# FHWA Asphalt Mixture and Construction Expert Task Group

Mixture & Construction ETG Purpose
The primary objective of the FHWA Expert Task Group is to provide a forum for the discussion of ongoing asphalt mixture technology and to provide technical input related to asphalt mixtures design, production and construction.

A total of 62 individuals attended the meeting (14 members, 46 visitors, and 2 contract personnel). Attachment A is the meeting Agenda, Attachment B includes a listing of the ETG members, and Attachment C is a listing of the Mixture ETG working task group members. Members of the FHWA Asphalt Mixture and Construction ETG that were in attendance at the September 2010 meeting included:

Frank Fee, NuStar Asphalt (Chairman)
Ray Bonaquist, Advanced Asphalt Technologies (Co-chairman)
John Bukowski, FHWA (Secretary)
Mike Anderson (Liaison), Asphalt Institute
Haleh Azari (Liaison), AASHTO-ARML
Shane Buchanan, Vulcan Materials Co.
Ervin L. Dukatz, Jr., Mathy Construction Company
John Haddock, Purdue University
Kevin D. Hall, University of Arkansas
F. M. Rick Harvey, Wyoming DOT/AASHTO SOM liaison
Gerry Huber, Hertiage Research Group
Cindy LaFleur, MWV, Asphalt Innovations
Louay Mohammad, LTRC/Lousiana State Univeristy
James Musselman, Florida DOT
Judie Ryan, Wisconsin DOT
Randy West (Liaison), NCAT

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

"Friends" of the ETG that were in attendance included:

Chris Abadie, Louisiana DOT
Adrian Andriescu, SES Group & Assoc.
Hussain Bahia, University of Wisconsin at Madison
Gaylon Baumgardner, Paragon Tech. Services
Satish Belagutti, FHWA/ESC
Mark Blow, Asphalt Institute
Ken Brown, Troxler Labs
Steve Burhans, Paramount Petroleum
Audrey Copeland, FHWA
Matthew Corrigan, FHWA
John D'Angelo, D'Angelo Consulting
Mihai Marasteanu, Univ. of Minnesota
Richard May, Shell Solutions
Louay Mohammad, LSU/LTRC
Ala Mohseni, Pave Systems
Karissa Mooney, NuStar Asphalt
Ioan Negulescu, LSU
Chuck Paugh, ESC, Inc.
Katherine Petros, FHWA
Roger Pyle, Pine Instruments
Henry Romagosa, ICL – PPLP
Ali Regimanl, InstroTele, Inc.

Codrin Daranga, Blacklidge Emulsions
Mike Farrar, WRI
Lee Gallivan, FHWA
Nelson Gibson, FHWA
Stacy Glidden, MTE
Ron Glaser, WRI – Laramie
Beth Griffin, DuPont
Ellie Hajj, University of Nevada at Reno
Andrew Hanz, University of Wisconsin at Madison
Mike Harnsberger, WRI
Darren Hazlett, Texas DOT
Edgard Hitti, Paramount Petroleum
Carl Johnson, Stark Asphalt
Gerald Reinke, Mathy Construction
Geoff Rowe, ABATECH
Delmar Salomon, PPS, LLC
Con Sinadinos, IPC – Global
Richard Steger, Road Science, LLC
Kevin VanFrank, Utah DOT
Scott Veglahn, MTE
Raul Velasquez, University of Wisconsin
Jack Weiger, Cinack Solutions
Jack Youtcheff, FHWA
Habtamu Zelelew, ESC Inc./FHWA

## DAY 1: Monday, September 20, 2010

**1. Call to Order—**Chairman Frank Fee (NuStar) called the meeting to order at 8:20 AM.

**Welcome and Introduction** – Chairman Frank Fee welcomed the group to the meeting.

Secretary John Bukowski (FHWA) reported that the agenda is being distributed, but that it will be changed to facilitate travel schedules for some of the members that were arriving later for this meeting. Attachment A is a copy of the agenda that was distributed prior to and at the meeting. Self introductions were made, and the attendance sign-in sheets were distributed to log attendance. During the introduction,

Fee reported that the ETG meeting is being webcast with the support of the University of Wisconsin at Madison. Bukowski noted that there were problems with the microphone, so the website was closed at the beginning of the meeting, because of these issues.

Bukowski reported an error is on page 4 of the last meeting minutes (minutes for the 2010 Irvine, California meeting). The minutes stated that the internal angle is no longer used. The correct wording should have been that the external angle is no longer used. Bukowski stated that he will correct this item in the previous minutes.

**2. Previous Meeting Action Items—**John Bukowski (FHWA)
Secretary Bukowski reported that the minutes from the last ETG meeting were sent out via e-mail prior to this meeting

Secretary Bukowski reviewed the action items from the February 2010 Mix and Construction ETG meeting. The following is a listing and status of those previous action items.

1. Ed Harrigan is requested to provide the recommendations from the NCHRP 9-39 project related to mixture and compaction temperature for review at the next ETG meeting and subsequent referral to the AASHTO SOM.
   ***UPDATE***: Action item is on the agenda, and Randy West will give the update on this item.

2. ETG members are asked to review the Semi Circular Bend procedure and provide their comments directly to Mihai Marasteanu.
   ***UPDATE***: Action item is on the agenda. Comments were received and provided to Mihai Marasteanu and will be discussed later in the meeting.

3. Frank Fee and Ray Bonaquist will attempt to obtain suppliers to provide materials to fill all the cells in Table 2 – of the experimental plan for the Flow Number evaluation effort, as presented at the meeting. If this is successful, the experiment will proceed as planned.
   ***UPDATE***: Action item is on the agenda. Fee and Bonaquist will be making the presentation.

4. ETG members are asked to provide feedback to Audrey Copeland on potential areas to study under the next FHWA accelerated Load Facility (ALF) project.
   ***UPDATE***: Audrey Copeland provided Jack Youtcheff comments/feedback from the ETG.

5. Richard Kim will proceed with the IDT E* ruggedness effort as presented at the meeting, any additional comments should be forwarded directly to him.
   ***UPDATE***: Action item is on the agenda. Bukowski reported that Kim did get three labs to participate in the ruggedness study. Haleh Azari (ARML) and NCAT are two of the laboratories that agreed to participate.

6. Richard Kim has asked for input on his VECD analysis software. A new ETG task group (West, Reinke, Scarpas, Rowe, Daniels, Bennert, Gibson, Von Quintus, and Mogawer) was formed to accommodate this. Richard Kim will provide the spreadsheet for the protocol or analysis software and a list of specific questions for the TG's input.
   ***UPDATE*** Kim has put together an update for comment. Fee reported that the task group is working on this item. Haleh Azari reported that everything is ready to start the ruggedness testing. The task group is waiting on the materials. Fee reported that this item is moving forward to provide a simpler way to perform the E* testing. He also stated that there is a strong interest in providing some type of cracking protocol to be used to evaluate cracking susceptibility of HMA mixtures. Bukowski reported that Kim did send out the link to download the program and analysis protocol.

7. Haleh Azari was requested to provide a copy of the interim ARML report on mixture aging/conditioning impact on testing of E* and Flow Number. This will be distributed to the Group for review.
   ***UPDATE***: Action item is on the agenda.

8. The ETG task group on construction is asked to review, and if needed, prepare a proposal for a potential TRB/NCHRP synthesis of practices to measure and accept in place pavement density.

***UPDATE***: Cindy LaFleur is on the agenda to present some of their findings to date.

9. John D'Angelo will prepare a draft document to provide technical guidance to agencies for making changes to the N-Design value.
   ***UPDATE***: Action item is on the agenda. Members should have received the technical brief prepared by John D'Angelo.

10. Matt Corrigan and Chuck Paugh will prepare a draft for a potential appendix to T312 on the comparability of different gyratory compactors.
    ***UPDATE***: Action item is on the agenda. Corrigan will be making the presentation. The existing procedure had been dropped, but AASHTO is looking at reinstating it or an alternative.

11. Haleh Azari is requested to have ARML revisit and possibly update the precision statement for T312 considering recent improvements in the procedure and the development of the internal angle measurement. She is to report back at the next ETG meeting on the effort.
    ***UPDATE***: Item is on the agenda to look at the precision statement.

12. A copy of the draft procedure for "Determining Aggregate Structure in Asphalt Mixes by Means of Planar Imaging" will be sent to the ETG members for review and comment.
    ***UPDATE***: Bahia will comment on this item later in the meeting.

13. ETG members are asked to send Frank Fee their comments on the proposed research needs statement on developing a new Lab Short Term Aging Procedure that Correlates to Various HMA Plant Processing. Louay Mohammad to review the draft problem statement and identify any redundancies between his NCHRP 09-48 project and the one being proposed.
    ***UPDATE***: Rick Harvey will cover some of these items later in the meeting. This action item was to look at short term aging procedures. Harvey will brief the ETG on a number of items related to this topic. There were a lot of items that have moved forward from recommended actions from this ETG.

**3. Subcommittee on Materials: AASHTO Standards Update Report—**Rick Harvey (Wyoming DOT); Liaison for the AASHTO Subcommittee on Materials

Presentation Title #1: *AASHTO Standards Update*
Rick Harvey reported that the ETG has been very active in making recommendations that need to be included as standards, revisions, and changes. The Subcommittee on Materials (SOM) did meet in Madison last month (August 9-13, 2010).

Summary of Presentation/Report:
Summary of the annual meeting activities to resolve comments and negatives from 2009 SOM and 2010 Technical Section Ballots.

- T 312 AMRL Enforcement of Use of Internal Angle.

The final action has been taken and it is now the recommended method.

- T 209 Determination of Voidless Unit Weight.

Item needed to be updated to allow for including mechanical agitation and other items. Has been accepted and printed in the book (mechanical agitation was mandatory). Harvey reported that standard now allows mechanical or manual agitations and AMRL is now looking into preparing separate precision statement for manual and mechanical agitation. Harvey asked Haleh Azari to provide an update.

Azari reported that each of the mechanical agitators has a bias, but all reached the optimum value. Past the optimum frequency, due to over agitation, stripping did begin to be observed as well as other issues with the agitators.

John D'Angelo asked if they are all can reach optimum density, can we put in a range of acceptability from the frequency. Frequency range may be a better way to do this rather than having a specified frequency for each machine. Azari replied that may be the case and could be considered.

Kevin Hall asked whether the mechanical agitation is higher or lower than the manual agitation. Azari answered that the frequency is lower than for mechanical agitation. Harvey commented on the intent of this effort. Discussion on whether you have to specify how you shake the mix and what impact that has on the variability of the Rice value ($G_{mm}$). Harvey noted that some type of manual agitation will be required and referred to the ARML study that found manual agitation had the lower variability. Harvey stated that this standard gets a lot of attention and has been difficult to move forward because of the large investment that agencies have made with different equipment. The intent however is to still move eventually to exclusively mechanical agitation.

Julie Ryan noted two main concerns or questions with this standard in Wisconsin are: (1) will mechanical change the asphalt content and (2) will they see differences in QA procedures in controlling the laboratories? Azari answered that with mechanical agitation it appears you get a higher value for $G_{mm}$ than for manual agitation. So there is a bias between the two methods.

Asked whether there is a report on this item? Azari answered; there is a draft report available, but it has yet to be printed or distributed. Fee noted that there is a lot of the detail is in the final report which will be released shortly.

Discussion took place on whether issues would be resolved by allowing both methods of agitation in the procedure.

- T 79; Determining the Dynamic Modulus and Flow Number for HMA using the Asphalt Mixture Performance Tester (AMPT).

Harvey reported that notes were added concerning the venting of the sample to atmospheric pressure based on ETG comments. Comments were received on this ballot item. Harvey also asked the ETG to comment concerning the air void tolerance. Another SOM comment was: *Details of the model used to compute flow number need to be provided as done in the 9-29*

*report. The original models based on power-law model resulted in large coefficient of variation in FN (as large as 58% has been reported by Mohammad et al, 2006 in TRR No. 1970). Hence, currently Francken model is used and we think this information should be provided so that the standard does not become a "black box." Inclusion of models may also serve as a good education tool.*" Harvey commented that there appears to be a need for a commentary on this issue added to the standard. Harvey wanted an opinion from the ETG on this.

