

## Appendix - Table of Contents –22

Appendix Title	Page
A1 Materials Advisory Committee (MAC) Charter.....	2
A2 Independent Assurance (IA) Testers Committee Charter.....	6
A3 Flexible Pavement Operators’ Group (FPOG) Charter.....	9
B Task Force Management Guide .....	12
C Personnel Roster, Staff Materials & Region Materials .....	16
D Definitions.....	22
E Acronyms.....	27
F Significant Publications.....	31
G Colorado Procedures - Laboratory <i>Numeric Order</i> .....	32
H Metric Conversion Tables.....	34
I Materials Testing Accuracy Criteria.....	36
J Laboratory Test Time.....	39
K Establishing Lots or Process Control on the Project.....	41
L Random Sampling.....	41
M Sample Processing Procedure.....	42
N Use of Laboratory Check Tests on More Than One Project .....	42

## Appendix A1 - Materials Advisory Committee (MAC) Charter - 21

### PURPOSE

To oversee the Field Materials Manual, the Laboratory Manual of Test Procedures, Pavement Design Manual, MAC Task Forces, and Task Groups. To review and approve all changes in the Schedules and test procedures in these manuals. To develop, review, approve and propose to the Specification Committee specifications addressing materials problems and needs. To develop and implement programs, procedures, and policies to maintain the quality and statewide uniformity of materials incorporated into CDOT construction projects.

### MEMBERSHIP

<b>Voting Members:</b>	<b>Votes</b>
CDOT Materials Engineer (Chairman)	1
Region Materials Engineers (*).....	6
Central Laboratory Program Managers (**)	2
Applied Research and Innovation Branch	0
Total Vote .....	9

(\*) There are (6) RMEs for the (5) Regions.

(\*\*) Two of the (6) Program Managers from the Central Materials Laboratory, designated by the Materials & Geotechnical Branch Manager or per the respective specialty area.

### Advisory members:

Representatives from Central Laboratory Program Subject Matter Experts, Standards & Specifications, Area Engineers, Staff Maintenance, FHWA, etc.

### MEETINGS

Every two months, in odd months, on the 2nd Wednesday of the month (if possible). The meeting facilitation responsibilities will rotate among the five Regions. The host Region Materials Engineer (RME) will arrange for and preside at the meeting.

- The rotation of the meeting facilitator will be by consensus between the MAC Chairman and the RMEs.
- The CDOT Materials Engineer will designate a person to be the Secretary of the MAC: to assist the Host Region, to create and distribute the Agenda, to take notes at the Meetings, write the Minutes, distribute the Minutes and the Executive Summary, and maintain the MAC on Teams web site.

**SCOPE**

1. Review and approve changes to the following:
  - Quality Assurance Procedures
  - Documentation, Project Materials to Final Materials [for SiteManager / LIMS, for Design-Build, for CDOT Maintenance & Local Agency]
  - Special Notice to Contractors
  - Owner Acceptance (OA) Frequency Guide Schedule for Minimum Materials Sampling, Testing, and Inspection
  - Independent Assurance (IA) Frequency Guide Schedule for Evaluation of OA Sampling & Testing
  - Colorado Procedures (CP's)
  - Chapters, 200 – 800, Inspections
  - Job Safety Analysis (JSA), Materials
  - Colorado Procedures - Laboratory (CP-L's)
  - MAC Task Force Charters
2. Provide oversight for the Field Materials Manual, Laboratory Manual of Test Procedures, Pavement Design Manual, materials research, Pavement Management System implementation, and sampling & testing of maintenance material.
3. Review, discuss, develop, and approve specifications addressing materials problems or needs. Specifications approved by the MAC and submitted to the Specification Committee for consideration.

**GUIDELINES FOR MATERIALS ADVISORY COMMITTEE (MAC) MEETINGS**

**Overview** - The focus of MAC meetings will be to conduct the responsibilities of the MAC as designated under the **Purpose** and **Scope** Sections of the Materials Advisory Committee Charter.

**Conduct of Meeting** - The host Region Materials Engineer (RME) will preside over the meeting and act as the meeting facilitator. The agenda topics will be in the order of the agenda and discussion shall remain focused on the topic as presented in the Agenda. Additional topics that are included after the meeting agenda has been distributed will be discussed after the meeting agenda items have been addressed if time permits. Discussion on each topic will move toward a swift and efficient resolution of the problem with the Host acting as a facilitator if necessary. If substantial work is anticipated to resolve specific items, a task group may be assigned to develop an action plan, which will resolve the question. When discussion on any topic begins to stray from the topic or significantly exceeds the allotted time for that topic, the presiding RME shall push for a resolution or move to the next Agenda item.

**Who Attends** - Attendance will be **Voting** and **Advisory** members of the Committee, as shown in the Charter. Guests (Contractors, suppliers, etc.) will attend only if invited by a MAC member for a specific Agenda topic only.

**Guests** that come for one topic and then leave shall be assigned a time slot, most likely after lunch. Guests invited for an *Education and Research* topic may be scheduled during lunch to maximize efficient time utilization. The guests' schedules will be taken into consideration. Discretion will be used when an excessive amount of time, minor importance, or more than one topic is requested. In some instances, guests may be placed at the end of the agenda.

**Guests, Uninvited:** The Open Meetings Law (C.R.S. 24-6-401) does not apply to advisory committees or other internal work groups at CDOT. There is no right for non-invitees to attend such meetings. Policy clarified at November 2017 MAC Meeting.

