group:
Mike Anderson, Lead
Frank Fee
Edgard Hitti
Laurand Lewandowski
Karissa Mooney

Intermediate Test Temperature Group:

Mike Anderson, Lead	Bob McGennis
Dave Anderson	Jean-Pascal Planche
Hussain Bahia	Gerald Reinke
Gaylon Baumgardner	Geoff Rowe
Audrey Copeland	Hassan Tabatabaee
Gayle King	

BTC Task Force:
Haifang Wen, Lead
Dave Anderson
Mike Anderson
Gayle King
Ioan Negulescu
Jean-Pascal Planche
Geoff Rowe

DSR Task Force:
Mike Farrar, Lead
Dave Anderson
Mike Anderson
Jean-Pascal Planche
Gerald Reinke
Geoff Rowe
Steve Salmans

Emulsion Task Force:

Chris Abadie	Gayle King
Howard Anderson	Bob McGennis
Gaylon Baumgardner	Bruce Morgenstern
Lee Gallivan	Jean-Paul Planche
Darren Hazlett (confirm Hazlett's participation)	Gerald Reinke
	Geoff Rowe