I. Call to Order and Opening Remarks
Call to order scheduled for 10:00 a.m. Chair was not able to travel and is joining the meeting via phone conference.

II. Roll Call
Attendees please sign in. An attendance sheet was distributed for members and guests to signify their attendance. See Appendix A for the agenda and Appendix B for the attendance sheet.

III. Approval of Technical Section Minutes
The Minutes for the TS 2b Meeting on August 8, 2013 in Stateline, NV were approved during the Mid-Winter Webinar on March 5, 2014. Request approval of the Minutes for the March 5, 2014 Mid-Winter Webinar for TS 2b. A motion was made by Louisiana and a second by FHWA to approve the minutes without changes. The motion passed unopposed.

IV. Old Business
A. Previous Year SOM Ballot Items

Item 14: Concurrent ballot item to REVISE M 320, Performance Graded Asphalt Binder to accommodate the use of ground tire rubber as a modifier. Proposed revisions are presented on pages 25-28 of the 2013 Minutes and the motion and discussion can be found on pages 2-5 of the 2013 Minutes. 42-Affirmative, 4-Negative, 7-No Vote.

Item 15: Concurrent ballot item to REVISE MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) to accommodate the use of ground tire rubber as a modifier. Proposed revisions are presented on pages 29-32 of the 2013 Minutes and the motion and discussion can be found on pages 2-5 of the 2013 Minutes. 42-Affirmative, 4-Negative, 7-No Vote.

Item 16: Concurrent ballot item to REVISE T 315, Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to accommodate the use of ground tire rubber as a modifier. Proposed revisions are presented on pages 33-36 of the 2013 Minutes and the motion and discussion can be found on pages 2-5 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote.
As discussed at the Mid-Winter Webinar, Items 14 – 16 were not adopted due to the negatives. A task force was formed to develop a standalone specification for GTR in PG Binder. We will discuss further under Task Force Reports.

**Item 17:** Concurrent ballot item to REVISE MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) to change the requirement for J nr3.2 for standard grade asphalt. Proposed revisions are presented on pages 37-41 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. Mississippi withdrew their negative during the meeting based on the explanation provided by the Chairman during the meeting. This standard was published as balloted. No further action is needed.

**Item 18:** Concurrent ballot item to REVISE TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to clarify wording and ensure essential data is recorded. Proposed revisions are presented on pages 42-44 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 45-Affirmative, 1-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. These standards will be published. Bob Kluttz (Kraton) asked if any changes in TP 70 would be reflected to ASTM D 7405, and how that would be handled. Maria Knake indicated that she will coordinate that effort. No further action is needed.

**Item 19:** Concurrent ballot item to REVISE TP 92, Determining the Cracking Temperatures of Asphalt Binder Using the Asphalt Binder Cracking Device (ABCD) to clarify the sample preparation/pouring. Proposed revisions are presented on pages 45-53 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 45-Affirmative, 1-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. These standards will be published. No further action is needed.

**Item 20:** Concurrent ballot item to REVISE R 29, Grading or Verifying the Performance Grade of an Asphalt Binder to allow the flash point to be done by another lab. Proposed revisions are presented on pages 54-58 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the negatives by AK and ID were found to be persuasive. The Chairman suggested that R 29 be modified to remove flash point. The Chairman also suggested that a standard to address the grading if you are using MP 19. The Chairman volunteered to draft this standard and for discussion at Summer Meeting.

A ballot Item to revise R 29 was on the TS 2b 2014_02 ballot and will be discussed under that item on the agenda. The Chairman has not yet drafted a new standalone version to address MSCR testing.

**Item 21:** Concurrent ballot item to REVISE T 44, Solubility of Bituminous Materials to allow the use of multiple flasks to complete the test. Proposed revisions are presented
on pages 59-60 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. Editorial comments addressed. Comment by SC noted. No further action necessary.

**Item 22**: Concurrent ballot item to REVISE T 49, Penetration of Bituminous Materials to allow air bubbles on the surface to be removed by flashing. Proposed revisions are presented on pages 61-62 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. No further action is needed.

**Item 23**: Concurrent ballot item to REVISE MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) to add Appendix 2 from MP 70 and change the way that binders are designated. Proposed revisions are presented on pages 63-70 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. Editorial comments addressed. TS to consider Kentucky, Arkansas, and Oklahoma comments. As discussed at the Mid-Winter Webinar, the Chairman indicated that the AASHTO editorial staff had been consulted and the correct location is in the appendix. AR wanted to know if it would be appropriate to list miles/hour instead of km/hour since we use miles/hour in the US. Since the standard was written in metric units – it was determined that it should remain km/hour. The Chairman explained the development of the nomenclature for MP 19. LA agreed that it does go with the high temperature. Mike Anderson said it also reduced the confusion on loading trucks and so forth. The comment by PA was discussed and it was agreed that the samples which actually tested out on the line were not covered by the specification. LA would declare on the line as passing. Mike Anderson indicated that when curve was developed it was sort of arbitrary. Pamela Marks with Ontario – On or above the line as acceptable. – AI also gave this interpretation. Ontario indicated that they don’t do anything unless the test result falls 10% below the line. The Chairman made the change editorially to include points on the line as passing. No further action is needed.

**Item 24**: Concurrent ballot item to REVISE TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to delete Appendix 2. Proposed revisions are presented on pages 71-72 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to discuss. No further action is needed.

**Item 25**: Concurrent ballot item to ADOPT MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) as a Full Standard including all changes adopted as a result of the 2013 SOM Ballot. The motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. MP 19 adopted as a full standard including changes balloted in Items 17 and 23. **New designation is M 332.** No further action is needed.

**Item 26**: Concurrent ballot item to ADOPT TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) as a Full Standard including all changes adopted as a result of the 2013 SOM Ballot. The motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. TP 70 adopted as a full standard including changes balloted in Items 18 and 24. **New designation is T 350.** No further action is needed.
B. Previous Year TS letter ballots

**SOM TS 2B 14-01**

**Item 1:** Adopt as a provisional test method, Standard Method of Test for Determination of Asphalt Binder Resistance to Ductile Failure Using the Double Edge Notch Tension Test. See Attachment #2 for the proposed test method as well as discussions from the Binder ETG regarding the test method. For more information on the test method, visit the following website:


23-Affirmative, 4-Negative, 4-No Vote. See Attachment #1 for comments and negatives.

The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

<table>
<thead>
<tr>
<th>State/Department</th>
<th>Comments and/or Recommendations</th>
<th>Vote</th>
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</thead>
<tbody>
<tr>
<td>New Hampshire Department of Transportation (Alan D. Rawson)</td>
<td>This test may have merit from a research standpoint but do not see it being useful for DOT acceptance testing.</td>
<td>Affirmative</td>
</tr>
<tr>
<td>Kentucky Transportation Cabinet (Allen Myers) (<a href="mailto:allen.myers@ky.gov">allen.myers@ky.gov</a>)</td>
<td>Not all states, including us, perform the force ductility test and have the laboratory equipment to conduct this method. The comments from the Binder ETG indicate significant skepticism about this procedure. This test appears to be a good research tool at present, but why create another provisional standard for a method that may never be used on a widespread basis?</td>
<td>Negative</td>
</tr>
</tbody>
</table>
| Arizona Department of Transportation (Bill Hurguy) (bhurguy@azdot.gov) | 1) The proposed standard does not have enough technical/documented support at this point to be considered as an AASHTO provisional test method. The stress concentrations at the crack tips are questionable, especially when the samples are stretched at long distances.  
2) Section 1.3 should be deleted. Such verbiage is not normally used in AASHTO Provisional Standards. (Item #2 and Item #3 on this ballot do not include this language.) | Negative |
| Louisiana Department of Transportation and Development (Christopher David Abadie) (chris.abadie@la.gov) | It was suggested at the Binder ETG that AASHTO consider placing additional wording in the description of this provisional test method. Revise 1.3 which reads:  
1.3 This AASHTO method has been published as a provisional test method. The test is a working document; continuous refinement to the test method may be expected.  

Note: I recommend this revised wording be included on all new provisional standards until one state adopts it into their spec. When one state adopts the standard, the original 1.3 wording should be used. | Affirmative |
| Texas Department of Transportation (Darren Hazlett) (darren.hazlett@txdot.gov) | We don’t have any objection to this as a provisional standard, but this is not something we’re going to want to use. We’re going away from ER, partially because it’s too material intensive and creates a bottleneck in the testing process. This is not only going to require the ductilometers (how many people can test the number of dictilies or... | Affirmative |
ERs that we can) but force ductilometers, and multiple bath temperatures, at least one of which we don't currently use. This also requires ER sized specimens of material out of the PAV. With all the argument of whether we are looking at the right property, at the end of the day, this test is extremely impractical for production testing. We don't want to prevent others from using, so we're voting affirmative.

<table>
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<tr>
<th>Location</th>
<th>Vote</th>
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<tbody>
<tr>
<td>Federal Highway Administration (John R Bukowski)</td>
<td>Negative</td>
</tr>
<tr>
<td>Alabama Department of Transportation (Lyndi D Blackburn) (<a href="mailto:blackburnl@dot.state.al.us">blackburnl@dot.state.al.us</a>)</td>
<td>Negative</td>
</tr>
<tr>
<td>Virginia Department of Transportation (William R Bailey) (<a href="mailto:bill.bailey@vdot.virginia.gov">bill.bailey@vdot.virginia.gov</a>)</td>
<td>Affirmative</td>
</tr>
</tbody>
</table>

After reviewing the included documents, I do not believe that this test will be included in the daily testing for approval of PG samples. Yes it is a more in depth intermediate temperature test, but as noted by Sandy Brown: "When you ask for the DENT or MSCR, you get results that generally pass both." At one point in the minutes it was asked if this test was needed, and no solid answer was provided. Although it is agreed that an intermediate temp test is beneficial for measuring the quality of binders, the DENT is most likely not it. D'Angelo stated at one point that he does not believe that the DENT is a useable test. The test also requires additional equipment and molds, and there was also mention of issues with sample preparation in getting the notches correct.

In general I think people are trying to get away from using ductilometers. That, plus the issues with sample preparation and the lack of any substantial evidence that this test gives us critical information on binder performance leads me to be rather hesitant to jump on board with this test method.

Virginia would agree adopting this standard as a provisional test method is prudent, giving the opportunity to gain more varied experience.

Section 6.4 notes that material may be reheated and remolded into another specimen for testing at a lower temperature if the initial specimen does not fail. This does not allow for any loss of material that occurs during pouring from a reheating vessel (due to material adhering to the vessel). Can this be clarified or otherwise addressed to provide consistency in specimens?