Fee and Bukowski discussed the reasons why a specific model was used and its impact on the results. In tent of the current comment in the standard was to explain how one model was selected over another and the research that led to its selection. Commenter wanted a note with more information on why the model was selected. Bukowski commented that all this is already included in the NCHRP 9-29 final report, so does it really need to go into the standard. Ray Bonaquist replied and gave the reason that the Francken model was selected and that it could add some brief additions to the appendix, if it is needed or recommended by the group. Fee's first preference is to add the reference to the NCHRP 9-29 final report. Hoe could the research report feasible be put into the standard. Bonaquist noted that maybe he could extract some brief information from the ASU report and noted that a similar approach was used in the determination of the BBR test data – the fitting of the BBR data. Fee asked Bonaquist to draft a one page explanation. Bonaquist noted that the explanation would be short and included as an appendix. An annex would be mandatory so this would be an appendix that would not be required by the standard.

**ACTION ITEM #1; Bonaquist will develop and distribute for ETG an appendix (1-2 pages) to be added to TP79 on explanation of the Franken Model.**

- PP 61; Developing Dynamic Modulus Master Curves for HMA using the AMPT and PP 62, Developing Dynamic Modulus Master Curves for HMA.

Harvey asked whether PP 61 and PP 62 can be moved to an annex in TP 79 and TP 62 and whether these are the only two standards where master curves are used or will they be used in other standards, like Kim's procedure? Fee noted the reason for these separate standards was to separate the test standard from how the data is used. Maybe the title needs to be clarified, but if someone does not understand the title, have the user read the scope of the standard. After discussion on this item it was decided that the standards need to remain separated.. Harvey reported it is planned for publication as is.

- T 166, Specific Gravity task force recommendations.

Harvey reported that he received the ETGs recommendations and forwarded to Technical Section 2c (Tom Baker, Washington DOT). This Technical Section had planned to discuss but was unable to coordinate a presentation at their 2010 SOM meeting. A 2c task force was created to review and prepare this item for ballot. Frank Fee asked that Harvey send the 2c minutes to him and West. Harvey agreed to do this.

On the publication of the ETG report on this item, Bukowski noted that Fred Hejl had responded that TRB will now not produce as an E-Circular. This is due to the fact that the report did not

originate from a TRB committee. Consequently, Bukowski reported that these items will be put in the FHWA's technical brief format. They have already been reviewed and should be available in print prior to the next ETG meeting. Bukowski will send the ETG members the electronic link to the FHWA Technical Brief on this subject. Harvey requested this notice be sent to all SOM members or their agencies. Fee noted that since this mechanism of FHWA Technical Briefs is now available it will be the ETG preferred distribution of materials as applicable.

**ACTION ITEM #2; Bukowski will send to ETG members the web link to FHWA Technical Briefs (Previously intended as TRB E-Circulars) on the SGC and Specific Gravity Determination/Issues. Also sent to all SOM members or their agencies.**

- TP 62 Determining Dynamic Modulus for HMA

The 8 years as a provisional for this standard is now over. It will now be moved to a full standard. At the SOM meeting there were comments on this as follows; "*The criteria in the standard (Table 7) are from NCHRP 9-29, which was developed on smaller specimen. Sometimes, it is difficult to meet the criterion of 20% uniformation of coefficient for strain. We suggest to increase it to 35%. But we concur with the standard"*. Bonaquist commented on the 20% uniformation or consistency of data being difficult to achieve. The 20% value was the best guess at the beginning. 30 to 35% is a better number as more agencies use the standard. Frank Fee asked if this will be included as a change to the standard? Bonaquist noted that the commenter had suggested that it be changed. Fee noted that Harvey will make the change to increase the number. Erv Dukatz asked if "uniformation" is an actual word that will be added; Bonaquist replied that Don Christiansen used the wording "Coefficient of Uniformity." Fee asked that Harvey make the change and send it to Christiansen and Bonaquist prior to finalizing the ballot. Harvey agreed. The second comment has been discussed previously in Harvey's report..

- TP 79 Determining the Dynamic Modulus and Flow Number of HMA Using the AMPT.

Harvey noted that there was a comment on the revision to this ballot item. He also reported that some of these items may be looked at during the pool fund study by FHWA TP 5-178, but wanted to get the ETG input. The specific comment was related to calibration versus verification of the equipment. Fee commented that one of the items to be accomplished under the ETG is to finalizing the parameters of the Flow Number test. After completion and review by the ETG we can then move forward. Harvey agreed with that opinion but wanted comments from the ETG. Bonaquist replied that he needs to relook at how the wording was included in the standard. It was not to include a calibration study, only to verify that they equipment is functioning correctly --- not to calibrate the machine. Bonaquist comment was that the annex is not well-written well. He will read the language and clarify the annex – the verification is not to calibrate the AMPT. Harvey noted that there are standard definitions for each of these terms. Fee asked Bukowski to look into this and make sure the terms and their definitions are consistent. Harvey requested that this be completed within the next couple. Bonaquist asked Harvey to send him the current version.

**ACTION ITEM #3; Bonaquist will develop and distribute to ETG members wording to be added to TP 79 section 8.2.1 on equipment calibration recommendations.**

- T 312 SGC Mold Wear

This item had considerable discussion at the SOM Technical Section meeting. On measuring the T 312 SGC mold wear recommendations, Harvey reported there were several negative votes and comments (5 negative votes and 8 pages of comments). They significant issues are as follows;

- Mold tolerance changes not needed; wording as received from the ballot was: *As stated this proposal will extend the service life of SGC molds and provide a cost benefit, but only after the expense of the new mold measurement equipment has been recovered. This ballot notes that by increasing the internal mold diameter an increase was observed in the bulk specific gravity. Any proposal that increases the bulk specific gravity of HMA thus increases variability attributed to T312 which seems counterproductive to the ongoing efforts to improve the accuracy of HMA $G_{mb}$ and volumetric property determinations."* Harvey's opinion was that Hall's paper(to be published as an FHWA Technical Brief) did a good job in explaining this item. Harvey recommended that nothing else really needs to be done in response to this comment with the exception of attaching Hall's white paper with the next ballot to explain the information relative to this comment --- increasing the mold diameter may increase the variability in results. Kevin VanFrank replied that this commenter may have a different interpretation or meaning of the wording used. Hall noted that the commenter may have misinterpreted the purpose of an improved method of measuring mold wear. Harvey reported this was not a persuasive comment. Erv Dukatz noted this is probably a difference between a theoretical and practical basis. The difference from the commenter is a theoretical difference, but it is not a practical difference.

- Section 4.2 is confusing by adding temperature requirements to measuring mold wear and inconsistent with the Annex. Commenter gave an alternate wording: "*New molds shall be manufactured to have an inside diameter of 149.90 to 150.00 mm. The inside diameter of in service molds shall not exceed 150.20 mm. Molds shall be at least 250 mm in length. Mold inside diameter and length shall be measured in accordance with Annex A1*." Harvey reported this wording will be used on the next ballot. Belief by Technical Section that with removal of temperature requirement , meaning of measurement procedure is clearer.

- The next comments were difficult to resolve and the SOM Technical Section may need further ETG support on these.. The first was the 3 point versus 2 point bore gauge. Some agencies have already bought the 2 point gauges and are questioning the benefit or need to go to a 3 point gauge. Harvey had the Technical Section vote on this item, and was found non persuasive from the hand votes. Harvey needs the ETG's discussion on the need for the 3 point gauge to be included on the SOM ballot. Bukowski attended the SOM meeting and noted that the discussion was not principally technical on this issue, but rather more from the standpoint of economics.

Some individuals already had the 2 point gauges and wanted to know if the 2 point gauges could still be sufficient with the need to buy a 3 point gauge. Fee noted that several e-mails have been exchanged on this issue. Fee stated that he will send Harvey these e-mails and then look at this again to see what needs to be done as an ETG. Harvey reported this will go to ballot as is, but does not know how it will be received. Roger Pyle questioned at which point do we get the true measurement? Pyle reported they did try to allow for the 2 point gauge system; but if the mold is to be certified, you really have to go to the 3 point gauge. Sooner or later you will have to resolve this issue for the true diameter. Jim Musselman stated at some point in time you have to get a control on the variability, so sooner or later we will have to go to the 3 point gauges from a variability standpoint. The SOM wanted to know what was the improvement is accuracy or reduction in variability. Harvey also replied there is sufficient data to show the increase in accuracy and did make a case for the improvement in accuracy. Harvey noted historically we had nothing related to this accuracy of the diameter and now it looks like we are going to something very accurate. Pyle noted the correct range is 1mm that they have confidence in, which lead to the recommendation presented. This is the 10% level; 0.001mm and resolution of 0.0025mm. D'Angelo noted the misunderstanding between the 0.0025 and 0.001 being less restrictive. We need to clarify or point out which one is more restrictive. Harvey asked Fee to forward to him Pyle's rationale/explanation on this item that could be then included in the ballot. Bukowski noted that the difference in costs is much less than stated in the meeting and asked Pyle to clarify. Pyle reported that $2500 will give you a device with the needed resolution. Harvey noted that this price had not included in the discussion of the ballot item.

- Section A1.5; "Procedure for Evaluating the Internal Angle of a Superpave Gyratory Mold." This section is complicated and is not necessary on a routine basis. Harvey reported this could be included in Appendix C for comparing gyratory compactors. This should be added somewhere else and not as an annex. Harvey was unclear about whether this item should be included or excluded. Fee thought that a note could be added explaining it was not mandatory for the standard and gives information to the user about the issue. The note would provide information to the user on what to look for if it is determined to be an issue. Matt Corrigan stated this issue will be covered later in the meeting.

- NCHRP Problem Statement; Develop an Approach for lab mix short term aging that correlates to various HMA plant processing and warm mix asphalts. Harvey reported this problem statement has been submitted to NCHRP and was supported by the SOM. A separate problem statement was submitted separately on Warm Mix Asphalt, but Harvey hoped that both would be combined under the same RFP. Harvey stated that a lot of problem statements were submitted this year to NCHRP and hoped that these could be prioritized. Harvey reported that prioritizing each problem statement would be done by the SOM and only the top priorities would forwarded onto NCHRP.

A number of the older Superpave tests are up for renewal; including T 320 (SST), T 321 (Fatigue), and T 322 (IDT). Harvey asked that a Task group be put together to review and determine if any comments or recommendations need to be made from the ETG. Fee agreed that he will assign members for reviewing each one of these and make a recommendation on what if anything needs to be done.

**ACTION ITEM #4; Task Group (Mike Anderson – lead) will review T320, 321 and 322 for any necessary updates and recommendations to the SOM. Volunteers to assist in this Task Group should contact Mike Anderson.**

- Refinement of 4.75 mm Mix Design Criteria.

No action item from the last SOM meeting. However, Harvey wanted to know what ETG involvement needs to be done on this item. Fee agreed and noted that there would be more discussion on this item later in the meeting.

4. **Summary of NCHRP 9-33 Mix Design Recommendations; Potential AASHTO Standards**—Frank Fee gave the overview.

Fee reported that there are recommendations from this project that need ETG review. Fee briefly overviewed the four products from the project. He asked for volunteers to review the products for making recommendations prior to the next ETG meeting and then can be forwarded to the SOM.

Summary of Report:

Fee gave an update on the status of activities and products from the NCHRP project 9-33. Fee stated that there are recommendations that should be reviewed as potential replacement to existing standards. Fee reported that need to determine what can go forward from the NCHRP 9-33 project. Harvey strongly suggested that technical commentary be put together to go along with any SOM ballot on this. Agencies will need to be briefed to become familiar with 9=33 recommendations.