Becca Lane from Ontario gave a presentation on Ontario’s use of this test method along with other revised test methods. TS to decide on moving this test method forward to SOM Ballot either as is or with revisions.

A motion was made by West Virginia to find the 3 negatives (Kentucky, Arizona, Alabama) non-persuasive and to move the standard on to SOM Ballot. Rationale: This is typically a northern states issue, and while there may not be very many states using it, it may be useful for some. Alaska seconded the motion. There were two members opposed to the motion (Kentucky and FHWA). Motion passes. This test will move on to Concurrent ballot as a provisional standard with modifications to the originally balloted standard with new figures and clearer explanation of the sample preparation. See Appendix D-1 for the standard being balloted.

FHWA withdrew negative. There was discussion regarding this test not being a fundamental test. Ontario noted that they are currently using the standard and plan to continue to use the standard. Ontario offered to provide more information to any interested parties.
Blackburn mentioned that a statement at the beginning of provisional standards in order to indicate that they are in fact provisional and not full standards is in the works.

**Item 2:** Adopt as a provisional test method the new standard, Standard Method of Test for Determining the Fracture Properties of Asphalt Binders Using the Single Edge Notched Bending Test. See Attachment #3 for the proposed test method and a Tech Brief regarding the test method. 24-Affirmative, 3-Negative, 4-No Vote. See Attachment #1 for comments and negatives. The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

| West Virginia Department of Transportation (Aaron C. Gillispie) (aaron.c.gillispie@wv.gov) | BBR- Single Edge Notch Tension Test. Comment by John Crane and Jimmy Pritt, Laboratory Engineers, noted the "Single Edge Notch" has no dimension spec. "i.e. how deep? How wide? How accurately can the notch be repeated? This notch will be analogous to etching glass tubing in a chemistry lab before breaking to make glassware. The precision of this notch, we believe, will significantly affect the variability of the test results. | Negative |
| New Hampshire Department of Transportation (Alan D. Rawson) (arawson@dot.state.nh.us) | This test could yield valuable information for DOT's in colder climates concerned about low temperature cracking. Utilization of current BBR's would be possible if BBR manufacturers were contacted for providing modification kits to perform the testing. (This has already been done in the case of crack sealer testing.) | Affirmative |
| Arizona Department of Transportation (Bill Hurguy) (bhurguy@azdot.gov) | 1) While this test method appears to have merit, the proposed standard itself does not appear to have enough technical/document support at this point to be considered as an AASHTO provisional test method. | Negative |
| Texas Department of Transportation (Darren Hazlett) (darren.hazlett@txdot.gov) | We don't have an objection to this as a provisional standard. However the process for making the notched specimen is not very clear, and our biggest question would be about how difficult it may be to consistently make these specimens, (in three replicates) especially in a high volume testing environment. We'd suggest it might be better to use an insert that sits on the base plate to make the notch on the untrimmed side of the specimen. | Affirmative |
| Federal Highway Administration (John R Bukowski) (john.bukowski@dot.gov) |  | Negative |
| Alabama Department of Transportation (Lyndi D Blackburn) (blackburnl@dot.state.al.us) | This test is very similar to the BBR but determines fracture properties of binders at low temperatures. The literature states that a better approach for thermal cracking characterization of asphalt materials is to use fracture mechanics principles rather than use the results provided by the regular BBR test. New testing equipment and molds will be required, although once the molds are acquired they can be used for the BBR and | Affirmative |
This test seems like it could be promising, but will these fracture properties of binders be much more relevant than normal BBR testing in approving daily samples? Will the difference warrant the extra test per sample as well as the extra equipment and molds? Iâ€™m not opposed to making this test a provisional standard, but I would like to see additional data and discussion before we ever move forward with it.

TS to decide on moving this test method forward to SOM Ballot either as is or with revisions.

NEW TASK FORCE: A task force was formed in order to further review the dimensions specified, as noted by the negative voters. West Virginia will chair the task force. Other members include Arizona, Ontario, and Vermont. Hussein Bahia and Eric Weaver submitted the standard to the TS. The chair asked that the Task Force members consult Dr. Bahia and Mr. Weaver for additional guidance.

**Item 3:** Adopt as a provisional test method a new standard, Standard Method of Test for Measuring Asphalt Binder Yield Energy and Elastic Recovery Using the Dynamic Shear Rheometer. See attachments for proposed test method, memo of explanation, and letter of support. 26-Affirmative, 1-Negative, 4-No Vote. See Attachment #1 for comments and negatives. The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

<table>
<thead>
<tr>
<th>West Virginia Department of Transportation (Aaron C. Gillispie) (<a href="mailto:aaron.c.gillispie@wv.gov">aaron.c.gillispie@wv.gov</a>)</th>
<th>DSR “Yield Energy and Elastic Recovery Test. Laboratory personnel found a concern with the wording. In section 5.2 (Significance And Use) at the end of section 5.2 there is a statement, if not erroneous, believed to be at least contradictory. The statement is” ”Note: It is to be noted that the relationship between ductility and elastic recovery to pavement performance is not known and there is no clear evidence that having higher Ductility or higher Elastic Recovery improve pavement performance. The significance of this test is to replace the use of Ductilometer used for Ductility, forced ductility and Elastic Recovery with simpler and more repeatable tests in the DSR.” The reason we pay 50% more for PG Modified Binders is because they have higher Elastic Recovery and improve pavement performance substantially. We have had clear evidence of this phenomenon for years.</th>
<th>Affirmative</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Hampshire Department of Transportation (Alan D. Rawson) (<a href="mailto:arawson@dot.state.nh.us">arawson@dot.state.nh.us</a>)</td>
<td>The test would be much easier. It is a good substitute for ductility and elastic recovery tests and utilizes equipment DOT’s already have. Loading temperature is not specified in the standard. The usual test temperatures noted in the standard are 4C or 25C. Given the constant shear loading rate to achieve strains of 2500 to 4140 %, should the samples be loaded and trimmed at a higher temperature to ensure a good adhesive bond between the sample and the plates? Many DOT’s are no longer degassing PAV material for their acceptance testing as allowed in R28. Would micro-</td>
<td>Affirmative</td>
</tr>
</tbody>
</table>
porosity affect the accuracy and results of this test because of the constant shear rate loading? If so, maybe degassing would be required.

Kentucky Transportation Cabinet (Allen Myers) (allen.myers@ky.gov)

This method appears to be an alternate to the MSCR analysis as a replacement for "PG+" tests. Most states, including us, appear to be pursuing the MSCR option, so the usage of this procedure is in question. This test appears to be a good research tool at present, but why create another provisional standard for a method that may never be used on a widespread basis?

Alabama Department of Transportation (Lyndi D Blackburn) (blackburnl@dot.state.al.us)

These tests replace the ductilometer, and seem to be suitable methods for qualifying modified asphalts in terms of their true resistance to yielding at intermediate temperatures. With the MSCR becoming more relevant, and the fact that we don’t currently run ductilometer ductility or force ductility on PG samples, is this test method still valuable? The ER-DSR results look very similar to MSCR results on modified binders, and had a high correlation to elastic recovery test results in ductilometer. One thing that seemed odd to me in the report was that ER-DSR was compared to Elastic recovery (%) for correlation, but MSCR recovery was compared to Ductility (0.1cm) instead of elastic recovery (%) for correlation. I could be missing something, but this seemed off.

Virginia Department of Transportation (William R Bailey)

Virginia, is not sure how this test would improve upon or otherwise supplement the DSR testing if we adopt the MSCR test specifications.

Virginia made a motion to find the negative non-persuasive under the rationale because the negative voter did not base their rationale on the technical merits of the test. Montana made a second to the motion. The motion received three negative votes (Louisiana, FHWA, Kentucky). Discussion: Louisiana would like to see this item move to a task force for further exploration. This was found acceptable by the members.

NEW TASK FORCE: A task force was formed with Montana as the Chair, and Colorado, Wisconsin, Idaho, Utah participating.

SOM TS 2B 14-02

**Item 1:** Revise R 29 as shown in Attachment #6 to eliminate the need for flash point and rotational viscosity testing as part of determining the grade of a PG Binder. 25-Affirmative, 2-Negative, 5-No Vote. See Attachment #5 for comments. Editorial comments were addressed in the version in Attachment #6 of the agenda. Following is the negative:

Virginia Department of Transportation (William R. Bailey) (bill.bailey@vdot.virginia.gov)

Not having been a part of the mid-year webinar, I'm not sure of the rationale for eliminating these. I don't really see a problem with eliminating the flash point from determination of performance grade, but the rotational viscosity does provide information to the technician performing the test as to what test temperature is likely to be a good starting point for an unknown binder.
TS to address the Virginia and Vermont negatives and consider sending this item to Concurrent Ballot.

**Vermont and Virginia withdraw the negative votes.**
A motion was made by Virginia to move this change to SOM ballot. Pennsylvania made a second. Motion passed unopposed. See Appendix D-2 for standard being balloted.

**Item 2:** Revise T 49 as shown in Attachment #7 of the agenda to update precision and bias and to reference the current ASTM (D 5). Also attached is the NCHRP study as backup for the P&B... 27-Affirmative, 0-Negative, 5-No Vote. See Attachment #5 of the agenda for comments. All comments except Texas and Ontario were editorial.

Ontario’s comment was sent to Haleh Ansari for consideration and was addressed. Texas’ comment, “The precision estimate for pen after RTFO is really a representation of the RTFO’s precision. Shouldn’t it belong in that test procedure instead of in the pen procedure?” The p&b belongs with the test method that generates the result not with the conditioning test method. Although the variation in penetration after RTFO is affected by the RTFO, the penetration test is done in accordance with T 49 (pen) not T 240 (RTFO). TS to consider sending this item to Concurrent Ballot with editorial changes made.

A motion made by FHWA and a second by Louisiana to send this change to SOM ballot. The motion passed unopposed. See Appendix D-3 for standard being balloted.

**Item 3:** Revise T 201 as shown in Attachment #8 to update the precision and bias and to update to the current ASTM (D2170). Also, see NCHRP report in Ballot Item #2. 27-Affirmative, 0-Negative, 5-No Vote. See Attachment #5 of the agenda for comments. All comments were editorial. TS to consider sending this item to Concurrent Ballot with editorial changes made.

**Item 4:** Revise T 202 as shown in Attachment #9 to update the precision and bias and to update to the current ASTM (D2117). Also see NCHRP attached to ballot item 2.. 27-Affirmative, 0-Negative, 5-No Vote. See Attachment #5 for comments. All comments were editorial. TS to consider sending this item to Concurrent Ballot with editorial changes made.

A motion was made by Pennsylvania and a second by Virginia to send Items 3 and 4 to SOM ballot. The motion passed unopposed. See Appendixes D-4 and D-5 for the standards being balloted.

**C. Task Force Reports**

- **T 350 (Former TP 70) MSCR Temperature task force** consisting of Matt Corrigan- FHWA (lead), John D’Angelo, Darren Hazlett (TX), Lyndi Blackburn (Alabama), Mike Anderson (Asphalt Institute), Chris Abadie (LA), and Eileen Sheehy was put together to develop further guidance on temperature selection for T 350. Task force is setting up a conference call in the next week or so and will make recommendations prior to the July meeting.

  Task force report made by Corrigan (FHWA). Task force believes that no further changes to the standard are needed at this time based on temperature selection. The task force was sunset.

- **GTR specification task force** consisting of Lyndi Blackburn (AL), Tanya Nash (FL), Matt Corrigan (FHWA), and Felicia Reid (Paragon) will participate on this task force. Lyndi will
chair, Matt will act as the liaison to the binder ETG. Goal of the task force is to develop standalone specification(s) for GTR in PG Binder.

Blackburn (Alabama) reported on Task Force. There is not enough information available at this time to develop a standalone standard. The Task Force Chair asked for additional support on the task force. D’Angelo, Way, Youtcheff, Louisiana, and Pennsylvania joined the task force.

V. New Business
A. Research Proposals – Chris Abadie to report.
Abadie (Louisiana) presented two new research needs statements for consideration by the technical section:
- Sustainable Modification of Performance-Graded Asphalts to Enhance Low-Temperature Properties.
  - A synthesis and research project to look at several different tests for correlation to Low-Temperature Performance.
  - The TS recommended that the DENT test be added to Task 2 of the statement.
  - Additional modifications recommended where one of the outcomes would be to recommend the most promising methods.
  - Alaska made a motion and FHWA a second support this research needs statement. The motion passed unopposed.
- Coefficient of Thermal Expansion/Contraction (CTE) for Asphalt Binders and Asphalt Mixtures and Its Effect on Thermal Cracking.
  - A motion was made by Texas and a second by Utah to support this research needs statement. The motion passed unopposed.

Ahern (Vermont) also presented a new research needs statement for consideration by the technical section:
  - Since there was very little time for members to review the statement, Mr. Ahearn stated that this is for future consideration by the technical section

B. AMRL/CCRL Issues – Maria Knake to report on progress with rewrite of T 48. Discussion put off until Mid-Year Webinar due to shortness of time.
C. NCHRP Issues - None
D. Correspondence, calls, meetings/ Presentation by Industry
  - Terry Arnold, FHWA – Turner Fairbanks, reported that they are investigating used motor oil in asphalt binder. He requested to present at TS 2b’s Mid-Winter Webinar.
  - PAV Temperature – Binder ETG considering modifications to the requirements for temperature for PAV conditioning. See Attachment #10 of the agenda. Matt Corrigan to give a brief presentation. Presentation put off until Mid-Year Webinar due to shortness of time.
  - Binder ETG Update – John Bukowski requested to give an update on ETG activities. There was no time for an update.
F. Proposed New Task Forces – Review any task forces established during the meeting. Task Force established to review Single Edge Notched Bending Test and Binder Yield Energy and Elastic Recovery Test to determine if any changes to the standards are necessary and to make a recommendation to TS 2b on whether to move these standards forward as provisional standards.
G. Standards Requiring Reconfirmation – M 320, T 48, T 201, T 202, T 313, and T 315 are scheduled for reconfirmation in 2014 unless they are balloted for change. T 201 and T 202 are being balloted for change. The remaining standards will be balloted for reconfirmation. See Appendix C for list of TS 2b standards.

H. SOM Ballot Items (including any ASTM changes) – Review SOM ballot items established during the meeting.

VI. Open Discussion
   NCHRP Problem Statement- Fatigue Statement was approved.

VII. Adjourn
   Motion to adjourn: Texas, Second: Illinois
SUBCOMMITTEE ON MATERIALS  
100th Annual Meeting – Minneapolis, Minnesota  
Thursday, July 31, 2014  
10:00 a.m. – 12:00 noon CST  

TECHNICAL SECTION 2b  
ASPHALT  

I. Call to Order and Opening Remarks  
Call to order scheduled for 10:00 a.m.  

II. Roll Call  
Attendees please sign in.  

III. Approval of Technical Section Minutes  
The Minutes for the TS 2b Meeting on August 8, 2013 in Stateline, NV were approved during the Mid-Winter Webinar on March 5, 2014. Request approval of the Minutes for the March 5, 2014 Mid-Winter Webinar for TS 2b.  

IV. Old Business  
A. Previous Year SOM Ballot Items  

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Item 16: Concurrent ballot item to REVISE T 315, Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to accommodate the use of ground tire rubber as a modifier. Proposed revisions are presented on pages 33-36 of the 2013 Minutes and the motion and discussion can be found on pages 2-5 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote.  

As discussed at the Mid-Winter Webinar, Items 14 – 16 were not adopted due to the negatives. A task force was formed to develop a standalone specification for GTR in PG Binder. We will discuss further under Task Force Reports.
Appendix A - Agenda

**Item 17:** Concurrent ballot item to REVISE MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) to change the requirement for J nr3.2 for standard grade asphalt. Proposed revisions are presented on pages 37-41 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. Mississippi withdrew their negative during the meeting based on the explanation provided by the Chairman during the meeting. This standard was published as balloted. No further action is needed.

**Item 18:** Concurrent ballot item to REVISE TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to clarify wording and ensure essential data is recorded. Proposed revisions are presented on pages 42-44 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 45-Affirmative, 1-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. These standards will be published. Bob Kluttz (Kraton) asked if any changes in TP 70 would be reflected to ASTM D 7405, and how that would be handled. Maria Knake indicated that she will coordinate that effort. No further action is needed.

**Item 19:** Concurrent ballot item to REVISE TP 92, Determining the Cracking Temperatures of Asphalt Binder Using the Asphalt Binder Cracking Device (ABCD) to clarify the sample preparation/pouring. Proposed revisions are presented on pages 45-53 of the 2013 Minutes and the motion and discussion can be found on page 6 of the 2013 Minutes. 45-Affirmative, 1-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the Chairman explained after conversations with Nebraska that their negative was withdrawn before the meeting. These standards will be published. No further action is needed.

**Item 20:** Concurrent ballot item to REVISE R 29, Grading or Verifying the Performance Grade of an Asphalt Binder to allow the flash point to be done by another lab. Proposed revisions are presented on pages 54-58 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 44-Affirmative, 2-Negative, 7-No Vote. Editorial comments addressed.

As discussed at the Mid-Winter Webinar, the negatives by AK and ID were found to be persuasive. The Chairman suggested that R 29 be modified to remove flash point. The Chairman also suggested that a standard to address the grading if you are using MP 19. The Chairman volunteered to draft this standard and for discussion at Summer Meeting.

A ballot item to revise R 29 was on the TS 2b 2014_02 ballot and will be discussed under that item on the agenda. The Chairman has not yet drafted a new standalone version to address MSCR testing.

**Item 21:** Concurrent ballot item to REVISE T 44, Solubility of Bituminous Materials to allow the use of multiple flasks to complete the test. Proposed revisions are presented on pages 59-60 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. Editorial comments addressed. Comment by SC noted. No further action necessary.
Appendix A - Agenda

**Item 22:** Concurrent ballot item to REVISE T 49, Penetration of Bituminous Materials to allow air bubbles on the surface to be removed by flashing. Proposed revisions are presented on pages 61-62 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. No further action is needed.

**Item 23:** Concurrent ballot item to REVISE MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) to add Appendix 2 from MP 70 and change the way that binders are designated. Proposed revisions are presented on pages 63-70 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. Editorial comments addressed. TS to consider Kentucky, Arkansas, and Oklahoma comments.

As discussed at the Mid-Winter Webinar, the Chairman indicated that the AASHTO editorial staff had been consulted and the correct location is in the appendix. AR wanted to know if it would be appropriate to list miles/hour instead of km/hour since we use miles/hour in the US. Since the standard was written in metric units – it was determined that it should remain km/hour.

The Chairman explained the development of the nomenclature for MP 19. LA agreed that it does go with the high temperature. Mike Anderson said it also reduced the confusion on loading trucks and so forth. The comment by PA was discussed and it was agreed that the samples which actually tested out on the line were not covered by the specification. LA would declare on the line as passing. Mike Anderson indicated that when curve was developed it was sort of arbitrary. Pamela Marks with Ontario – On or above the line as acceptable. – AI also gave this interpretation. Ontario indicated that they don’t do anything unless the test result falls 10% below the line. The Chairman made the change editorially to include points on the line as passing. No further action is needed.

**Item 24:** Concurrent ballot item to REVISE TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) to delete Appendix 2. Proposed revisions are presented on pages 71-72 of the 2013 Minutes and the motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to discuss. No further action is needed.

**Item 25:** Concurrent ballot item to ADOPT MP 19, Performance Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) as a Full Standard including all changes adopted as a result of the 2013 SOM Ballot. The motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. MP 19 adopted as a full standard including changes balloted in Items 17 and 23. **New designation is M 332.** No further action is needed.

**Item 26:** Concurrent ballot item to ADOPT TP 70, Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR) as a Full Standard including all changes adopted as a result of the 2013 SOM Ballot. The motion and discussion can be found on page 7 of the 2013 Minutes. 46-Affirmative, 0-Negative, 7-No Vote. No comments or negatives to address. TP 70 adopted as a full standard including changes balloted in Items 18 and 24. **New designation is T 350.** No further action is needed.

B. Previous Year TS letter ballots

**SOM TS 2B 14-01**
Appendix A - Agenda

**Item 1:** Adopt as a provisional test method, Standard Method of Test for Determination of Asphalt Binder Resistance to Ductile Failure Using the Double Edge Notch Tension Test. See Attachment #2 for the proposed test method as well as discussions from the Binder ETG regarding the test method. For more information on the test method, visit the following website:
23-Affirmative, 4-Negative, 4-No Vote. See Attachment #1 for comments and negatives. The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

Becca Lane from Ontario has a presentation on Ontario’s use of this test method along with other revised test methods. TS to decide on moving this test method forward to SOM Ballot either as is or with revisions.