Bonaquist reported there is an executive summary that goes along with the project. This executive summary includes a commentary on each recommendation that was reported to NCHRP. The commentary summarizes what is to be changed, what data are needed, and where that data comes from. Bonaquist can provide a copy of the commentary and suggested that the commentary be reviewed by the ETG and forwarded to the SOM for being attached to the ballot. Bonaquist will send all of the commentaries to Fee for the ETG review. Fee will establish a task group for reviewing the commentaries and make recommendations to the ETG and then the SOM. Bukowski commented that it looks like much of this has already been done in preparation for the ballot items, and it can go forward because the commentaries already exist. He announced that time can be put on the agenda for next meeting for this discussion on the commentaries and products.

**ACTION ITEM #5; Bukowski will distribute to ETG members, NCHRP 9-33 information related to proposed new procedures and commentary for review and discussion at next meeting, prior to forwarding a final recommendation to the SOM.**

Bonaquist also reported that Ed Harrigan has extended the project to create one additional chapter on warm mix asphalt, which will be part of the NCHRP project 9-43. Harvey requested that the recommendations from the WMA and mix ETG coincide with one another.

5. **Comments on NCHRP 9-43 WMA Mix Design Changes Proposed for R35—**Ramon Bonaquist (AAT)

Presentation Title: *NCHRP 9-43 Mix Design Practices for Warm Mix Asphalt*

Summary of Presentation/Report:
Bonaquist briefly overviewed the products from the NCHRP 9-43. The four products from this project were listed and reviewed. These products are:

1. Draft Appendix to AASHTO R35, *Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA).*
2. Commentary to draft appendix.
3. Training materials for draft appendix.
4. Draft Standard Practice, *Standard Practice for Measuring Properties of Warm Mix Asphalt (WMA) for Performance Analysis Using the AASHTO MEPDG*.

Draft Appendix to R35. Bonaquist summarized the additional equipment needed for designing WMA, selecting the binder grade, including RAP in WMA mixtures, the factors used in evaluating WMA mixtures, and the method for adjusting the mixture to meet specification requirements. The following are some of the points made by Bonaquist during his report.

- Stated that the appendix to R35 is written based on using the planetary mixers, and reported that the bucket mixers produce a different product than the planetary mixers. The appendix is based mixes using the planetary mixers because the bulk of the work and testing was completed on mixers using this equipment.
- Bonaquist reported that for the Binder Grade Selection process, it was initially envisioned that grade bumping would be utilized, but the field data did not indicate this. The appendix recommends that the binder selected is the grade normally used by the agency.
- Bonaquist noted that there is a requirement for high temperature grade of RAP; it should be lower than the compaction temperature. This requirement should not have a major impact. The important impact will be when agencies use shingles and other type of materials that significantly change the compaction temperature.
- Specimen fabrication is the major part of the appendix. Four generic approaches are provided in the appendix; (1) additive added to the binder, (2) additive added to the mixture, (3) wet aggregate mixtures, and (4) foamed asphalt mixtures.

- Mix evaluations include 4 factors and/or tests: coating, compactability, moisture sensitivity, and rutting resistance.
- For coating, the procedure suggests that you evaluate for coating using one sample. Look at AASHTO T 195 where 95 percent of coarse aggregate particles must be fully coated using the planetary mixer. The 95 percent only applies to the planetary mixers.
    - Asked, what time is required for the planetary mixer? Bonaquist replied; about a minute. What temperatures would be used for the mixing and compaction temperatures? Bonaquist replied; the user identifies the target mixing and compaction temperatures and the remainder of the procedure is evaluating the mix at those conditions.
    - Some commented on concern how to determine those temperatures and this might be a major gap in the procedure. Bonaquist stated that this is the starting point. Randy West commented that the coating percent is a very subjective item which is a concern.
    - Some comments that when coating aggregate in a bucket mixer, unsure where this leads, some get coating very quickly but subjective how to evaluate complete coating
    - Setting the percent coated too high can be a problem. Dukatz referred to the problem with the boil test that was proposed years ago. Dukatz noted that a visual characterization of coating is probably not the same between different groups. Discussion between the ETG and Bonaquist on this item. Bonaquist noted that this topic was also discussed during the panel meeting and much of the same comments were received. He put this item into the procedure from standard equipment data as a place holder for evaluating the coating and recommended that the ETG review this information and criteria for comment to modify as needed. Dukatz basically agreed but noted a concern that it is not practical, is theoretical, and there will be differences between laboratories. The test procedures portion of the report and evaluation of WMA mixtures started a lot of discussion.
    - Rick Harvey asked about a good definition of what WMA is with the different processes, and if the definition was in the procedure? Bonaquist answered that a good definition is not covered in what they did in terms of lowering the production temperature. In other words, when do not go to the modified R35 (WMA) or use the standard R35(HMA) procedure.

- For compactability, Bonaquist summarized the items that are included in the compactability evaluations.
    - A comment was made that you need to be very specific about the compaction temperatures. D'Angelo stated that the meaning of the words become very important as you go to AASHTO. Bonaquist replied that he will look at those items when he goes through the final editing and review prior to sending it to the ETG and AASHTO.

- Evaluations of moisture sensitivity. AASHTO M323 retains the same test and criteria; 0.80 for moisture sensitivity.

- Evaluations of rutting resistance. Uses the flow number test procedure AASHTO TP 79. Have different criteria in relation to HMA because of reduced aging. Bonaquist reported that there needs to be a lot of work done of the aging issue; production versus long term aging of HMA and WMA mixtures.
    - D'Angelo reported that the Texas DOT had to change the Hamburg criteria in terms of aging at 4 hours. That value was to replicate what happens in the field within one year. D'Angelo stated that performance testing is to evaluate years of service and not within short time periods (1 year or so, unless you have a mix problem). He believes that rapid aging needs to be examined within a short period of time, the stiffness of the mixture looks about the same. D'Angelo's opinion is that the performance test should evaluate what happens within a short time period of about 1 year. D'Angelo believes that this aging process does not really represent what happens in the field over years of service.
    - Matt Corrigan noted that FHWA did submit to TRB a problem statement on this aging issue, and they have looked at this issue on some of the projects where the FHWA mobile laboratory has been used. He noted that results for these tests with WMA are typically different than HMA. These would indicate if using the same test protocol; that WMA would not perform as well as HMA in terms of performance tests. Corrigan asked; where do we target the criteria? We know the WMA mixes are softer in the field. WMA out of the plant are softer than HMA. There was a lot of discussion on this issue.
    - Fee reminded everyone about the objective of the aging process – it is the initial stiffness coming out of the plant. Bonaquist agreed but that the mixes being tested are probably less stiff than when aged in the lab; so the criteria is lowered for WMA but the criteria needs to be looked at for both WMA and HMA. Bonaquist suggested looking at the two step aging process – immediately at the plant and over time.
    - Discussion about mixes being less stiff at the plant than as we age them in the lab. But he was referring to the testing conditions that we are using in the lab for the performance test. Bonaquist believes that we should be using the same testing methods and criteria for all mixtures; WMA and HMA. Why use one criterion for HMA and another criterion for WMA?
    - Randy West stated that he agrees that this is an interim recommendation and more work needs to be done. He noted that they are only seeing a 2 to 3 degree PG grade drop between WMA and HMA, so his opinion is that we are not changing the grade of the binder that much. He also noted that the performance of WMA from those sections placed would indicate that they are performing well.
    - Kevin VanFrank asked another question about when the test changed from unconfined to confined tests? Bonaquist answered that it has not changed. Where the test changed is under NCHRP 9-30A in terms of using confinement. He referred to and referenced the work done by Von Quintus and Schwartz.
- Adjusting the mixture is the last part of the appendix that comes back to the question asked by Randy West in terms of changing the mixing and compaction temperatures. Bonaquist reported they are working with the material providers for revising the mixing and compaction temperatures.

Fee asked about the schedule for finishing the 9-43 project. Bonaquist answered it would be the end of 2010. Corrigan reported that Harrigan has approved the distribution of the commentary and other information to the ETG. Bukowski also reported that Harrigan has given him the draft to the R35, appendix. That appendix was submitted to the ETG with the meeting minutes. Bukowski stated that any member that does not have the appendix please let him know and he will resend it. Bonaquist replied that one needs to read the commentaries in their review. Fee stated that he will make the commentaries available to the group.

A Task Group will be established for reviewing the material and providing comments and recommendations to the ETG. Rick Harvey requested that the recommendations from both the WMA and mix ETG should coincide with one another..

**ACTION ITEM #6; A Task Group on WMA (Corrigan – lead) will be established to review and coordinate comments with the WMA TWG on the proposed changes to R35 as a result of the 9-43 project. And report at the next ETG meeting**.

**6. Comparisons of Gyratory Compactors—**Matt Corrigan (FHWA)
Matt Corrigan gave a verbal report and made comments regarding the comparison of different gyratory compactors. He reported that it was the consensus of the AASHTO group that this item was worthwhile; a combination of PP47 and the information that Kevin Hall group put together (FHWA Technical Brief). This related to the information that was dropped from T 312.. This standard practice is being put together. Corrigan concluded that it is intended to put together a standard practice that the ETG can review and comment.

**ACTION ITEM #7; Corrigan will prepare and distribute to ETG members an appendix to T312 dealing with comparison of different Superpave Gyratory Compactors.**

**7. Status SGC Ndesign Technical Brief—**John D'Angelo (D'Angelo Consulting)
D'Angelo attempted to bring together in a Technical Brief various presentations and information on approaches to evaluate the impact of changes in N design levels. The Technical Brief that he put together and reviewed was intended to overview the status and what really needs to be done in terms of changing the Ndesign values.

John Bukowski reported that the Technical Brief has been submitted to all ETG members for comments prior to this meeting.

Presentation Title #1: *Gyration Levels: Where do we go?*

Summary of Presentation/Report:
Many highway agencies are considering lowering the Ndesign gyration levels and/or changing different items regarding their perceived mixture performance observations in terms of durability and long term performance. This issue relates to using the N design values for design and finding

the target asphalt content value. D'Angelo started the report with questions that were answered and discussed in the presentation:

- Why are agencies considering lowering the gyration levels used for design? Typical answers to that question: increase the binder content, increase VMA, increase compactability, and allow the use of aggregates that could not meet existing VMA requirements.
- Does lowering the number gyrations change the end product?

The answers are probably no increase in binder content, no increase in VMA, and no increase in compactability because gradations will be adjusted to provide minimum asphalt content. Lower gyrations will allow the use of aggregates that could not meet existing VMA requirements because the lower values will reduce the crushing of aggregate and VMA loss.

D'Angelo showed the current AASHTO recommended Ndesign table. This table has been used for the past 15 or so years. D'Angelo commented that there has been much less rutting since Superpave and the gyratory compactor were introduced and adopted. D'Angelo reported; some believe that more cracking has started to occur, but questions whether there is data to support these perceptions.

With input from the ETG, he has put together an draft of a FHWA Technical Brief that provides an outline of a process for evaluating mixes to determine if gyration levels should be changed based on local materials, and if yes, to what extent do they need to be changed.

D'Angelo overviewed what needs to be tested prior to changing the Ndesign levels. He gave an example of typical gyratory plots and included a brief analysis on what starts to happen when we start lowering the number of gyrations?

The next part of D'Angelo's report was to overview the AMPT and other tests in terms of what we can and cannot do. As part of this review, he used some typical mix design gradations between an E-1 and E-10 type gradations. The E-1 mix has more natural sand in it and thus less binder content even though it has a lower Ndesign value. D'Angelo included a graph comparing the results from testing the E-1 and E-10 mixtures. In summary, the E-1 mix has more susceptibility to rutting.

D'Angelo concluded his report with performance testing; the key part in the Technical Brief is the use of performance testing to evaluate the different mixtures to estimate what happens when we start to change the Ndesign values. His last comment was that in the end we still have to build it right regardless of the values used in design.

<u>ETG Comments, Questions, and Discussion:</u>
One comment was made that HMA producers buy what's produced in the quarry. The concept that aggregate gradations get changed to lower the asphalt content does not happen or is not reality. D'Angelo agreed with the comment.