**Item 2:** Adopt as a provisional test method the new standard, Standard Method of Test for Determining the Fracture Properties of Asphalt Binders Using the Single Edge Notched Bending Test. See Attachment #3 for the proposed test method and a Tech Brief regarding the test method. 24-Affirmative, 3-Negative, 4-No Vote. See Attachment #1 for comments and negatives. The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

TS to decide on moving this test method forward to SOM Ballot either as is or with revisions.

**Item 3:** Adopt as a provisional test method a new standard, Standard Method of Test for Measuring Asphalt Binder Yield Energy and Elastic Recovery Using the Dynamic Shear Rheometer. See attachments for proposed test method, memo of explanation, and letter of support. 26-Affirmative, 1-Negative, 4-No Vote. See Attachment #1 for comments and negatives. The TS to consider the following negatives and non-editorial comments. Editorial comments will be addressed if proposed standard moves forward to SOM Ballot.

TS to decide on moving this test method forward to SOM Ballot either as is or with revisions.

**SOM TS 2B 14-02**

**Item 1:** Revise R 29 as shown in Attachment #6 to eliminate the need for flash point and rotational viscosity testing as part of determining the grade of a PG Binder. 19-Affirmative, 1-Negative, 12-No Vote. See Attachment #5 for comments. Editorial comments were addressed in the version in Attachment #6 of the agenda. Following is the negative:

Due to short schedule for ballot, there were not enough votes to pass the TS ballot. TS to address the Virginia negative and consider sending this item to Concurrent Ballot.

**Item 2:** Revise T 49 as shown in Attachment #7 to update precision and bias and to reference the current ASTM (D 5). Also attached is the NCHRP study as backup for the P&B. 20-Affirmative, 0-Negative, 12-No Vote. See Attachment #5 for comments. All comments except Texas and Ontario were editorial.

Ontario’s comment was sent to Haleh Ansari for consideration. Texas’ comment, “The precision estimate for pen after RTFO is really a representation of the RTFO’s precision. Shouldn’t it belong in that test procedure instead of in the pen procedure?” The p&b belongs with the test method that generates the result not with the conditioning test method. Although the variation in penetration after RTFO is affected by the RTFO, the penetration test is done in accordance with T 49 (pen) not T 240 (RTFO). Due to short schedule for ballot, there were not enough votes to pass the TS ballot. TS to consider sending this item to Concurrent Ballot with editorial changes made.
Appendix A - Agenda

Item 3: Revise T 201 as shown in Attachment #8 to update the precision and bias and to update to the current ASTM (D2170). Also see NCHRP report in Ballot item #2. 20-Affirmative, 0-Negative, 12-No Vote. See Attachment #5 for comments. All comments were editorial. Due to short schedule for ballot, there were not enough votes to pass the TS ballot. TS to consider sending this item to Concurrent Ballot with editorial changes made.

Item 4: Revise T 202 as shown in Attachment #9 to update the precision and bias and to update to the current ASTM (D2117). Also see NCHRP attached to ballot item 2.. 20-Affirmative, 0-Negative, 12-No Vote. See Attachment #5 for comments. All comments were editorial. Due to short schedule for ballot, there were not enough votes to pass the TS ballot. TS to consider sending this item to Concurrent Ballot with editorial changes made.

C. Task Force Reports
   • T 350 (Former TP 70) MSCR Temperature task force consisting of Matt Corrigan- FHWA (lead), John D’Angelo, Darren Hazlett (TX), Lyndi Blackburn (Alabama), Mike Anderson (Asphalt Institute), Chris Abadie (LA), and Eileen Sheehy was put together to develop further guidance on temperature selection for T 350. Task force is setting up a conference call in the next week or so and will make recommendations prior to the July meeting.
   • GTR specification task force consisting of Lyndi Blackburn (AL), Tanya Nash (FL), Matt Corrigan (FHWA), and Felicia Reid (Paragon) will participate on this task force. Lyndi will chair, Matt will act as the liaison to the binder ETG. Goal of the task force is to develop standalone specification(s) for GTR in PG Binder.

V. New Business
   A. Research Proposals – Chris Abadie to report.
   B. AMRL/CCRL Issues – Maria Knake to report on progress with rewrite of T 48.
   C. NCHRP Issues - None
   D. Correspondence, calls, meetings/ Presentation by Industry
      • Terry Arnold, FHWA – Turner Fairbanks, reported that they are investigating used motor oil in asphalt binder. He requested to present at TS 2b’s Mid-Winter Webinar.
      • PAV Temperature – Binder ETG considering modifications to the requirements for temperature for PAV conditioning. See Attachment #10. Matt Corrigan to give a brief presentation.
      • Binder ETG Update – John Bukowski requested to give an update on ETG activities.
   F. Proposed New Task Forces – Review any task forces established during the meeting.
   G. Standards Requiring Reconfirmation – M 320, T 48, T 201, T 202, T 313, and T 315 are scheduled for reconfirmation in 2014 unless they are ballot for change. See Attachment #11 for list of TS 2b standards.
   H. SOM Ballot Items (including any ASTM changes) – Review SOM ballot items established during the meeting.

VI. Open Discussion

VII. Adjourn
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## 2014 SOM ANNUAL MEETING
### TS 2b
### Asphalts
#### Thursday, July 31, 2014 (10:00am-12:00pm)

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<th>Phone Number</th>
<th>Member of TS?</th>
<th>Would you like to join this TS?</th>
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**Subcommittee on Materials 2014**  
Renaissance Depot Hotel  
Minneapolis, Minnesota
<table>
<thead>
<tr>
<th>Name</th>
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### Appendix C-Standards

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<tr>
<td>1</td>
<td>SOM ballot item to ADOPT a new provisional test method for DETERMINATION OF ASPHALT BINDER RESISTANCE TO DUCTILE FAILURE USING DOUBLE EDGE NOTCHED TENSION (DENT) TEST as presented on pages 25-34 of the 2014 Minutes. The motion and discussion can be found on pages 4-6 of the 2014 Minutes.</td>
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<td>SOM ballot item to REVISE R 29, Grading or Verifying the Performance Grade of an Asphalt Binder. Proposed revisions are presented on pages 35-40 of the 2014 Minutes and the motion and discussion can be found on pages 8-9 of the 2014 Minutes.</td>
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<td>SOM ballot item to REVISE T 49, Penetration of Bituminous Materials to update the precision and bias statement. Proposed revisions are presented on pages 41-43 of the 2014 Minutes and the motion and discussion can be found on pages 9 of the 2014 Minutes.</td>
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<tr>
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<td>SOM ballot item to REVISE T 202, Viscosity of Asphalts by Vacuum Capillary Viscometer to update the precision and bias statement. Proposed revisions are presented on pages 47-49 of the 2014 Minutes and the motion and discussion can be found on pages 9 of the 2014 Minutes.</td>
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</table>
Standard Method of Test for

DETERMINATION OF ASPHALT BINDER RESISTANCE TO DUCTILE FAILURE USING DOUBLE-EDGE-NOTCHED TENSION (DENT) TEST

AASHTO Designation: TP XXX-15

Rationale:

This test method is currently used by Ontario MTO for all modified binders. They have found good correlation with field performance. The FHWA also found good correlation between this test method and the ALF performance.

The specification property CTOD provides a measure of strain tolerance for a thin fiber of asphalt cement, in the ductile state, and under severe constraint as in between two large aggregate particles.

See Appendix E for a presentation from Ontario MTO.

See the following web address for more information on this test method:
Standard Method of Test for

DETERMINATION OF ASPHALT BINDER RESISTANCE TO DUCTILE FAILURE USING DOUBLE-EDGE-NOTCHED TENSION (DENT) TEST

AASHTO Designation: TP XXX-15

1. SCOPE

1.1. This test method covers the determination of an asphalt binder’s resistance to ductile failure using a double-edge-notched tension test.

1.2. The test is conducted after thermal conditioning to determine the essential work of failure, the plastic work of failure, and an approximate critical crack tip opening displacement at a specified temperature and rate of loading.

1.3. The values stated in SI units are to be regarded as the standard.

1.4. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standards:
   - R28 Accelerated Aging of Asphalt binder Using a Pressurized Aging Vessel (PAV)
   - T 240 Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-film Oven Test)
   - T 300 Force-Ductility Test of Bituminous Materials
   - T 301 Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer
   - T 315 Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

2.2. ASTM Standards:
   - D8 Standard Definitions of Terms Relating to Materials for Roads and Pavements
   - D113 Standard Test Method for Ductility of Bituminous Materials

2.3. Other Standards:
   - LS 299 Ministry of Transportation Ontario - Method of Test for the Determination of Asphalt Binder’s Resistance to Ductile Failure using Double-Edge-Notched Tension Test (DENT)
3. TERMINOLOGY

3.1. \( W_t \) = total work of failure, area under the load versus load-line displacement curve, J (cal)

3.2. \( w_t \) = specific total work of failure \( (W_t / B \ell) \), kJ/m\(^2\) (kcal/in.\(^2\))

3.3. \( w_e \) = specific essential work of failure, the energy required to fracture or break the sample without plastic deformation away from the fracture zone, kJ/m\(^2\) (kcal/in.\(^2\))

3.4. \( w_p \) = specific plastic work of failure, the non-essential work dissipated during the deformation of a volume of asphalt around the failure zone, MJ/m\(^3\) (Mcal/in.\(^3\))

3.5. \( \beta \) = geometric constant describing the shape of the plastic zone

3.6. \( \delta_t \) = critical crack tip opening displacement also referred to as CTOD, mm (in.)

3.7. \( P \) = load, N (lbf)

3.8. \( d \) = displacement in test, m (in.)

3.9. \( B \) = sample thickness, m (in.)

3.10. \( \ell \) = ligament length, the space between the notches, m (in.)

3.11. \( \sigma_n \) = net section stress of sample, N/m\(^2\) (psi)

4. APPARATUS

4.1. TESTING APPARATUS: A constant rate of displacement device capable of maintaining displacement at rates of 100 ± 2.5 mm/min (3.937 ± 0.098 in.). The maximum stroke for the instrument(s) shall be 1000 mm (39.370 in.) or greater. The apparatus should have a set of loading pins that ensure precise alignment of the sample during the test. The apparatus shall be able to determine displacement to an accuracy of ± 0.05 mm (± 0.0019685 in.).

Note 1: DENT testing apparatus is commonly a force-ductility apparatus installed in a ductilometer.

4.2. LOAD SENSOR: The sensitivity of the load sensor and recording electronics shall allow the load, P, to be measured every 0.3 sec during the test with an accuracy of at least ± 1%. The load sensor shall be capable of measuring a nominal maximum force of up to 133 N (29.8996 lbf).

4.3. TEMPERATURE CONTROLLED BATH FOR TESTING: Bath shall be large enough to contain the testing apparatus and samples in their molds prior to testing under a minimum of 25 mm (0.9843 in.) of water. The equipment shall be capable of maintaining the water at the testing temperature to an accuracy of at least ± 0.5°C (0.9°F).

4.4. TEMPERATURE CONTROLLED BATH FOR CONDITIONING: Bath capable of maintaining 25 mm (0.9843 in.) minimum of water over the sample at the conditioning temperature requirements to within ± 0.5°C (0.9°F). Typically, the temperature controlled bath for testing is utilized.

4.5. GLASS STIR: Stick capable of stirring the hot asphalt binder vigorously.
4.6. BASE PLATES: The base plates shall be made of non-absorbent material of sufficient thickness to prevent deformation and of a sufficient size to hold from one to three molds, but still able to fit in the temperature controlled bath for conditioning. The plate shall be uniformly flat to ensure that the bottom surfaces of each mold will touch it throughout.

4.7. MOLD: consists of two end pieces for each sample and a silicone mold.

Note 2: User agencies and asphalt binder suppliers may agree on an all metal design for the molds provided it does not deviate from the dimensions and tolerances given.

4.7.1. SILICONE MOLD: consists of a silicon mold with the dimensions shown in Figure 1 with capability of forming three samples.

![Figure 1: Dimensions of Silicon Molds](image)

Note: All dimensions in mm, and general tolerance is 0.2 mm (0.007874 in.).

4.7.1.1. DENT END PIECES: For three samples, six aluminum end pieces with dimensions given in Figure 2.
5. PREPARATION OF SAMPLES

5.1. Preparation of Apparatus—Place the mold on the base plate and insert the DENT end pieces.

5.2. Six samples shall be prepared using PAV aged asphalt binder, 2 for each ligament length of 15, 10, and 5 mm (0.5690, 0.3793 and 0.1897 in.) by fitting each of the three pairs of inserts firmly within their recessed positions in the silicone molds.

5.2.1. Asphalt binder shall be aged according to T 240 (RTFO) and R28 (PAV). The aged asphalt binder shall then be heated for 1 h at 160 ± 5°C (320 ± 9°F) to ensure that the asphalt binder readily flows when dispensed from the container into the prepared molds.

Note 3: The heating temperature may be raised to a maximum of 180°C (356°F) to provide a low enough viscosity but the sample material shall not be overheated.

5.3. Prior to pouring the asphalt binder into the mold, measure and record the actual ligament length, ℓ, to within 0.1 mm (0.003937 in.).

5.4. After thorough stirring, pour the asphalt material into the mold, taking care not to entrain any air bubbles. Pour the material in a thin stream back and forth from end to end until the mold is level full. In filling the mold, take care not to disarrange the end pieces or distort the sample. Let the mold and contents cool to room temperature for 30 to 40 min, and then place the base plate and filled mold in the water bath maintained at the specified test temperature for 30 min.
5.5. Measure and record the sample thickness, B, in meters (inches) to 4(6) decimal places to 0.1 mm (0.003937 in.). If the sample is flush with the mold, B will be equal to the thickness of the mold.

6. **TEST PROCEDURES**

6.1. Condition the samples on the base plates at 25 ± 0.5°C (77 ± 0.9°F) for 3 hours ± 5 minutes in their molds in a temperature controlled bath under a minimum of 25 mm (0.9843 in.) of water.

6.2. Once conditioned, prepare the sample for testing, without causing excessive deformation or stress concentrations to the sample, by removing the sample from the mold. Keep the sample always under the surface of the water, and load it through the holes in the end pieces onto the testing apparatus’ loading pins. The sample shall be loaded so there is a minimum of 25 mm (0.9843 in.) of water below and above the sample. Allow the sample to sit and equilibrate for a minimum of 5 minutes before starting the test.

![Figure 3: DENT samples placed on loading pins.](image)

Note: Water was omitted in this photograph to improve the image quality but specimens are to be kept under water at all times.

6.3. Run the test according to T 300, but at a displacement rate of 100 ± 2.5 mm/min (3.937 ± 0.098 in.) in a bath maintained at 25 ± 0.5°C (77 ± 0°F), until ductile failure is reached or a stroke length of 1000 mm (39.37 in.) is reached.

6.4. If ductile failure is not achieved before a displacement of 1000 mm (39.37 in.) is reached, the test shall be stopped and the material retested as follows at a lower temperature: reheat the sample material in a manner that minimizes damage to the material (see Section 5), prepare the sample as per Section 5, and condition and retest according to steps 6.1, 6.2, and 6.3 at a temperature of 15 ± 0.5°C (59 ± 0.9°F) for 3 hours ± 5 minutes in the molds in a temperature controlled bath under a minimum of 25 mm (0.9843 in.) of water.
6.5. Record actual sample ligament length, $\ell$ (as measured according to 5.3), displacement rate, water bath temperature, and load (every 0.3 sec) for the entire test time.

6.6. Repeat steps 6.1 to 6.5 on the duplicate sample and then on all the other ligament length samples.

7. **CALCULATIONS**

7.1. Calculate the average $W_t$ for each ligament length where $W_t$ for each sample is:

$$W_t = \int_0^{t_f} P \times d\, , \, \text{kJ}$$

$$t_f = \text{time when ductile failure or the maximum stroke length is reached, whichever comes first.}$$

Note 3: Any negative load readings or negative $W(t)$ values are not to be included in calculating $W_t$. Any $W(t)$ obtained after $t_f$ are not to be included in calculating $W_t$. Although it is not always noticeable, additional data is often recorded for the run after failure. For example when the load is very small and then increases slightly or the load is very small and remains constant this data is a residual load on the device. Please check each of the run sheets to ensure that these residual and any initial pre-start values are zeroed so they are not included in the total $W_t$.

7.2. Calculate $w_t$ for each ligament length for each average $W_t$ where:

$$w_t = \frac{(\text{average } W_t)}{(B\ell)}, \, \text{J/m}^2 \text{ (cal/in.}^2)$$

7.3. Plot $w_t$ for the three ligament lengths, $\ell$, and draw a best fit straight line (see Figure 4 for an example). From the graph or using the method of least squares fitting, obtain values for $w_e$, and the term $\beta w_p$, where:

- $w_e$ is the specific essential work of fracture, i.e. $w_t$ for $\ell = 0.0$ mm (in.)
- $\beta w_p$ is the slope of the best fit straight line, for $w_t = w_e + \beta w_p \ell$

7.4. Determine $\delta_t = \frac{w_e}{\sigma_n}$, where:

$$\sigma_n = \frac{P_{\text{peak}}}{(B\ell)},$$

$P_{\text{peak}}$ = average peak load obtained for the sample tested with the smallest ligament length, i.e. the average maximum load for the 5 mm (0.1969 in.) ligament samples.

8. **REPORT**

8.1. Report the following information (See Figure 6 for an example):

8.1.1. Sample identification;

8.1.2. Test temperature, to the nearest 0.1°C;

8.1.3. $w_e$;

8.1.4. $\beta w$;

8.1.5. $\delta_t$;

8.1.6. $P_{\text{peak}}$;

8.1.7. Best fit line for the $w_t$ versus ligament lengths plot and the plot (see Figure 4 for example);
8.1.8. and for each ligament length
8.1.8.1. Average actual sample ligament length;
8.1.8.2. Average actual sample thickness;
8.1.8.3. Average \( W_t \)
8.1.8.4. \( w_t \);
8.1.8.5. and load versus displacement curves (see Figure 5 for example).

Figure 4: Example \( w_t \) versus ligament length plot for determining essential work of failure, \( w_e \).

Figure 5: Typical duplicate load-displacement curves for essential work of failure test.
Figure 6: Example reporting sheet.

DENT Test Reporting Sheet

PG Grade:  
Sample:  
Test Temp. C:  
Date of Test:  
Tested By:  

RESULTS:

<table>
<thead>
<tr>
<th>Ligament Length</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>t, average measured ligament length</td>
<td>m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B, average measured sample thickness</td>
<td>m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wt, total work of fracture, average</td>
<td>J</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ws, specific total work of fracture</td>
<td>kJ/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wes, specific essential work of fracture</td>
<td>kJ/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wps, specific plastic work of fracture</td>
<td>MJ/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pmax, average for 5mm run</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&amp;&lt;sub&gt;5&lt;/sub&gt;, CTOD, average</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHARTS:

Specific Total Work of Fracture

Load Versus Displacement Curves

COMMENTS:
9. PRECISION AND BIAS

9.1. Precision—The research required to develop precision estimates has not been conducted.

9.2. Bias—The research required to establish the bias has not been conducted.

10. KEYWORDS

10.1. Asphalt Binders; Double-Edge Notch Tension; DENT; Ductile Failure, Fatigue, Specification Testing.
Standard Practice for

Grading or Verifying the Performance Grade (PG) of an Asphalt Binder

AASHTO Designation: R 29-1415

Rationale:
Based on discussion in the Mid-year webinar, modifications have been made to R 29 to not require testing of flash point or rotational viscosity as part of determining the grading of a PG binder in R 29. The requirements for flash point and rotational viscosity remain in M 320 and are still a requirement for the acceptance and certification of PG binder, but the testing is removed from this standard on determining the grade of PG binder. M 320 is the purchasing standard and the standard that is used in specifications. R 29 is the standard that guides how testing should be conducted to determine which grade a binder is.
Standard Practice for

Grading or Verifying the Performance Grade (PG) of an Asphalt Binder

AASHTO Designation: R 29-1415

1. SCOPE

1.1. This standard practice describes the testing required to determine the performance grade (PG) of an asphalt binder according to M 320, Table 1. It presents two approaches. In the first, the PG of an unknown asphalt binder is determined. In the second, the nominal PG of an asphalt binder is verified. It also provides an estimate of the time required to complete a single test sequence.

1.2. This standard practice may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standards:
M 320, Performance-Graded Asphalt Binder
R 28, Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
T 48, Flash and Fire Points by Cleveland Open Cup
T 240, Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
T 313, Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
T 314, Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
T 315, Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
T 316, Viscosity Determination of Asphalt Binder Using Rotational Viscometer

3. SUMMARY OF THE PRACTICE

3.1. The tank (as-received) sample of asphalt binder is tested to determine the flash point (T 48), viscosity at 135°C (T 316), and shear modulus (G*) and phase angle (δ) (T 315).