Randy West noted this was a good explanation of what happens when the Ndesign values get changed, but disagreed with the concept. The objective of lowering Ndesign is to match what gets done in the field. In other words, what gyration level is needed to estimate what compaction level will be achieved on the roadway. West's opinion is that the gyratory does crack or crush aggregate but that does not occur in the field. The reason to define the correct number of gyrations to be used is to match field conditions. West opinion is that the level we are now using is above the data or scatter plot that D'Angelo showed in his presentation (ESAL versus gyrations to match in place density; using best fit to predict gyrations). D'Angelo agreed with West, but wants to give agencies a system or procedure to use for making those changes and how to consider or define the items that need to be changed. In other words, establish and recommend a process for agencies to use in making an educated decision on changing Ndesign.

Jim Musselman commented that he likes the Technical Briefs that have been prepared and submitted. He then overviewed the changes and the outcomes in Florida. Going to Superpave basically closed the door to the use of softer aggregates. Musselman reported that going to the higher levels has been good and improved performance in Florida. He noted that dropping the Ndesign does not mean that you are going to increase asphalt content, other things could also change through industry (use of higher RAP contents).

D'Angelo requested that any additional comments should be sent to Bukowski. Bukowski stated; any additional comments should be submitted to him by October 15. He will then summarize the comments and get with D'Angelo to finalize the technical brief.

West made another recommendation that was an outcome from NCHRP 9-9, which was to drop Nmax. This recommendation was taken off the table because there was no evidence that it should be removed or left as is. He requested that the recommendation be put back on the table. Shane Buchannan agreed with West. West believes that Nmax is pointless as was Ninitial.. Bukowski reported that in the NCHRP 9-33 procedure and recommendations that both parameters have been removed.

Fee requested for a show of hands on those agencies that still use 125 gyrations. Some agency representatives did raise their hand, but the comment was that it is not used on a regular basis. D'Angelo commented that this goes back to his argument that some aggregates may need 12, but disagrees with a blanket statement to drop those parameters. His opinion is to give agencies tools to evaluate whether a 125 level is needed.

Ellie Hajj asked if time was used as a factor in the analysis. It may take a couple of years or decades on achieving the values shown in the scatter graph (ESALs versus gyrations to match in place density levels). Randy West and Shane Buchannan commented that the scatter graph was based on a limited 2-year of traffic and then extrapolated the traffic out to 20 years. West believed that it should be based on short term traffic level (2 years). D'Angelo reported that the work and results showed there was a substantial leveling off in the growth of density over time. Fee commented you never know what the final value is, so that makes it difficult to control and know the important factors.

Gerry Huber commented that one of the items he likes about the Technical Brief is that it ties back to mechanical properties and not asphalt content. Ndesign is not tied to asphalt content; it is tied to mechanical properties. This needs to emphasized. Mechanical properties will influence the target asphalt content and final density on the roadway. It drives home that the amount of design compaction, drives mechanical properties and not asphalt content.

Bukowski reminded the ETG; the purpose of the Technical Brief is to describe the approach that can be taken for changing the Ndesign values, if an agency does not like the current values. Bukowski replied that this is not an FHWA policy but rather put forward as the best technical guidance.

**ACTION ITEM #8; ETG members are requested to review and send any final comments to John D'Angelo, prior to October 15 on the draft Technical Brief on adjusting Ndesign levels.**

**8. Construction Task Group In-Place Density Issues**—Cindy LaFleur (MWV, Asphalt Innovations)

Presentation Title: A verbal report.

Summary of Report:
Cindy LaFleur gave a report and update on the task group regarding different topic areas.

- ***Compaction Issue/Topic***

The compaction issue was the first topic discussed. A verbal report was given on what needs to be done related to compaction. LaFleur reported that the results of core tests and a summary of the survey completed on state practice related to density specifications had been previously presented to the ETG. One question to be answered is: How much additional densification really occurs after construction?

Fee commented that the task group was to do a synthesis on how do you measure density and is there a change in the amount of density prior to and after Superpave. In other words, has there been any statistical change in the values measured over time. The results would be turned over to Rick Harvey to see if funding could be secured assuming the ETG endorses some action item. Judie Ryan agreed with Fee, but asked which direction do we want to go? Some questions that need to be considered and answered are:

- What simulations are used to estimate the density required in the field versus what is being actually achieved?
- What is the truth? We have a lot of different materials being used, so how do those materials impact the answer to that question for creating a best practices document.
- Will nuclear density gauges read the same for WMA mixtures as for HMA?
- What about Gmm in terms of what was discussed by Azari earlier today on mechanical versus manual agitation?

LaFleur referred to Ray Brown's best practices document on compaction in her reply to some of the above questions and discussion. Ryan believes that there are multiple topics to pursue and they are unsure on which one to pursue by the Task Group. Fee suggested bringing this information together on those activities being pursued by individual agencies or developing a synthesis on what has been the trend in terms of density being achieved and how to use that information would be beneficial. Fee mentioned other questions that need to be answered; How to measure the in place density and how that information is being used.

Lee Gallivan commented that he would to add intelligent compaction (IC) to Fee's suggestion. Fee agreed with that comment. This includes the use of IC systems for compacting HMA mixtures. Fee asked; is this worth pursuing? Fee also commented; you need to justify or determine the importance of the data to determine if this should be pursued. His opinion is that this is a staged process, just like an NCHRP problem statement. We need to decide, first; is it worth doing?

Hall commented; all states have something different in terms of density and measurement and is there a real need for this study. His other question is; are agencies satisfied with what they are already doing in terms of density? Ryan replied that agencies are always looking for an answer when a project goes bad. There is usually are all sorts of questions related to compaction; is it better to lower the criteria and get a more consistent product, or increase the criteria and have a less consistent product? Harvey commented; he looked at some of the existing studies that summarized which agencies are using a nuclear density gauge or what type of device is used for controlling density.

Musselman overviewed some of the work that they have done to try and define the specification value. He suggested a synthesis on what is being used to specify and measure density so that agencies know the range of the specification values to develop a target value and range of that value. Mark Blow also commented; that just compiling all of the agencies mix specifications is very beneficial. Randy West asked; what is the value that we really need to be measuring? His opinion is that permeability is the key property rather than percent maximum density. West believes that we do need a national initiative on what value should be specified and how to measure that value.

Harvey agreed on this topic about needing a national initiative on this item of compaction. He suggested that the ETG put together a best practices document. LaFleur commented that there are so many items to be looked at, which one should the Task Group address first? Fee suggested summarizing what has been done within the past couple of decades, what is the current status, and how have things changed over time. Fee heard from the discussion, the suggestion is: there is a need for a standard practice for handling in place density and provide a best practices document for achieving that goal. Harvey's opinion is that this goal is attainable. Louay Mohammad suggested pursuing NCHRP to complete this task.

Fee stated what he would like from the task group today is an answer to the question; is this what we recommend be done? The question to be answered is this worthwhile? Hall suggested to go forward with this topic; it is a worthwhile goal to prepare a synthesis statement to go forward to

NCHRP for advertising it. Mohammad asked when it would be prepared. Fee noted that the Task Group should try to get it done prior to the end of 2010. This product would be the basic map, rather than the detailed information. In summary, the conclusion is to move forward with preparing a synthesis statement on how do you measure density and is there a change in the amount of density prior to and after Superpave. In other words, has there been any statistical change in the values measured over time.

**ACTION ITEM #9; Task Group on Construction (LeFleur – lead) will prepare a research needs statement related to in-place density, how it is specified and measured among the various agencies. One issue to determine is whether there has been an actual change in the amount of in-place density prior to and after Superpave.**

- ***WMA Issue/Topic***

The other item that the construction group needs to deal with is WMA. LaFleur overviewed the questions related to WMA and her concern about the overlap with other design groups and ETGs. She mentioned intelligent compaction and other engineered mixtures, as part of this discussion, and how these materials compact relative to conventional mixtures. These are the other areas that need to be reviewed and discussed under this group.

Bukowski stated as a general comment related to WMA, most issues are being handled by the WMA TWG. However, different topics can be handled by different groups as long as we stay coordinated. Matt Corrigan noted that NCHRP synthesis statements were due by August 13, 2010. The next round of synthesis statements are due in February, 2011.

Fee asked LaFleur for any other issues? LaFleur mentioned tack coats. Fee asked LaFleur to make a list of items that her group should move forward with so that it can be discussed and debated within the ETG.

**ACTION ITEM #10; Task Group on Construction (LeFleur – lead) will compile a list of critical construction topics, distribute to ETG members and discuss at the next ETG meeting.**

**9. Establishing Bias of Aggregate Gravity Tests (**T-84/T-85)—Kevin Hall (University of Arkansas)

Presentation Title: Possible Establishment of BIAS in Specific Gravity/Absorption Testing (AASHTO &-84/T-85).

Summary of Presentation/Report:
Kevin Hall presented a few slides in his report and discussion on the absorption and bias issue with the ETG.

Hall overviewed the device that they have at the University of Arkansas that will be marketed in the near future. He reported that there are precision statements for the device, but no bias for the data. Hall believed that they have a device that can provide the ultimate absorption independent of material. One question is how long do you have for the absorption to take place? Hall reported that they have equipment and a process that is highly accurate for measuring the absorption over 36-hours. His opinion is that they can establish the true absorption which is highly accurate.

Hall is recommending a study to do a comparison between results from this device and the current test procedures. He asked if this of interest to agencies or individuals? Current tests based on SSD have variability built in because of the nature of the test.

ETG Comments, Questions, and Discussion:
D'Angelo asked how does the equipment do this? Hall replied; the procedure and equipment are proprietary right now and did not those answers. Hall commented that no study has been done to answer the question of bias for T84 and T85 and asked whether this is something that is important or needs to be answered? Shane Buchannan asked about the test procedure and how it differs from the existing procedure. Hall replied that it is not much different. Hall commented they started this effort by trying to answer the question; where did the 15 to 19 hours in the current system come from? An additional question asked is this an overnight test? Hall replied; yes, but not necessarily. Hall mentioned that no agitation is used, but it is being looked into whether agitation is needed.

Harvey asked about the complexity of the equipment and procedure. Hall responded that it is not highly complex and uses some of the same concepts; water absorption, that are currently used.

Hall stated he is just looking for advice from the ETG. Fee commented that there is interest in this. Asked if the device is under a certain head of water and if that condition changes will that change the answer? Hall did not know the answer to that question but stated that it is under a constant head of water. West noted that one of the benefits of T85 is that you test the aggregate in its natural state. He asked that when you compared these results to those from T85, what did you find? Hall answered; you get less absorption or higher specific gravities.

Nelson Gibson asked about the use of innovative materials for certification of the equipment and process. Hall replied; the device is traceable and is very accurate. Gerry Huber commented; there is always a lot of discussion on absorption related to surface and internal voids. He asked what is the starting point and is it assumed that there is no water in the voids, and if so, is that a valid assumption? Hall noted that he assumes oven dried condition, so no water. Huber agreed but was asking is that valid? Huber also asked about other industries that use absorption.

In summary, Hall wanted to advise the ETG of this activity and equipment development. They are moving forward with developing and marketing this equipment to measure absorption.

**10. Interim Report on ARML Data E* Flow Number Studies—**Haleh Azari (ARML)

Presentation Title: *Effect of Laboratory Short-Term Conditioning on Mechanical Properties of Asphalt Mixtures*

Summary of Presentation/Report:
Haleh Azari summarized the background of the study and the rationale. She also reviewed the problem statement for the project, as well as its objective. The objective statement of the project is to: *evaluate the effect of conditioning time on mechanical performance of an asphalt mixture to provide recommendations on appropriate laboratory short-term conditioning time for mixture mechanical property testing*.

The scope of the study was overviewed by Azari. The different tests being performed include: flow number, minimum strain rate, dynamic modulus, creep flexural stiffness, and creep stress relaxation rate on mixtures conditioned from 0 to 6 hours at one hour intervals. One question asked; what was the compaction temperature for all of the mixtures? Azari replied; most of the mixtures were tested at 135$^{o}$C.

Azari then overviewed the criteria for selecting optimum conditioning time or what is defined as the optimum conditioning time. She defined what is meant by the minimum, maximum and optimum conditioning times. This was based on the flow number versus conditioning time for the three conditioning temperatures. The three conditioning temperatures used were 135 $^{o}$C, 135 to 145 $^{o}$C, and 145 $^{o}$C.

She presented some of the test results from the statistical analysis of flow time or MSR; minimum strain rate. She also showed an example of the conditioning time in 0.5 hour intervals on the dynamic modulus data. The minimum conditioning time was defined by both the RLPD and E* tests, but only the RLPD test could define the maximum conditioning time. One finding from their evaluation is that the results become about the same between the unconditioned and conditioned samples after about 3 hours of short term aging.

The conclusions from this study were that conditioning time that resulted in convergence of properties based on short-term and long-term conditioned samples was determined as the maximum conditioning time. Results of statistical test on various performance properties indicated that the relationship between conditioning time and the mechanical properties differs from property to property, but the majority of the properties indicated a minimum conditioning time of 2 hours and a maximum conditioning time of 4 hours for the mixture's performance testing. In conclusion, Azari presented the recommendations based on testing completed to date, which include:

- The guidelines for the aging of laboratory samples should to be changed.
- 3 hours of conditioning is sufficient time to meet the minimum conditioning requirements of the samples, while ensuring that the samples do not become over conditioned. This recommendation only applies to laboratory conditioning.

ETG Comments, Questions, and Discussion:

D'Angelo noted going to back to the discussion this morning relates to the objective of what is really needed related to this topic. He complimented Azari on the effort to evaluate the changes in mixture properties being affected by what happens in the field. However, work needs to go one more step forward to determine what effect happens in the field and what should be represented in the field and lab. Azari replied that they tried to get samples at different times during production but contractor emptied the silos too quickly to get time dependent samples during the production. Fee commented; this is not short term aging. This discussion focused on the debate of this topic of what is short term aging? Some commented that short term aging represents the HMA condition up to a year. There were different opinions of what is short term aging.

Chris Abadie asked; what about absorptive aggregates and were they used in the experiment? Azari answered that the aggregates were used had about 1.5% water absorption.

Noted that it appeared that only a single asphalt binder was used in the study and questioned the effects with other binders.

Matt Corrigan asked if conditioning temperatures lower than 135 $^{o}$C were used? Azari answered; they were not used. Corrigan agreed with D'Angelo; the study needs to be expanded to simulate short term performance relative to field performance in terms of defining what temperatures and times should be used. Azari replied that this work was restricted to production and placement. Both Corrigan and D'Angelo disagreed with that definition. This definition debate created a lot of discussion on what is needed in terms of performance testing. Opinion is that until short term is defined, all of this is a mathematical process or exercise. Corrigan reminded the group that Bonaquist has a staged approach that may need to be considered. The definition needs to be addressed and agreed upon.

Fee suggested that we need to determine what is happening to the material through the plant. Mohammad and Fee then debated on what is needed relative to the purpose of the data being used. Bukowski commented that the definition included in R30 on short term aging is production related aging or hardening. A lot of debate and discussion on this issue and what is needed. In summary, no consensus was reached on this issue. One comment was that we are losing site on how the results are to be used. Musselman asked why do we want to know what the properties of the mixture one year later in terms of rutting? One comment voiced concern we have never been clear as to what was meant by short term aging. WMA has made this issue even more evident and shown that we have never settled on what is happening with the HMA mixture. Gerald Reinke asked Musselman; do you have a problem or see pavements failing in a year? Musselman answered; no. So why are we so worried about a problem that does not exist? What are we really after or what is the question we are trying to answer?

Fee commented that the primary and more important issue is the longer term one of cracking. The test is to ensure that we will not get into a problem with rutting within the first year of performance. However, we need to find a reliable test to measure the properties over time and how they change. One potential test that can be used is the repeated load constant height shear

test in comparing properties of laboratory aged specimens using different times and temperatures to the properties measured in the field on cores recovered from the roadway.

**11. Asphalt Institute Update on MS-2**—Mike Anderson (Asphalt Institute)

Presentation Title: *Asphalt Institute Mix Design Manual*

Summary of Presentation/Report:
Mike Anderson started the report with an overview of the Mix Design Manual. He then overviewed the new manuals or major rewrites of the Asphalt Institute (AI) manuals. Anderson noted that Mark Buncher originally put this information together for a presentation and update that was given earlier this year.

- Anderson reported that the MS-26 manual was planned for release for 2010, but will probably be published within the first quarter of 2011.
- The new MS-2 Manual, *Mix Design Technology for Dense Graded and Other Asphalt Mix Types*. Anderson overviewed the purpose of the revised manual and how it is structured. This manual also includes sections on guidance for Best Practices that AI feels is important.
- The intent of the new MS-2 manual will serve as the new textbook for MDT course and is intended to serve as a working manual for practicing mix design engineers and technicians. Anderson also reported on how the manual was developed or revised.
- Anderson presented an outline of the revised MS-2 manual. He also listed and overviewed some of the questions that have come up relative to the NCHRP 9-33 work. He reported that AI is trying to make this manual as similar as possible to the 9-33 approach.

ETG Comments, Questions, and Discussion:
Randy West questioned the reasoning for including the Marshall and Hveem mix design methods in the manual, since they are considered out-of-date procedures. Anderson replied that California is still planning to use the Hveem stabilometer, but recognized that it might be outdated in a short period of time. Rick Harvey noted that many cities and counties still use the Marshall and Hveem mixture design procedures, so he agrees with including them in the manual.

**12. Update on FHWA Items**—Nelson Gibson (FHWA)
Nelson Gibson then gave an overview of two topics; a report on the webinar from the ALF test program and on the locking point concept. A verbal report was provided to the ETG.

- *Webinar and ALF Summary Update*

Gibson summarized the results from the TPF 5-19 experiment that was used to validate Superpave and SPR 2-74 experiment on crumb rubber mixtures/materials. Gibson reported that the webinar was held in August, 2010. He reported that a second one will be hosted in the near future for those that missed the first one. He stated that most of the results are applicable to the

Binder ETG, but some of the results will be of interest to the Mix ETG. The following summarizes some of the findings and/or outcomes from the ALF testing.

- Gibson overviewed some of the strengths and weaknesses of the Superpave PG specification and should results with new MEPDG that were revealed from these ALF studies and tests. The experiment found that polymers improved resistance to rutting and fatigue cracking.
- Cores showed that the gap graded wet process crumb rubber modified mix can and did stop cracking. Crumb rubber modified mix was found to be beneficial from this experiment.
- Terminally blended crumb rubber performed well in fatigue and rutting and handled easier than the wet process crumb rubber which needs a shear mixer on site; terminally blended crumb rubber does not.
- Gibson reported that an unmodified mix with polyester fibers performed the best in terms of cracking in thinner lanes, but provided little benefit in term of reducing rutting. He also stated that the TTI overlay tester did not capture the effects of the fibers along with axial fatigue – this still challenges some of the better mixture performance tests.
- The SST (simple shear test) did evaluate material well, but so did the flow number test, as being a good discriminator in identifying and capturing the rutting difference between mixtures although there were some notable statistical and numerical challenges.
- He reported that the MEPDG did not discriminate between the PMA mixtures.
- Gibson reported that laboratory test results with the MEPDG did improve on discriminating between the mixtures when a similar procedure coming from NCHRP 9-30A which uses Flow Number test data.
- MSCR was the strongest binder test for rutting determination although the data also showed |G*|/sin(d) was ‘not bad’.
- The Critical Tip Opening Displacement (CTOD) binder notched edge test also did a very good job in terms of identifying the susceptibility to cracking of the different binders and mixtures.
- An earlier protocol for axial fatigue test which has been refined and implemented in the AMPT is a viable alternative to conventional beam fatigue; good ranking with ALF cracking.
- The binder yield energy test, the older version developed by the University of Wisconsin at Madison, was included in the ALF test program, but not the updated test procedure. That initial test procedure did a reasonable job of classifying mixtures.

Fee asked if these results would be available to the public. Gibson answered that they would do their best in providing this information and data to the ETG members.

The recorded webinar is too large to post on an ftp site, but if you were unable to download the presentations during the first webinar, FHWA has posted them at the following FTP site:

**ftp://fhwaftp.fhwa.dot.gov/HRDI/ALF_PowerPoints/**
**Username: hrdiguest**
**Password: hrdiguest**

- *Locking Point Update*

Gibson then gave a report on the locking point. He overviewed what had been included in previous presentation to the ETG and the experiment that was planned during the last ETG meeting.

- A paper was submitted to AAPT on the results from the locking point study.
- Gibson reported that some agencies are moving away from the standard table on the gyratory recommendations for design. He summarized the findings from a similar survey to the one reported on by Judie Ryan in 2006 that was sponsored by FHWA in terms of what agencies are doing relative to Superpave compaction criteria; the number of gyration levels along with other criteria. FHWA did their own updated 2010 survey based on State specifications on FHWA's website and he summarized the results from their survey. He reported 39 states had modified Superpave specifications.
- The purpose of this experiment was to investigate the reality of a locking mechanism between the aggregate structure to provide insight and guidance to consider for those interested in modifying gyration levels.
- They quantified the packing using the flow number test on a practical or mechanical basis by the volume change in the specimens during confined Flow Number repeated load permanent deformation test. Reviewed the consolidation of mixes staring at 8 gyrations and going to 125 and tried to evaluate aggregate packing and effect of going past the number of design gyrations.
- Their hypothesis is that if you track VMA through the compaction process and then switch over to track VMA changes during the Flow Number test, the VMA should decrease during compacting and then decrease in Flow Number if the specimen was fabricated at low gyrations. Vice versa, the hypothesis was VMA should decrease during compaction and then increase in Flow Number if the specimen was fabricated at a high number of gyrations and therefore a high degree of packing. Somewhere between high and low gyrations the mix will transition from consolidation to dilation during the flow number test and therefore mark the point of aggregate locking. At 10 psi confining all mixes at all gyration levels dilated. When confining pressure was increased to 30 psi mix consolidated over the range in gyrations
- For the materials evaluated it appeared that at 60+ gyrations, these mixtures tended to have similar test results (based on the triaxial repeated load testing) regardless of increases gyrations. Volumetric permanent strain leveled off with gyrations before axial permanent strain. Gibson, however noted, that this does not mean that you can simply drop the gyration level because there are other items to be looked at.
- Gibson noted that there is an area that if you go beyond in terms of locking point, the hypothesis is there is some very marginal compaction but significant aggregate reorientation.
- Gibson reported that only one soft aggregate with 44% MicroDeval loss showed definite degradation with the gyratory compactor but this only occurred in the fine aggregate.
- Gibson noted that maybe we do not need to go to such high gyration levels based on their data, however more peer review and evaluation and more mixes than the 4 used in the experiment would need to be studied..

## DAY 2: Tuesday, September 214, 2010

Chairman Fee called the meeting to order at 8:05 AM. He first overviewed the presentations that will be given today and changes that were included in the agenda.

**13. Status Report on MIST-Tester**—Evr Dukatz (Mathy Construction)

Presentation Title: Moisture Induced Sensitivity Test (*MIST)*

Summary of Presentation/Report:
Evr Dukatz reported on the test results that were unavailable at the last ETG meeting. He noted that additional test results should be available at the next meeting. Dukatz showed the equipment that is used, explained the test itself and overviewed the procedure as a predictor of mixture moisture sensitivity. Dukatz also summarized the concepts included in the test procedure and how it works.

Dukatz summarized the small study that was used in the test program. He summarized the testing conditions and the different mixes that were included in the initial experiment. The data set included lab mixed samples as well as plant produced samples. He presented the correlation analysis from the test results. In summary, there was not much of a difference between 10 and 30 psi. Aggregate type was the most significant variable and whether it was plant mixed or lab mixed type of sample was also found to be important.