3.2. The asphalt binder is aged in the rolling thin-film oven (RTFO) (T 240), and the residue is tested to determine the mass change (T 240) and the shear modulus (G*) and phase angle (δ) (T 315).

3.3. The residue from the RTFO is aged in the pressurized aging vessel (R 28), and this residue is tested to determine the shear modulus (G*) and phase angle (δ) (T 315), creep stiffness (S) and slope, m, of the log creep stiffness versus log time relationship at 60 s (T 313), and the failure strain in direct tension (T 314), as necessary.
3.4. Based on these test results, the asphalt binder is graded according to M 320, Table 1.

4. SIGNIFICANCE AND USE

4.1. This practice describes the testing required for grading or verifying the PG of an asphalt binder according to M 320, Table 1.

5. ESTIMATED TIME NECESSARY FOR TESTING

5.1. For both grading and verification, if the analysis is started at the beginning of a morning work shift, all testing and analysis should be completed during the afternoon of the next day. This schedule provides the 20 h needed for PAV conditioning. Of course, samples can be aged and analyzed in parallel, and the productivity of the laboratory thus increased. However, for the purpose of this document, analysis of a single asphalt binder will be discussed.

6. TEST PROCEDURE FOR GRADING AN UNKNOWN ASPHALT BINDER

6.1. Prepare samples and test specimens using the procedures specified in the applicable test methods. In the case where the grade of the asphalt binder is unknown, approximately 400 g of unaged asphalt binder is required to complete the tests with the necessary replicates.

6.2. Begin conditioning asphalt binder in the RTFO. Condition a sufficient amount of asphalt binder depending on the type and number of tests to be performed. 

Note 1—Two BBR beams requiring PAV-aged material are needed at each test temperature. In addition, at least six direct tension (DT) specimens requiring PAV-aged material may also be needed at each test temperature. A minimum of two test temperatures will be required. This testing will utilize approximately 200 g of RTFO residue.

6.3. Perform the DSR test (T 315) on the original asphalt binder beginning at 58°C, and increase or decrease the test temperature at 6.0°C increments until a value for \( G^*/\sin \delta \geq 1.00 \text{ kPa} \) is obtained. The highest test temperature where the value for \( G^*/\sin \delta \geq 1.00 \text{ kPa} \) determines the starting PG grade.

Note 2—For example, if \( G^*/\sin \delta \) is 0.60 kPa at 64°C and 1.20 kPa at 58°C, the starting asphalt binder grade is PG 58-xx.

6.4. Determine the flash point on a sample of original binder using T 48. The flash point must be greater than 230°C to meet the requirements of M 320. Alternatively, the flash point can be determined by the user or producer of the asphalt binder.

6.5. Determine the viscosity of the original asphalt binder at 135°C using T 316. The viscosity must not exceed 3 Pa s to meet the requirements of M 320.

6.6. After the RTFO conditioning (T 240) is complete, determine the mass change of the original asphalt binder. The mass change must be \( \leq 1.00 \text{ percent} \) to meet the requirements of M 320.

6.7. If the original asphalt binder does not meet M 320 requirements for the tests in Sections 6.4, 6.5, or 6.6, the asphalt binder will not satisfy the specification for any PG, and no further testing is required.
6.8.6.5. Perform the DSR test (T 315) on the RTFO residue at the test temperature used to determine the starting PG grade (Section 6.3) to confirm the high-temperature grade of the asphalt binder (e.g., PG 46-xx, 52-xx, 58-xx, etc.). The value for $G^*/\sin \delta$ of the RTFO residue must be $\geq 2.20$ kPa.

Choose the lower performance grade in cases where the test values in Sections 6.3 and 6.8.5 give conflicting grades.

6.9.6.6. Age a sufficient quantity of RTFO residue in the PAV (R 28) (Note 1). Use an aging temperature of 90°C for starting grades PG 46-xx or 52-xx and 100°C for starting grades PG 58-xx and higher. A PAV temperature of 110°C is used in simulating desert environments.

Note 3—Complete Sections 6.1 through 6.6.9 during the first day of testing. This schedule will allow further testing to begin on the second day after PAV aging is complete.

6.10.6.7. At the conclusion of the PAV aging procedure (R 28), including aging, combining, and degassing the binder, prepare two BBR specimens for each test temperature according to T 313. Retain sufficient residue to prepare at least six DT specimens for each test temperature, if required.

6.11.6.8. Perform the DSR test (T 315) on the PAV residue beginning at a test temperature of 16 and 19°C, respectively, for starting grades PG 52-xx and 58-xx, 22°C for starting grade PG 64-xx, and 28°C for starting grade PG 70-xx, unless there is other information to suggest the temperature at which $G^* \sin \delta \leq 5000$ kPa. Decrease or increase the test temperature at 3.0°C increments until the value for $G^* \sin \delta > 5000$ kPa.

6.12.6.9. Determine the beginning test temperature for the BBR test (T 313) on the PAV residue from Table 1 of M 320 using the starting PG grade determined in Section 6.3 and the lowest temperature from Section 6.11.6.8 where the value for $G^* \sin \delta \leq 5000$ kPa, unless there is other information to suggest the temperature at which the creep stiffness ($S$) $\leq 300$ MPa and the slope ($m$) $\geq 0.300$.

6.13.6.10. Test pairs of BBR specimens according to T 313 beginning at the test temperature selected in Section 6.12.6.9 and increasing at 6.0°C increments, until a creep stiffness ($S$) and slope ($m$) meeting the requirements of M 320, Table 1 are obtained. Test fresh BBR specimens at each temperature.

6.14.6.11. Certain asphalt binders may satisfy the M 320, Table 1 slope requirement at substantially lower temperatures than they satisfy the creep stiffness ($S$) requirement. If the creep stiffness is between 300 and 600 MPa at a test temperature at which the slope, $m$, $\geq 0.300$, it may be possible to satisfy the DT (T 314) failure strain requirement in lieu of the creep stiffness requirement. Test DT specimens according to T 314 at the test temperature at which $m \geq 0.300$, and determine if the failure strain $\geq 1.0$ percent. Test a sufficient number of specimens so that a minimum of six valid test results are obtained.

6.15.6.12. If the failure strain < 1.0 percent, test additional sets of DT specimens, increasing the test temperature in 6.0°C increments, until a failure strain $\geq 1.0$ percent is obtained.

6.16.6.13. Using the results of Sections 6.11.6.8 through 6.15.6.12, determine the final grade of the asphalt binder.

7. TEST PROCEDURE FOR VERIFYING THE NOMINAL GRADE OF AN ASPHALT BINDER

7.1. Prepare samples and test specimens using the procedures specified in the applicable test methods. In the case where the grade of the asphalt binder is being verified, approximately 250 g of unaged asphalt binder are required to complete the tests with the necessary replicates.
7.2. Begin conditioning asphalt binder in the RTFO. Condition a sufficient amount of asphalt binder depending on the type and number of tests to be performed.

**Note 4**—Two BBR beams requiring PAV aged material are needed. In addition, at least six DT specimens requiring PAV-aged material may also be required. Only one test temperature will be required. This testing will utilize approximately 100 g of RTFO residue.

7.3. Perform the DSR test (T 315) on the original asphalt binder at the test temperature indicated by the high-temperature grading designation. For example, test a PG 70-16 asphalt binder at 70°C. The value for G*/sin δ must be ≥1.0 kPa to meet the requirements of M 320.

**Note 5**—This step verifies the starting PG grade. For example, if a PG 58-22 is tested at 58°C and G*/sin δ ≥1.00 kPa, the high-temperature grading designation for the asphalt binder is verified to be PG 58-xx.

**Note 6**—If the asphalt binder fails to meet the requirements of M 320, Table 1 for the grade designated, it may be treated as a binder of unknown grade and tested according to Section 6, or the testing may be stopped because the grade was not verified.

7.4. Determine the flash point on a sample of original binder using T 48. The flash point must be greater than 230°C to meet the requirements of M 320. Alternatively, the flash point can be determined by the user or producer of the asphalt binder.

7.5. Determine the viscosity of the original asphalt binder at 135°C using T 316. The viscosity must not exceed 3 Pa·s to meet the requirements of M 320.

7.6. After the RTFO conditioning (T 240) is complete, determine the mass change of the original asphalt binder. The mass change must be ≤1.00 percent to meet the requirements of M 320.

7.7. If the original asphalt binder does not meet M 320, Table 1 requirements for any of the tests performed in Sections 7.4, 7.5, or 7.6, the asphalt binder will not satisfy the specification for any PG, and no further testing is required.

7.8. To verify the high-temperature properties of the binder, perform the DSR test (T 315) on the RTFO residue at the test temperature indicated by the high-temperature grading designation. For example, test a PG 70-16 asphalt binder at 70°C. The value for G*/sin δ of the RTFO residue must be ≥2.20 kPa to meet the requirements of M 320, Table 1 (Note 6).

7.9. Age a sufficient quantity of RTFO residue in the PAV (R 28). Use an aging temperature of 90°C for binders having a high-temperature grading designation of PG 46-xx or PG 52-xx and 100°C for binders having high-temperature grading designations of PG 58-xx and higher. A PAV temperature of 110°C is used in simulating desert environments.

**Note 7**—Two BBR beams (requiring PAV-aged material) are required. In addition, six DT samples may also be needed requiring about 60 g of PAV-aged asphalt binder.

**Note 8**—Complete Sections 7.1 through 7.9 during the first day of testing. This schedule will allow further testing to begin on the second day after PAV aging is complete.

7.10. At the conclusion of the PAV aging procedure (R 28), including aging, combining, and degassing the binder, prepare two BBR specimens according to T 313. Retain sufficient residue to prepare at least six DT specimens if required.

7.11. Perform the DSR test (T 315) on the PAV residue at the test temperature specified in Table 1 of M 320 for the high-temperature and low-temperature grading designation of the binder being verified. For example, test a PG 64-40 asphalt binder at 16°C. The value for G*sin δ must not exceed 5000 kPa to meet the requirements of M 320 (Note 6).
Test two BBR specimens according to T 313 at the test temperature specified in Table 1 of M 320 for the high-temperature and low-temperature grading designation of the binder being verified. For example, test a PG 58-28 asphalt binder at –18°C. The value of the slope, \( m \), must be ≥0.300 to meet the requirements of M 320, Table 1. The value of the creep stiffness (\( S \)) must be ≤300 MPa to meet the requirements of M 320, Table 1. Certain asphalt binders may satisfy the BBR slope requirement at substantially lower temperatures than they satisfy the BBR stiffness requirement (Note 6).

If the creep stiffness (\( S \)) is between 300 and 600 MPa and the slope (\( m \)) ≥0.300 at the test temperature, it may be possible to satisfy the DT (T 314) failure strain requirement in lieu of the creep stiffness (\( S \)) requirement. Test DT samples according to T 314 at the same test temperature used to test the BBR specimens. Test a sufficient number of specimens so that a minimum of six valid test results are obtained. The failure strain must be ≥1.0 percent to meet the requirements of M 320, Table 1 (Note 6).

8.報告

8.1. If the grade of the asphalt binder tested is determined, report the results of all tests performed and the high-temperature grading designation determined, followed by the low-temperature designation (e.g., PG 52-34).

8.2. If the grade of an asphalt binder is verified, report the results of all tests performed and if the binder meets the requirements of M 320, Table 1.

9.关键字

Standard Method of Test for

Penetration of Bituminous Materials

AASHTO Designation: T 49-14XX
ASTM Designation: D 5/D 5M-06\textsuperscript{13}

Rationale:
Based on AMRL study on precision and bias, changes are recommended to this standard to update the precision and bias statements.

In addition, it is recommended to update to the current ASTM standard.

Note: Also see attached ASTM D 5 comparison and NCHRP Research Digest 388.
AASHTO Designation: T 49-14 XX
ASTM Designation: D 5/D5M-06<sup>13</sup><sup>13</sup>

AASHTO T 49-14 XX is identical to ASTM D 5/D5M-13<sup>13</sup> except for the following provisions:

1. Replace all references to ASTM D 36 with AASHTO T 53.
2. Add the following to Section 2:
   2.4 AASHTO Standard:
      R 16, Regulatory Information for Chemicals Used in AASHTO Tests
3. Replace the last sentence of Section 6.1 with the following:
   The weight of the spindle shall be checked.
4. Add the following sentence to the end of Section 7.2:
   If air bubbles are visible in the surface of the specimen, briefly flash the top of the specimen with a flame.
5. Replace Section 11 with the following:

11. PRECISION AND BIAS

11.1. Precision—Criteria for judging the acceptability of penetration of asphalt binder results obtained by this method are given in Table X.

Note: Precision data for penetration on asphalt residue of emulsified asphalt can be found in T 59.

11.1.1. Single-Operator Precision (Repeatability)—The figures in Column 2 of Table X are the standard deviations that have been found to be appropriate for the conditions of test described in Column 1. Two results obtained in the same laboratory, by the same operator using the same equipment, in the shortest practical period of time, should not be considered suspect unless the difference in the two results exceeds the values given in Table X, Column 3.

11.1.2. Multilaboratory Precision (Reproducibility)—The figures in Column 2 of Table X are the standard deviations that have been found to be appropriate for the conditions of test described in Column 1. Two results submitted by two different operators testing the same material in different laboratories shall not be considered suspect unless the difference in the two results exceeds the values given in Table X, Column 3.

Table X – Precision Estimates of Penetration of Bituminous Materials

<table>
<thead>
<tr>
<th>Condition of Test and Test Property</th>
<th>Standard Deviation 1s&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>Acceptable Range of Two Test Results d2s&lt;sup&gt;a,b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Operator Precision:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4°C</td>
<td>1s = 0.01X + 0.8</td>
<td>d2s = (0.01X + 0.8) x 2.83</td>
</tr>
<tr>
<td>Original</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTFO</td>
<td>1s = 0.02X + 0.4</td>
<td>d2s = (0.03X + 0.3) x 2.83</td>
</tr>
<tr>
<td></td>
<td>Original</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>25°C</strong></td>
<td>1s = 0.01X + 0.7</td>
<td>d2s = (0.01X + 0.6) x 2.83</td>
</tr>
<tr>
<td><strong>Multilaboratory Precision:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4°C</strong></td>
<td>1s = 0.06X + 1.9</td>
<td>d2s = (0.06X + 2.0) x 2.83</td>
</tr>
<tr>
<td><strong>25°C</strong></td>
<td>1s = 0.03X + 1.3</td>
<td>d2s = (0.02X + 1.8) x 2.83</td>
</tr>
</tbody>
</table>

*These values represent the 1s and d2s limits described in ASTM Practice C670.*

*The value of X represents the average value of two test results.*

Note – The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 71 to 97 laboratories for each of the pairs of samples. The analysis included original asphalt cements with the average penetration value of 11.7 units to 44 units at 4°C and 33.4 units to 128.9 units at 25°C and RTFO residue with the average penetration value of 7.8 units to 27.2 units at 4°C and 19.8 units to 68.4 units at 25°C.

**11.2. Bias**- No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.
Standard Method of Test for

Kinematic Viscosity of Asphalts (Bitumens)

AASHTO Designation: T 201-40XX
ASTM Designation: D 2170/D 2170M-0710

Rationale:
Based on AMRL study on precision and bias, changes are recommended to this standard to update the precision and bias statements.

In addition, it is recommended to update to the current ASTM standard. In the current ASTM standard, ASTM has corrected some of the errors that AASHTO had identified and developed exceptions for. Therefore, exceptions 5, 6, and 7 can be deleted.

Note: Also see attached ASTM D 2170 comparison and NCHRP Research Digest 388.
Appendix D-4

Standard Method of Test for

Kinematic Viscosity of Asphalts (Bitumens)

AASHTO Designation: T 201-\textbf{40XX}
ASTM Designation: D 2170/D 2170M-0710

AASHTO T 201-\textbf{40XX} is identical to ASTM D 2170/D 2170M-0710 except for the following provisions:

1. All references to ASTM D 92 shall be replaced with AASHTO T 48. Add reference to R 16, Regulatory Information for Chemicals Used in AASHTO Tests.
2. Delete the 1 in front of \(\text{cm}^2/\text{s}\) in the fourth sentence of Section 3.1.2.
3. Replace the last two sentences in Section 6.3 with the following:

   The efficiency of the stirring and the balance between heat losses and heat input must be such that the temperature of the bath medium does not vary by more than \(\pm 0.1^\circ\text{C} (\pm 0.2^\circ\text{F})\) over the length of the viscometer, or from viscometer to viscometer in the various bath positions.
4. Replace Section 8.2 with the following:

   8.2 Maintain the bath at the test temperature within \(\pm 0.1^\circ\text{C} (\pm 0.2^\circ\text{F})\). Apply the necessary corrections, if any, to all thermometer readings.
5. Add a last sentence to Section A2.3.3.1 as follows:

   When the sample travels through capillary R and fills bulb A approximately half full, arrest its flow by placing a stopper in tube L.
6. Add a last sentence to Section A2.3.3.3 as follows:

   This 15-min period is part of and not in addition to the equilibration time of Section A2.3.4.
7. Revise the second sentence of Section A2.3.5 to read as follows:

   For the Zeitfuchs cross-arm viscometer, apply slight vacuum to tube M (or pressure to tube N) to cause...

5. Replace Section 11 with the following:

### 11. PRECISION AND BIAS

11.1. \textit{Precision}—Criteria for judging the acceptability of kinematic viscosity results obtained by this method are given in Table X.

11.1.1. \textit{Single-Operator Precision (Repeatability)}—The figures in Column 2 of Table X are the coefficients of variation that have been found to be appropriate for the conditions of test described in Column 1. Two results obtained in the same laboratory, by the same operator using the same equipment, in the shortest practical period of time, should not be considered suspect unless the difference in the two results, expressed as a percent of their mean, exceeds the values given in Table X, Column 3.

11.1.2. \textit{Multilaboratory Precision (Reproducibility)}—The figures in Column 2 of Table X are the coefficients of variation that have been found to be appropriate for the conditions of test described in Column 1. Two results submitted by two different operators testing the same material in
different laboratories shall not be considered suspect unless the difference in the two results, expressed as a percent of their mean, exceeds the values given in Table X, Column 3.

### Table X – Precision Estimates of Kinematic Viscosity of Asphalts (Bitumens)

<table>
<thead>
<tr>
<th>Condition of Test and Test Property</th>
<th>Coefficient of Variation (percent of mean)</th>
<th>Acceptable Range of Two Test Results (Percent of Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1s%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>d2s%&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Single-Operator Precision:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>1.3</td>
<td>3.8</td>
</tr>
<tr>
<td>RTFO (Average of Kinematic Viscosity &lt; 850 mm&lt;sup&gt;2&lt;/sup&gt;/s)</td>
<td>1.5</td>
<td>4.2</td>
</tr>
<tr>
<td>RTFO (Average of Kinematic Viscosity ≥ 850 mm&lt;sup&gt;2&lt;/sup&gt;/s)</td>
<td>2.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Multilaboratory Precision:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>2.3</td>
<td>6.6</td>
</tr>
<tr>
<td>RTFO (Average of Kinematic Viscosity &lt; 850 mm&lt;sup&gt;2&lt;/sup&gt;/s)</td>
<td>3.3</td>
<td>9.2</td>
</tr>
<tr>
<td>RTFO (Average of Kinematic Viscosity ≥ 850 mm&lt;sup&gt;2&lt;/sup&gt;/s)</td>
<td>5.1</td>
<td>14.4</td>
</tr>
</tbody>
</table>

<sup>a</sup> These values represent the 1s % and d2s% limits described in ASTM Practice C670.

Note – The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 75 to 118 laboratories for each of the pairs of samples. The analysis included asphalt cements with the average kinematic viscosity of 283 mm<sup>2</sup>/s to 702 mm<sup>2</sup>/s for the original asphalt and 429 mm<sup>2</sup>/s to 1,036 mm<sup>2</sup>/s for the RTFO residue.

11.2. Bias - No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.
Standard Method of Test for

Viscosity of Asphalts by Vacuum Capillary Viscometer

AASHTO Designation: T 202-40XX
ASTM Designation: D 2171/D 2171M-0710

Rationale:
Based on AMRL study on precision and bias, changes are recommended to this standard to update the precision and bias statements.