A regression model for the MIST TSR was developed in terms of relating MIST TSR to different parameters within the study. Dukatz showed a summary of the variables that were found to be significant within the regression study. Temperature was very significant. Dukatz noted that they also looked at what caused the differences between the test results. The delta Gmb or change in the bulk specific gravity.

Dukatz showed a graphical comparison of the test results in terms of a bar chart of strength versus mix design. Not shown on the x-axis is the type of mix; E-1, E-10, and the limestone mix PG 78. Dukatz reported they have worked with Tom Bennert on this topic and they no longer get MIST strengths that are higher than the unconditioned strengths.

Dukatz reported they have completed other tests, but due to unforeseen problems only a limited data set could be reported and presented at the meeting. Dukatz overviewed some of their findings to date. The aggregate effect does not seem to be as strong when looking at a lot of mixtures. The relationship between the TSR through the MIST and other parameters still has an $R^2$ term of 60 to 65%.

Dukatz then questioned what does this mean in the long term. He stated that they still do not know the answer. They are still getting some unusual values or anomalies and are trying to explain the reason for these results. Most of the tests results have been completed on what they

consider to be very good aggregates. The next step is to include mixtures or aggregates that are not considered good performers. Dukatz reported Tom Bennert is running the E* on many of their mixtures on both the unconditioned and conditioned MIST specimens to try and determine the TSR and define which mixtures can be discriminated between moisture sensitive and non-moisture sensitive mixtures.

ETG Comments, Questions, and Discussion:
Harvey asked if you run the freeze-thaw cycles in the test? Dukatz answered; no we do not. Ali Regimanl commented that the MIST conditioning replicates the conditioning of the cold and warm cycles. They seem to replicate the freeze-thaw conditioning used in the existing test procedure. Dukatz replied that one benefit of the MIST tester is that you can run one to two specimens per day. An advantage is better duplication to simulate field conditions and it is a quicker test in comparison to AASHTO T 283 that has been used.

Regimand asked that when the MIST TSR has higher values than T 283, whether Dukatz observed a change in density between the two. Dukatz replied; the density increased. Regimand stated; so that could explain an increase in strength for the MIST TSR in comparison to the T 283. Dukatz overviewed that the conditioning of the MIST actually densified the mix, so the strength increased. He also reported; they have not been able to replicate that condition in all cases.

Hall asked; what is the status of the equipment in terms of a standard? Dukatz replied; the equipment is still considered a prototype; it has not been standardized to date.

D'Angelo noted the data are interesting, but one item to compare against is the work done under NCHRP 9-24 in which the specimen conditioning system that Oregon State University had promoted during SHRP was really found to be good in terms of identifying bad mixtures. The issue was that no one wanted to use the test because of the extensive time requirement to condition the specimens. D'Angelo suggested going back and getting those materials or mixtures from NCHRP 9-24 and trying to replicate those test results. Dukatz thought that was possible approach.

Fee asked; what needs to be done in future or where do we go from here? Dukatz suggested leaving this as the presentation and the only action item is doing what D'Angelo suggested and reporting on that at the next meeting. That recommendation was accepted.

**ACTION ITEM #11; For the MIST procedure; Erv Dukatz will try to obtain material from the mixtures that were used in NCHRP 9-24 and try to replicate those test results using the MIST tester. Report the results from this effort at the next ETG meeting.**

**14. Mix BBR and Semi-Circular Bend (SCB) Mixture Tests**—Mihai Marasteanu (University of Minnesota)

Presentation Title #1: *Update on Asphalt Mixture Low Temperature Testing Methods and Semi Circular Bend Test Bending Beam Rheometer*

Summary of Presentation/Report:
Mihai Marasteanu started with an overview of some of the task activities that they are doing. This relates to Task 3, Develop low temperature specification for asphalt mixtures, and Subtask 1 in terms of developing the test method. Right now they are in the process of running the DC(T) and SCB. Marasteanu reported that he submitted the draft test procedure and did get some good comments back from the ETG members, especially from Gerry Huber and appreciated getting those comments. He apologized for not getting back with those members that provided comments on what is being done.

Marasteanu discussed the mixture tests that are performed; specifically two – the semi circular bending (SCB) and disc-shaped compact tension (DC(T)) tests. These two tests are being used to determine the fracture parameters of HMA mixtures in accordance with fracture mechanics. Marasteanu graphically showed how the fracture energy is being determined from the test procedures (load versus non-load displacements). He summarized the experimental results by the use of a graph and noted that the results are repeatable as long as you pay close attention to setting up the test.

Marasteanu summarized and listed some of the possible issues with the proposed test methods. All of this work is at low temperatures. He reported that the data interpretation needs to include a rigorous process. There are differences between the two test procedures and they are investigating reasons for the difference between the two tests. They are also trying to speed up the test to eliminate some of the creep effects on the test results within the test procedure.

Marasteanu overviewed some of the sample preparation items or issues that are important in getting good test results. One example noted as being important is that the holes are parallel and properly aligned for the tension tests to eliminate eccentricity. Marasteanu showed and explained the sample set up and instrumentation. He also reported on some of the data scatter and overviewed what they did to reduce the scatter in the data. This included revising the loading head fixture to eliminate loading the specimen effects in a different direction than expected.

Marasteanu showed a revised test from Barcelona; the specimen is glued to metal plates to eliminate holes to eliminate the holes drilled in the specimen. This is called the Fenix Test. He commented this setup looks similar to the TTI Overlay Tester (it used a similar concept). He also presented and summarized the results from a finite element analysis of the Fenix Test simulation of the results from the test. This included typical results from the Fenix Test in terms of load versus displacement.

Marasteanu provided a summary of the results from their test that they have been using; the SCB and BBR test. He reported there is a report that has been published on some of their initial work. Marasteanu stated that the modeling shows that the results are reasonable, but he has a concern about the effects of cutting the specimens – the sawing operation causing micro-cracks in the specimen that would affect the results.

Marasteanu also summarized the specimen geometry effects that they have found. He stated that they are close to the representative volume point and that the results are similar to the BBR in terms of beam size effect. You can recreate the BBR test results or vise-versa. He reported they have a draft BBR creep mixture test method. He also mentioned they have received funding to investigate the effects of notched test specimens. He showed some of the preliminary data that looked encouraging, but commented it is very complicated. They used a water flow system within the test. Marasteanu reported that this test is more complicated than creep testing. He summarized the literature reviewed on the size-effects and the exploratory work being conducted to summarize the BBR, IDT, DT test results comparison without any size effects. After he corrected for size effects, you see that many of the values become closer. Marasteanu showed some example results that supported the process for accounting for the size effects.

Marasteanu noted they will have more results and items to report at the next meeting.

ETG Comments, Questions, and Discussion:
Fee asked whether the BBR has a standard. Marasteanu replied that a draft standard exists for the BBR and a draft exists but has yet to be submitted for the SCB. Fee requested that the draft standard be submitted to the ETG.

Reinke asked about the type of test and whether it needs to be different than a BBR test specimen. Marasteanu agreed with that comment. He reported; rather than starting all over, they decided to use the BBR type of specimen. Commented that's what makes this test useful is that it can be used on small specimens. Marasteanu agreed, and noted that as long as you keep the proportions the same, you can test larger test specimens. This was supported by Raul's data. The only item is that the longer specimens are subjected to creep effects that must be accounted for in the interpretation of the test data.

Karissa Mooney asked; what is the cost of the test and size of the specimen? Marasteanu replied it is relatively inexpensive and different size specimens can be used.

**ACTION ITEM #12; Mihai Marasteanu will provide Fee the final recommended procedure for the mixture Low Temperature Testing using the BBR.**

**15. Update of Flow Number Experiment—**Frank Fee (NuStar Asphalt)

Presentation Title: *Flow Experiment Overview*

Summary of Presentation/Report:
Frank Fee started with summarizing the experiment and listing the mixtures that have been selected to date. He distributed a copy of the final section of test cells from the original experimental plan. He reported that two laboratories will do all of the testing.

In summary, Erv Dukatz (Mathy Construction) has two mixtures that will be available, shortly; Todd Whittington (North Carolina DOT) will have a couple of mixtures; and Fee is still working with Dale Rand to get a mixture from Texas; this one has yet to be confirmed. Randy West has one mixture that was placed on the NCAT test track that can be used in the test plan; and Todd Lynn (APEC) has one mixture from Kansas or Missouri. Jim Musselman has a mixture that has already been placed and sampled (this mixture is tentative). Adam Hand has selected a project that will be sampled in a couple of days or so. Fee also has a project that will be sampled shortly in the New Jersey area (mixture recommended by Bob Sauber). Randy West has obtained the materials that are currently available to be shipped to the laboratories.

ETG Comments, Questions, and Discussion:
Randy West asked if these projects are new construction or is there performance data available. Fee asked Bonaquist about this question; Bonaquist replied that these are mixtures with good performance. The experimental plan and mixture selection guidelines did not ask for performance data. Jim Musselman reported that the Florida project is about 10 years old and performance data is available. Randy West emphasized the importance of knowing performance history of the mixes to be analyzed.

Huber asked how are you collecting materials on these older projects and where are the materials coming from? Musselman replied the only difference would be the quarried material at different times; materials are from the same quarry and there is no RAP in the mixture. In addition, the same PG binder is being used that they typically specify and use within the area.

Dukatz asked are you looking at the nominal maximum aggregate size, or only whether it has good rutting performance? Fee replied that the aggregate type does not influence the experiment.

Huber asked what are the in place properties of the mixtures? Those properties can have a large influence on the performance. How or where are the in place properties coming from for making the test specimens? Fee answered; we need to remember we are testing and comparing test methods and not the mixture itself; this is a relative comparison. Huber replied; he understood that, but can think of a couple of projects in Indiana where performance history is excellent but that is related back to construction and not the materials.

**ACTION ITEM #13: Frank Fee to report on the status of the Flow Number experiment, available test results, and any comparisons completed to date at the next meeting.**

**16. High Performance Thin Overlays—**Frank Fee (NuStar Asphalt)
This topic of thin overlays was not on the preliminary agenda.

Presentation Title #1: *High Performance Thin Overlay (HPTO)*
Frank Fee reported that he would like to move forward with this topic on High Performance Thin Overlays (HPTO).

Summary of Presentation/Report:
Fee summarized the requirements for HPTO and some of the identified applications. He focused on the application of HPTO in New Jersey. He summarized and overviewed how this technology is being moved forward.

As part of his presentation, he summarized one of the New Jersey projects, New Jersey I-280 maintenance project. The application of HPTO is to get an additional 15 years with a 1.25 inch overlay. Fee summarized the materials used on the project, showed the HPTO specification, and overviewed specific features of the maintenance project.

ETG Comments, Questions, and Discussion:
Hall asked if Fee was concerned about reflection cracking of the thin overlay. Fee replied no, because the material heals itself. The I-280 project is a thin overlay over a jointed PCC pavement. Fee reported they obtained good densities/low air voids. He showed the minimum and maximum air voids recorded from the different lots, average air voids was about 5%.

Musselman questioned the low air voids for the thin overlay. Geoff Rowe noted that the VMA for this mixture was high, so there was a lot of binder available to facilitate compaction. Fee included some of the physical properties of the HPTO in his presentation.

**17. Refinement of 4.75 mm Mix Design —**Randy West (NCAT)

Summary of Presentation/Report:
Randy West reported on the refinement of 4.75 mm Mix Design and included a short presentation on its status. West started with a summary of the survey that was done about 5 years ago. He noted that this work was initiated by Allen Cooley.

West reported that Mississippi had one of their thin overlay mixtures placed at the test track in 2003, and it exhibited little rutting. That thin overlay has performed very well. D'Angelo asked whether degradation has been monitored either in the field or through the gyratory on these small mixtures/thin overlays. West replied; this has not been looked at, but agrees with D'Angelo that the aggregates will move around within the gyratory during compaction, so the aggregate degradation might be higher. However, he also replied that these are small aggregates, and is unsure whether degradation is taking place.