In addition, it is recommended to update to the current ASTM standard. In the current ASTM standard, ASTM has corrected some of the errors that AASHTO had identified and developed exceptions for. Therefore, exceptions 4, 5, and 6 can be deleted. A new exception 5 is proposed to correct an error that ASTM introduced in the changes adopted in Table X2.1

Note: Also see attached ASTM D 2171 comparison and NCHRP Research Digest 388.
Standard Method of Test for

Viscosity of Asphalts by Vacuum Capillary Viscometer

AASHTO Designation: T 202-40XX
AASHTO Designation: T 202-10XX

AASHTO T 202-40XX is identical to ASTM D 2171/D 2171M-0710 except for the following provisions:

1. The following reference is added:
   R 16, Regulatory Information for Chemicals Used in AASHTO Tests.
2. Replace the last sentence in Section 6.3 with the following:
   The efficiency of the stirring and the balance between heat loss and heat input must be such that the temperature of the bath medium does not vary by more than ±0.1°C (±0.2°F) over the length of the viscometer, or from viscometer to viscometer in the various bath positions.
3. Replace Section 8.1.1 with the following:
   8.1.1 Maintain the bath at the test temperature within ±0.1°C (±0.2°F). Apply the necessary corrections, if any, to all thermometer readings.
4. In Table X1.1, change the viscosity range for Viscometer Size Number 12 to “36 to 800 Pa•s (360 to 8000 P).”
5. In Table X3.1, change the approximate calibration factor for Viscometer Size Number 25, Bulb D from “0.007” to “0.07”, and change the title to “Standard Viscometer Sizes, Capillary Radii, Approximate Calibration Factors, K, and Viscosity Ranges for Modified Koppers Vacuum Capillary Viscometer.”
6. Replace Section X4.3.1.7 with the following:
   X4.3.1.7 Calculate the calibration factor, K, for each bulb as follows:
   \[
   K = \frac{\eta}{t} \quad (X4.1)
   \]
   where:
   \[
   K = \text{viscometer bulb calibration factor at } 40.0 \text{ kPa (300 mm Hg), Pa}\cdot\text{s/s;}
   \]
   \[
   \eta = \text{viscosity of viscosity standard at calibration temperature, Pa}\cdot\text{s; and}
   \]
   \[
   t = \text{flow time, s.}
   \]
7. Replace Table X1.1 with the following table:

<table>
<thead>
<tr>
<th>Viscosity Standard</th>
<th>Approximate Viscosity, Pa•s</th>
<th>35°C</th>
<th>40°C</th>
<th>60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>N30000*</td>
<td>80</td>
<td>80</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>N190000*</td>
<td>520</td>
<td>140</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>N270000*</td>
<td>5300</td>
<td>140</td>
<td>340</td>
<td></td>
</tr>
<tr>
<td>S300000*</td>
<td>80</td>
<td>21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Available in 1-pint containers. Purchase orders should be addressed to Cannon Instrument Co., P.O. Box 16, State College, PA 16801 or see website, www.cannoninstrument.com. Shipment will be made as specified or by best means.

4. Replace Section 11 with the following:
11. PRECISION AND BIAS

11.1. Precision—Criteria for judging the acceptability of viscosity results obtained by this method are given in Table X.

11.1.1. Single-Operator Precision (Repeatability)—The figures in Column 2 of Table X are the coefficients of variation that have been found to be appropriate for the conditions of test described in Column 1. Two results obtained in the same laboratory, by the same operator using the same equipment, in the shortest practical period of time, should not be considered suspect unless the difference in the two results, expressed as a percent of their mean, exceeds the values given in Table X, Column 3.

11.1.2. Multilaboratory Precision (Reproducibility)—The figures in Column 2 of Table X are the coefficients of variation that have been found to be appropriate for the conditions of test described in Column 1. Two results submitted by two different operators testing the same material in different laboratories shall not be considered suspect unless the difference in the two results, expressed as a percent of their mean, exceeds the values given in Table X, Column 3.

<table>
<thead>
<tr>
<th>Condition of Test and Test Property</th>
<th>Coefficient of Variation (Percent of Mean)</th>
<th>Acceptable Range of Two Test Results (Percent of Mean)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>d2s%&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Single-Operator Precision:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RTFO</td>
<td>1.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Multilaboratory Precision:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>3.1</td>
<td>8.8</td>
</tr>
<tr>
<td>RTFO</td>
<td>6.8</td>
<td>19.2</td>
</tr>
</tbody>
</table>

<sup>a</sup> These values represent the 1s % and d2s% limits described in ASTM Practice C670.

Note—The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 94 to 135 laboratories for each of the pairs of samples. The analysis included asphalt cements with the average viscosity by vacuum capillary in a range of 102 Pa•s to 5,930 Pa•s for the original asphalt and 403 Pa•s to 11,585 Pa•s for the RTFO residue.

11.2. Bias—No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.

5. In Table X2.1, change the title to “Standard Viscometer Sizes, Capillary Radii, Approximate Calibration Factors, K, and Viscosity Ranges for Asphalt Institute Vacuum Capillary Viscometers.”
Ontario’s Quest for Improved Asphalt Cement Specifications

Becca Lane
Ministry of Transportation of Ontario
AASHTO TS 2b Committee Meeting
Minneapolis, Minnesota
July 2104

Move to Superpave - PGAC

- Performance graded asphalt cement (PGAC) specifications developed to control rutting, thermal and fatigue cracking.
- MTO fully implemented PGAC in 1998 to replace the penetration system.
- Implementation was successful but premature thermal and fatigue cracking has been identified since the early 2000’s.
Premature Pavement Cracking

- Although many things can lead to premature cracking, it is accepted that current PGAC used does not guarantee long term performance.
- PGAC system was developed with largely unmodified binders.
- Considerable research is ongoing in Ontario and elsewhere.

Ontario research has shown that AC with identical grades can provide wide performance variation.

Hwy 138 Cornwall to Monkland

Hwy 138 Monkland to Hwy 417
Improved MTO Laboratory Standards

1. LS-299 Double-Edge-Notched Tension (DENT)
   - *First published in 2006*
   - *Used for acceptance of modified AC on MTO contracts since 2012*

2. LS-308 Extended Bending Beam Rheometer (BBR)
   - *First published in 2006*
   - *Data reported since 2012 for MTO contracts*

3. LS-228 Modified Pressure Aging Vessel (PAV)
   - *First published in 2012*
LS-299 Double-Edge-Notched Tension

Improved Ductility Test

\[ W_{\text{total}} = W_{\text{essential}} + W_{\text{plastic}} = w_{\text{essential}}BL + w_{\text{plastic}}\beta BL^2 \]

\[ w_{\text{total}} = W_{\text{total}}/BL = w_{\text{essential}} + \beta w_{\text{plastic}}L \]

\[ \text{CTOD} \sim w_{\text{essential}}/\sigma_{\text{net section stress at 5 mm}} \]

LS-299 Double-Edge-Notched Tension

DENT Failure at L = 5 mm  Mixture Failure
**LS-299 Critical Crack Tip Opening Displacement (CTOD)**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Fatigue</th>
<th>Fatigue</th>
<th>Ratio</th>
<th>Composite Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Tip Opening</td>
<td>As-Res</td>
<td>100%</td>
<td>95%</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>95%</td>
<td>100%</td>
<td>0.99</td>
</tr>
<tr>
<td>Fatigue Yield Energy</td>
<td>As-Res</td>
<td>98%</td>
<td>98%</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>98%</td>
<td>98%</td>
<td>0.98</td>
</tr>
<tr>
<td>Fatigue Energy</td>
<td>As-Res</td>
<td>98%</td>
<td>98%</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>98%</td>
<td>98%</td>
<td>0.98</td>
</tr>
<tr>
<td>Pulse Stress in Low</td>
<td>As-Res</td>
<td>90%</td>
<td>90%</td>
<td>0.83</td>
</tr>
<tr>
<td>Temperature Direct Tension Test</td>
<td>ALF Cooling</td>
<td>90%</td>
<td>90%</td>
<td>0.83</td>
</tr>
<tr>
<td>Superpose IC/5%</td>
<td>As-Res</td>
<td>10%</td>
<td>10%</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>10%</td>
<td>10%</td>
<td>0.93</td>
</tr>
<tr>
<td>Large Stress Pulse</td>
<td>As-Res</td>
<td>85%</td>
<td>85%</td>
<td>0.73</td>
</tr>
<tr>
<td>Time Swing</td>
<td>ALF Cooling</td>
<td>85%</td>
<td>85%</td>
<td>0.73</td>
</tr>
<tr>
<td>Essential Work of Fracture</td>
<td>As-Res</td>
<td>55%</td>
<td>55%</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>55%</td>
<td>55%</td>
<td>0.55</td>
</tr>
<tr>
<td>Fracture Energy</td>
<td>As-Res</td>
<td>40%</td>
<td>40%</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>40%</td>
<td>40%</td>
<td>0.45</td>
</tr>
<tr>
<td>Stress Swep</td>
<td>As-Res</td>
<td>85%</td>
<td>85%</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>ALF Cooling</td>
<td>85%</td>
<td>85%</td>
<td>0.79</td>
</tr>
</tbody>
</table>

FHWA ALF Study — Gibson *et al.*, ICAPT 2012

**LS-299 Double-Edge-Notched Tension**

CTOD ~ 85% correct so also use:
- LS-308 (72 hr BBR)
- LS-228 (modified PAV)

Hesp *et al.*, IJPE 2009
LS-299 Double-Edge-Notched Tension

- MTO implemented CTOD acceptance criteria for contracts that use modified AC in 2012;
- LS-299 and LS-308 included in MTO asphalt correlations;
- Some municipalities also require asphalt meet LS-299 and LS-308 testing criteria.

\[ R^2 = 0.9038 \]

Erskine et al., Eurobitume 2012

LS-308 Extended BBR versus LS-228 Modified PAV

The graph shows the relationship between 72 h BBR loss at -20°C and 40 h - 20 h PAV grade loss. The correlation coefficient is given as \( R^2 = 0.9038 \).
Appendix E

**LS-308 Extended BBR**
(MTO Trial, Timmins, ON, 2003)

![Graph showing Cracking Distress vs. Limiting Grade Temperature, °C with R² values 0.1339, 0.871, and 0.8878.](image)

- Cracking Distress, #/500 m
- Limiting Grade Temperature, °C

Taylor and Hesp, 2014

**LS-228 Modified PAV**

![Graph showing Average Grading Difference vs. Grading Approach with values -6.2, -0.1, -1.3, 0.6, 1.3, and 1.6.](image)

- AASHTO M320
- LS-308
- 50 g @ 40 h PAV
- 25 g @ 20 h PAV
- 12.5 g dry @ 20 h PAV
- 12.5 g wet @ 20 h PAV

Erskine et al., 2012

10°C-20°C error!
Appendix E

Pavement Performance

Acknowledgments

• Queen’s University
• E.I. du Pont Canada
• Imperial Oil of Canada
• Ministry of Transportation of Ontario
• Natural Sciences and Engineering Council of Canada