West overviewed some the current 4.75 mm mix design criteria that has been recommended and published. It has been suggested that the range of air voids need to be looked at, just like for the Marshall method.

West summarized some of the advantages and disadvantages of the 4.75 mm mixtures. He commented that Fee had already mentioned some of these advantages in his report on the HPTO. West focused and highlighted the excellent smoothness that has been reported for these mixtures. West reported; part of the motivation of these mixtures was to get rid of the fine aggregate that was being stockpiled by contractors for producing more coarse-graded mixtures at the beginning of Superpave. There is a surplus of fine aggregate in some areas. West overviewed some of the

disadvantages of the 4.75 mm mixtures, which include: high asphalt contents, low frictional resistance due to low surface texture, and greater potential for permanent deformation. He referred to the project mentioned by Fee with a minimum VMA of 18.

West reported since these mixtures are placed thin (less than 1 inch), there normally is no density requirement. This comment related to the value of increased density and low air voids. West commented that permeability is low because the air voids are not interconnected.

West overviewed the recommended 4.75 mm mix design criteria. The design criterion uses the sliding scale for the design air void level (4 to 6 percent). D'Angelo commented on the VMA varying from 15 to 21%. He has concern over these ranges and believes some of which will never be obtained. West disagreed with that comment. They have recorded or estimated VMA values up to 21% on some projects. An additional comment was that these small mixtures are sensitive to permanent deformation and friction issues. This question caused additional discussion on why would a contractor want such a high VMA. West stated that asphalt is paid for as a separate item by some agencies. He also stated that your specifications need to protect against this rutting issue for some of these mixtures. West stated that economics is what is going to drive these mixture designs – contractors will lower the VMA to lower the asphalt content.

Fee noted that they have used some of these small mixtures, and in his opinion, skid will not be as a problem. Kevin Hall also replied; one of their findings is that the small mixtures and thin overlays actually retain higher skid values over a longer period of time than some of the larger mixtures. West also reported higher VMA mixtures were the ones that exhibited higher levels rutting.

West noted four criteria related to construction: no more than 15% sand, less than one inch lifts (3/4 inch is typical), no in place density requirement, and increased paving speeds. West reported; when more than 15% natural sand was used, they exhibited problems related to rutting. Be cautious about rollers staying up with the paver, because paving speeds increase with the use of these small sized mixtures.

West showed laboratory permeability test results on these small sized mixtures. He mentioned that Texas has exhibited blisters with the use of these mixtures, because they seal the existing pavement prior to placing the small-sized mixtures. Reinke asked what type of problems might you see, if these mixtures go down as WMA. West replied; these mixtures need to be workable because they are thin.

ETG Comments, Questions, and Discussion:
Fee asked; when will the revised draft mix design criteria available to the ETG? Harvey noted that when West is complete with the project, that this go forward as an action item for preparing it as a ballot item. West agreed to provide the document, specification, and whatever he thinks is important to move this item forward to AASHTO.

**ACTION ITEM #14; West will provide the revised mix design criteria, documentation, and specification to the ETG for moving this item forward to AASHTO.**

**18. Precision Estimates for T312, T166, and T331—**Haleh Azari (AASHTO-ARML)

Presentation Title: *Effect of T312 Parameters on Precision Estimates of T312, T166, and T331*

Summary of Presentation/Report:
Azari first noted the goal of the study (evaluate variability of T312, T166, and T331 test result as a function of parameters from T312) and the properties included in the study (Gmb from T166; Gmb from T331, height after 100 gyrations from T312; and percent of maximum density after 100 gyrations).

She summarized the parameters considered in the experiment and identified some of the problems that they encountered. One of the major issues was cleaning the data and the calibration process used. She is reporting on cleaning the data and the calibration process for this meeting. She also reported that most of the data was for 6 months, so they could not accomplish everything they wanted to as part of this experiment.

Azari provided a summary of the data used in the study, as well as the data analysis methodology. She reported whenever they have more than two data sets another analysis method was used, but when there were only two data sets or comparisons, they used a paired t-test for the comparison of the data sets. Azari presented some example test results from T166 (a comparison of internal and external calibration measurements) using bar charts. Some of the results were not included on the slide because of the colors selected. The results included in the presentation were: change in number of laboratories for Gmb from T166; change in repeatability for Gmb from T166; change in reproducibility for Gmb for T166.

She them summarized the statistics for Gmb using T166. Internal calibration improved on the repeatability of the test. The other item summarized by Azari was the tests of significance for Gmb from T 166.

Azari reported that she presented and showed only a portion of the data, because a lot of it did not make any sense. The data will be cleaned and presented at the next meeting.

ETG Comments, Questions, and Discussion:
Rick Harvey asked if the final report would be to propose a new precision statement. Azari replied; the new precision statement will be available for T 312 and then sent to AASHTO. Kevin Hall commented; the new precision statement should be sent to the ETG for review prior to forwarding it to AASHTO. Azari agreed that the report will be submitted for review to the ETG.

**ACTION ITEM #15: Azari will distribute to ETG members for comment/review the P& B statement for T166 and final discussion at the next RTG meeting. The statement, after review will be forwarded to the SOM.**

**19. Results of NCHRP 09-39 Mixing and Compaction Temperature Study**—Randy West (NCAT) and John Casola (Malvern Instruments)

Presentation Title: *Development of a Simple Method for Determining Mixing and Compaction Temperatures for Hot Mix Asphalt*

Summary of Presentation/Report:
West gave an overview of the background for this effort. The goal of the effort is to develop a standard for selecting the mixing and compaction temperatures. Another goal is to make this standard as simple as possible, similar to the equi-viscous method.

West listed some of the methods that they have looked at for determining the mixing and compaction temperatures, which include: high shear rate viscosity (Yildirim), steady shear flow (Reinke), and dynamic shear rheology (Casola). West stated; in reality what we are trying to find is the shear rate that occurs within a batch or drum mix plant during production, which is highly variable because there are many different shear rates throughout the production process. He gave a brief summary of each method.

Overall, the high shear viscosity procedure did not result in any improvement above the standard method. The Casola method recognizes that it is more than just the viscosity at a specific shear rate. West presented a graph that demonstrated this issue. The 86 degrees is the point where the binder moves from Newtonian to non-Newtonian. This will define the shear rate to be used in mixing the HMA.

West compared the mixing and compaction temperatures determined from the different methods for many different binders. One table summarized the results for the Steady Shear Flow viscosity method (Reinke method) to the equi-viscous standard method, while and a second table summarized the results for the phase angle method (Casola method) to the equi-viscous standard method. Binders C to M in the tables are all modified binders.

West presented the research approach being proposed and used under NCHRP project 9-39. He listed the different steps that were included in the research approach and presented the work plan flow chart for the project. He noted that the smoke emissions test was originally used by Mary Stroup-Gardiner, which was also used on this study. He overviewed and summarized the different tests included in the study.

- Mix coating tests – lab pugmill mixer and bucket mixer to simulate batch plant and drum mix plant mixing. Mix binders with a standard aggregate blend at four temperatures for a set time. Rate aggregate coating as a percentage using Ross count. West reported that they rated each one at an 89% coating of the aggregate value for comparisons.
- Mix Compactability – Four compaction temperatures were used, and 25 gyrations used to amplify the effect of binder stiffness.

- Mix Workability – West described details of this test, how the test results are being presented or interpreted, and how workability is being measured. Basically, measuring the torque to turn a paddle within the mix.

West overviewed the statistical comparison of results. He pointed out that the $r^2$ values are very low, but the reason for this finding is that the mix tests are not that good. He then overviewed some of the more important findings.

- Smoke and Emissions Potential. Opacity appears not to be related to type of binder and whether it was or was not modified. West's conclusion was that the SEP test did not appear to be a good test for use in determining the mixing and compaction temperatures.
- Creep compliance and strength tests and how overheating affects the mix properties. The magnitude of the shift in compliance was relatively low compared to heating the asphalt mixtures, which was lower than what West expected. They were not seeing a lot of degradation on the low temperature properties by overheating the asphalt.

West summarized the recommendations from the study. The report gives an option to use either the Casola or Steady Shear Flow methods. West reported that the New Mexico DOT has been using the Casola method for some time now. West was unaware of any others that have been using any one of these methods. The specific recommendations were:

- Steady shear flow or phase angle (Casola) methods are options for determining the mixing and compaction temperatures.
- Both methods can be easily included in routine PG binder testing.
- These methods should be further evaluated by users to compare the results to their current recommendations and assess the validity of the results.

West also identified some of the limitations of the test methods, which are:

- The recommended procedures are based only on binder characteristics. Other factors that affect coating and compactability include:
  - Aggregate and mineral filler characteristics.
  - RAP and other recycled materials.
  - Warm mix additives/processes.
- The methods are not suitable for binders containing:
  - Some WMA technologies.
  - Rubber.

West acknowledged there are different views on the application of lab and field use of mixing and compaction temperatures. West has an opinion that the methods should be lab methods to improve on the consistency and not mandate that these results should force them to be used in the field.

<u>ETG Comments, Questions, and Discussion:</u>
Mike Anderson commented that AI is interested in using these results. West reported that the project has been completed and a report is available for use and review.

Gerald Reinke reported they are using 1,000 Pa instead of the initial value.

**20. Asphalt Research Consortium Activity Update**—Ellie Hajj (University of Nevada at Reno); and Aaron Coenen and Hussain Bahia (University of Wisconsin at Madison)

Two presentations were given on this topic. Ellie Hajj gave the first one, while Aaron Coenen gave the second one.

Presentation Title #1: *Updates on ARC work Element E2d; Thermal Cracking Testing of Asphalt Mixtures*

Summary of Presentation/Report:

Ellie Hajj reported on and gave an update on ARC work element E2d in three areas:

A. Environmental conditions within intermountain region.
B. TSRST – SGC cylindrical specimens.
C. TSRST – Cooling rates experiment.

- ***Environmental Conditions***

Environmental conditions work was to determine the warming and cooling rates for comparing the results from the TSRST for evaluating different mixtures. They ended up using 10 LTPP SMP sections or sites in the intermountain region, 5 LTPP SMP sections or sites outside the intermountain region, and 3 test sections from the WesTrack project. The average daily warming and cooling rates:

- Hourly Cooling and Warming Rates based on a sensor depth of 12.5 mm.
- Using a 25 mm sensor depth, the scatter in the data increases and comparisons start to fall apart.

Hajj summarized a summary of findings to date:

- Lower temperature rates at deeper pavement depths (12.5 versus 25 mm)
- At 12.5 mm depth; higher average hourly cooling/warming rates for sections within the intermountain region.
- At 25 mm depth; similar cooling/warming rates for sections within and outside the intermountain region.
- Within the intermountain region – Maximum daily: cooling rates of 2 to 3 C/hr. range; warming rates of 6 to 10 C/hr; Maximum hourly: cooling rates of 4 to 6 C/hr.; warming rates of 6 to 10 C/hr.

- ***TSRST, SGC Cylinders Versus Beams to Improve on the Repeatability of the Test***

Specimen geometries were studied to improve the test; effect of geometry (cylinders versus beams) and compaction method (SGC versus kneading compactor) on TSRST test results. The test specimens were prepared in the laboratory using the short term aging procedure (4 hours at 275F), compacted, and then long term aged with 5 days at 185F.

Hajj presented and reviewed the 2D image analysis procedure that was included in the analysis. This will be included and overviewed in the next presentation. A summary of results is to move forward included:

- Cored sideways from SGC samples (perpendicular to compaction direction).
- Improved repeatability of test results.
- Can be cored out of field core samples from different lifts within asphalt layer parallel to traffic direction.

- ***TSRST Cooling Rate Experimental Plan***

Next part of Hajj's presentation was on the experimental plan using the results from the environmental analysis of the temperature change. Hajj reviewed the experimental plan and identified the parameters to be evaluated within this work plan.

- Effect of different temperature change rates.
- Effect of starting test temperature. Hajj presented the summary of the results. He noted that the starting temperature will have an impact on the test results.
- Effect of Binary Cooling rate. These test specimens were taken to failure. This test takes about a full day of testing. They encountered problems because of the higher air temperatures and the lab was too warm so the equipment overheated and had problems in trying to keep these cool rates.

Hajj summarized the preliminary findings from the part C of the study, which included:

- For monotonic cooling rates at a starting test temperature of 5C – warmer fracture temperature was observed but similar build-up of thermally induced stresses.
- Binary cooling rate showed similar thermally induced stress accumulation behavior for initial rate.
- A starting test temperature of 5C was not warm enough to see any difference in the thermally induced stress-temperature plots for the various rates.
- Warmer starting test temperature allowed additional thermal stresses to accumulate in specimens subjected to a higher cooling rate (longer relaxation period for specimen during the test).

Hajj acknowledged the FHWA and the ARC for this work. He also acknowledge others involved in this study.

ETG Comments, Questions, and Discussion:

D'Angelo asked what is really going on in the test and mixture? Hajj mentioned that the reason they highlighted the finding on increasing strengths is that the opposite is reported in the literature. Hajj also mentioned some results reported or provided by Claine Peterson that showed similar results on an optimum value for binders, so maybe there are some similarities between the two. Chris Williams mentioned some of the differences between what they have been doing and the findings presented by Hajj.

Presentation Title #2: *Aggregate Structure parameters as Performance Indicators for Rutting Resistance*

The authors of this presentation/report were Aaron Coenen and Hussain Bahia. Coenen gave the report.

Summary of Presentation/Report:
This presentation/report was focused on the imaging and image analysis used to study the effect of aggregate contact and its impact on performance. This work is being completed at the University of Wisconsin in Madison with support from Iowa State University.

Coenen overviewed the problem being studied and the hypothesis being evaluated regarding the aggregate to aggregate contact and its effect on performance, even for mixtures compacted to the same and different density levels. The hypothesis is:

- Asphalt mixture resistance to rutting is more dependent on aggregate to aggregate contact, rather than on volumetric properties of the mix.
- Contact points provide a means of quantifying connectivity of the aggregate matrix within the mix.
- A high level of connectivity is indicative of the aggregates forming a supportive matrix/skeleton which provide load capacity for resistance of rutting.

Two aggregate gradations were selected for use in the experiment: a fine-graded mix and a coarse-graded mix. The same amount of mineral filler (percent passing the 200 sieve) was set equal between the two gradations. Coenen summarized the specific materials included in the experiment.

Coenen reported that need to make sure that replicates were prepared and available for mechanical testing and image analysis. Replicates were used between the two procedures (mechanical analysis and image analysis). This comment relates to the experimental analysis and comparison between the different data sets.

Coenen provided an overview and summary of the software used to do the image analysis. The user defines the contact points. Coenen showed and discussed the reasoning for defining the contact points that show up as not really being a contact point. Another important element is the selection of surface distance threshold value. A lower Plato area defines the minimum aggregate size to be input into the software. Coenen used some examples to demonstrate the software and procedure. He provided multiple examples on what happens to the number of contact points with different minimum aggregate size for defining the contact point offset.

He also provided examples of coarse versus fine-graded aggregate gradation and its effect on the number of contact points. Two examples were provided on specimens that were compacted to the same density, but with different flow numbers. The question became; What does this mean? The next part of the presentation/report showed some results for flow number between percent air voids and mechanical property performance measured in the laboratory. Coenen showed some examples comparing air voids or density versus flow number.
Some test results were summarized illustrating the flow number as a function of the normalized number of contract points in the mix. After the examples, Coenen then presented the standard on

the image protocol and equipment. The suggested revisions to the standard were then presented and overviewed.

It was suggested that the revised draft for the standard practice be reviewed for moving this standard forward. The next step is to use the image analysis for different aggregates than what was used in the initial analysis. Coenen acknowledged the different agencies and individuals related to this work.

ETG Comments, Questions, and Discussion:
The following lists the questions that were asked:

- How was the threshold value determined? Coenen answered; it can be adjusted and is an iterative process to get the best representative of the 3-d sample.
- When you showed the slice of the sample, how do you know that changing the slice direction would not change significantly? Coenen answered; there will be a bias between different images through the offset from the center. They have not done this relative to offsetting the slices, so this needs to be looked into. Randy West mentioned the work done at NCAT where the slices were offset but they were looking more at aggregate orientation rather than contact points.

**ACTION ITEM #15; Requested that the ARC submit the revised draft recommended practice for the image analysis to the ETG for review/comment.**

**21. Additional Topics Related to Next ETG Meeting**
Frank Fee noted that Richard Kim was not present, but will be present at the next meeting to provide a status report and bring the ETG up to date on his group's activities.

**22. Next Meeting Location and Date**
Chairman Fee reported that the next ETG meeting is scheduled for the March, 2011, but the specific date and location have yet to be determined. As in the past, this ETG meeting will be coordinated and scheduled with the Binder and Models ETG.

**23. Overview of Action Items**
The action items from the meeting are:

1. Bonaquist will develop and distribute for ETG an appendix (1-2 pages) to be added to TP79 on explanation of the Franken Model.

2. Bukowski will send to ETG members the web link to FHWA Technical Briefs (Previously intended as TRB E-Circulars) on the SGC and Specific Gravity Determination/Issues. Also sent to all SOM members or their agencies.

3. Bonaquist will develop and distribute to ETG members wording to be added to TP 79 section 8.2.1 on equipment calibration recommendations.

4. Task Group (Mike Anderson – lead) will review T320, 321 and 322 for any necessary updates and recommendations to the SOM. Volunteers to assist in this Task Group should contact Mike Anderson.

5. Bukowski will distribute to ETG members NCHRP 9-33 information related to proposed new procedures and commentary for review and discussion at next meeting, prior to forwarding a final recommendation to the SOM.

6. A Task Group on WMA (Corrigan – lead) will be established to review and coordinate comments with the WMA TWG on the proposed changes to R35 as a result of the 9-43 project. And report at the next ETG meeting.

7. Corrigan will prepare and distribute to ETG members an appendix to T312 dealing with comparison of different Superpave Gyratory Compactors.

8. ETG members are requested to review and send any final comments to John D'Angelo, prior to October 15 on the draft Technical Brief on adjusting Ndesign levels.

9. Task Group on Construction (LeFleur – lead) will prepare a research needs statement related to in-place density, how it is specified and measured among the various agencies. One issue to determine is whether there has been an actual change in the amount of in-place density prior to and after Superpave.

10. Task Group on Construction (LeFleur – lead) will compile a list of critical construction topics, distribute to ETG members and discuss at the next ETG meeting.

11. For the MIST procedure; Erv Dukatz will try to obtain material from the mixtures that were used in NCHRP 9-24 and try to replicate those test results using the MIST tester. Report the results from this effort at the next ETG meeting.

12. Mihai Marasteanu will provide to Fee the final recommended procedure for the mixture Low Temperature Testing using the BBR.

13. Frank Fee to report on the status of the Flow Number experiment, available test results, and any comparisons completed to date at the next meeting.

14. West will prepare and distribute to ETG members for comment a draft standard for a 4.75 mm mix.

15. Azari will distribute to ETG members for comment/review the P& B statement for T166 and final discussion at the next RTG meeting. The statement, after review will be forwarded to the SOM.

16. Requested that the ARC submit the revised draft recommended practice for the image analysis to the ETG for review/comment.

**24. Meeting Adjournment**

Secretary John Bukowski and Chairman Frank Fee thanked everyone for attending the meeting and thanked the University of Wisconsin at Madison for hosting the ETG meeting. He thanked Hussain Bahia for his effort in coordinating the meeting, and providing the facilities. Fee adjourned the meeting at 12:15 PM.

# ATTACHMENT A

## FHWA Asphalt Mixture & Construction ETG Meeting Agenda

Madison, Wisconsin
September 20 & 21, 2010

## Meeting Agenda- Draft

**Day 1— September 20, 2010**

| | | |
|---|---|---|
| 8:00 am | Welcome and Introductions | **Fee** |
| 8:15 am | Review Agenda/Minutes Approval & Action Items September, 2010 Meeting | **Bukowski** |
| 8:45 am | Subcommittee on Materials Updates/Comments | **Harvey** |

AASHTO SOM Issues:

Discussion of Any Updates T320 (SST), T321 (Fatigue), T322 (IDT)
TP79 AMPT E* Add Appendix about Francken Model Calculation

| | | |
|---|---|---|
| | Research Proposal Mixture Aging in Production | **Fee** |
| 10:00 am | Break | |
| 10:30 am | Update Related NCHRP Activities | **Harrigan** |
| 11:00 am | Interim Report on ARML Data E* Flow Number Studies and ARML Review Precision Statement T 312 (SGC) | **Azari** |

Noon Lunch

| | | |
|---|---|---|
| 1:00 pm | Comments on 9-43 WMA Mix Design Changes - Proposed for R35 | **Bonaquist** |
| 1:30 pm | Summary of NCHRP 9-33 Mix Design Recommendations - Potential AASHTO Standards | **Bonaquist** |
| 2:00 pm | Potential Appendix for T 312 Comparing SGCs | **Corrigan** |
| 2:30 pm | Construction Task Group In-Place Density Issues | **TBD** |
| 3:00 pm | Break | |
| 3:30 pm | Status SGC Ndesign Technical Brief | **D'Angelo** |
| 4:00 pm | Establishing Bias of Aggregate Gravity Tests (T-84/T-85) | **Hall** |

| | | |
|---|---|---|
| 4:30 pm | Mix BBR and Semi Circular Bend (SCB) Mixture Tests | **Marasteanu** |
| 5:00 | Adjourn for the Day | |

**Day 2— September 21, 2010**

| | | |
|---|---|---|
| 8:00 am | Update Flow Number Experiment | **Fee** |
| 8:30 am | Status Report on MIST-Tester | **Dukatz** |
| 9:00 am | Results of 9-39 Mixing and Compaction Temperature Study | **West** |
| 9:30 am | Report on IDT E* Ruggedness Testing Plan | **TBD** |
| 10:00 am | Break | |
| 10:30 am | Asphalt Institute Update MS-2 | **M. Anderson** |
| 11:00 am | Asphalt Research Consortium Activity Update | **TBD** |
| Noon | Action Items and Next Meeting Planning | **Fee/Bukowski** |
| | Adjourn | |

# ATTACHMENT B

## FHWA Asphalt Mixture & Construction Expert Task Group Members

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# ATTACHMENT C

## Task Group Members and Assignments
## FHWA Asphalt Mixture & Construction ETG

| Task Group Identification: | | Members Assigned to Group: |
|---|---|---|
| 1 | Gyration Level Commentary | John D'Angelo (Lead);<br>Gerry Huber, Brian Prowell, Randy West, Frank Fee, Kevin Hall, Julie Kliewer |
| 2 | Guidance for Flow Number Testing | Ray Bonaquist (Lead);<br>Richard Kim, Ellie Hajj, Haleh Azari, Audrey Copeland, Kevin Van Frank, Phil Blankenship, Nam Tran, Raj Dongre, Nelson Gibson, Harold Von Quintus |
| 3 | Superpave Performance Test Review | Mike Anderson (Lead) |
| 4 | WMA Mixture Design/9-43 Comments | Matt Corrigan (Lead) |
| 5 | HMA In Place Density Practices & Specifications | Cindy LaFleur (Lead);<br>Erv Dukatz, Julie Kliewer, Todd Lynn, Jim Musselman, Judy Ryan, Chris Euler |
| 6 | S-VECD Alpha/Beta Testers | Richard Kim and Shane Underwood (Leaders);<br>Tom Bennert, Jo Daniels, Geoff Rowe, Tom Scarpas, Harold Von Quintus |