**Agenda Topics** - Only persons eligible to be voting members of the MAC may place topics on the agenda. Anyone else must work through these members to establish an agenda topic. The presenter of each topic shall lead the discussion on their topic and ask for a vote if necessary.

**Agenda Topic Votes** - Only voting members of the MAC may “Make a Motion” or “Second a Motion”. Only voting members may participate in E- Votes (Votes by E-Mail). Votes require (6) in affirmation. *Abstaining from a vote is not a passive act. Except in illness, a voting member who is missing must designate a proxy in advance to the MAC Secretary. The individual attending for the voting member should not designate himself or herself.*

**Appropriate Topics & Discussion** - Topics will normally address items listed under the **Purpose** and **Scope** of the MAC Charter. Topics for the upcoming meeting need to be submitted during the Topic Solicitation period. Each agenda item will be given a number. Topics that are brief updates without the possibility of discussion can be posted in the Agenda without discussion and stipulated as “Non-Verbal”.

**Documents Referenced for Topics** - All referenced documents shall be provided to the MAC Secretary as stipulated before the Meeting for distribution and presentation on the day of the MAC.

**Agenda & Meeting Organization** - The priority/order of the Agenda are:

- 1) The **Minutes** from the previous MAC Meeting will be approved by Vote.
- 2) The **Agenda** for the current MAC Meeting will be accepted or amended, if necessary, by the membership.
- 3) The **Facilitator will announce the E-Vote Summaries from between the MAC Meetings.** The intent is to read the e-vote into the Minutes not to further discuss the issue. If the topic needs any discussion, it shall be an Old Business Agenda item.
- 4) **Task Force Business.** Task Forces need to inform the Committee of their current status. Informational updates with discussion and votes are frequently necessary. An update is required a minimum of once per year.

Task Group Business. Task Groups being internal and of very limited scope need to inform the Committee of their current status within the applicable Old Business topic.

- 5) **Old Business.** This will include items that were on the last MAC agenda as either New Business or Additional Business. This will also include Old Business items that were not resolved at the previous MAC meeting because additional data needed to be gathered, or because it is long-term in implementation. Items not discussed during the previous three MAC meetings (6 months) shall be considered New Business if the topic is resumed.
- 6) **Education & Research.** Guest speakers, video presentations, etc. will occasionally be on the Agenda to assist in the sharing of relevant current information. If possible, all Education & Research topics will immediately follow the lunch break at approximately noon.

- 7) **New Business.** The MAC Chairman based on the importance of the agenda item and associated with related topics will prioritize this.
- 8) **Additional Business.** Items that are received after the deadline for submittal. Unless these are “emergency” items, they will be placed at the end of the agenda and discussed in priority order as time permits. Low priority items may be postponed and added to the next MAC agenda.

*MAC Meeting Minutes and Executive Summary* - The MAC Secretary will develop the draft version of the Minutes within two weeks after the date of the Meeting. Although distributed to all Meeting Attendees there should always be a response from the topic presenters, the MAC Facilitator, and the MAC Chairman. The MAC Chairman may develop an Executive Summary. The MAC Secretary may distribute and post the final version of the MAC Meeting Minutes and the Executive Summary.

## **Appendix A - Independent Assurance (IA) Testers Committee Charter - 14**

### **PURPOSE**

To review and aid in the development of the Independent Assurance (IA) Program and the Frequency Schedule for Independent Assurance Evaluation in the Field Materials Manual.

To receive and review procedures for testing materials used in the Field and recommend any necessary changes for implementation to the Materials Advisory Committee.

To establish and maintain statewide consistency between Quality Assurance and Independent Assurance Testers.

To establish and maintain consistency in the use of the Field Materials Manual.

### **MEMBERSHIP**

#### **Voting Members:**

A member of the Documentation Unit of Staff Materials and one IA tester from each of the six Regions will be allowed to vote. Regions with more than one IA Tester shall share a vote.

#### **Advisory Members:**

FHWA and CDOT employees with experience or expertise in the tests performed by Field personnel or the Central Laboratory.

### **MEETINGS**

Meetings will be on an annual basis and usually in January. The meeting will be held at a time close to the Materials Advisory Committee (MAC) meeting. If requested by the Committee, additional meetings may be required. The Pavement Design Program Engineer will host the meeting each calendar year. A member of the Documentation Unit will assist the Host, to create and distribute the Agenda, taking notes at the meetings, and produce and distribute the Minutes.

### **SCOPE**

To share information and ideas related to sampling and testing of material incorporated into CDOT projects.

To review new ideas, develop and approve (by simple majority) suggested changes to the Field Materials Manual, specifications, or procedures addressing materials problems or needs. Suggested changes will be forwarded to the MAC for consideration.

## GUIDELINES FOR THE INDEPENDENT ASSURANCE TESTERS COMMITTEE MEETINGS

**Overview** The focus of the IAT Meeting will be to conduct the responsibilities of the IAT Committee as designated under the **Purpose** and **Scope** sections of the Independent Assurance Tester Committee Charter.

**Conduct of Meeting** - The Chairperson will preside over the meeting. The agenda topics will be handled in order and discussion shall remain focused on the current topic. Additional topics added after the meeting agenda has been distributed will be discussed after the meeting agenda items have been addressed if time permits. Discussion on each topic will move toward a swift and efficient resolution of the problem. If substantial work is anticipated to resolve specific items, a task force can be formed to develop an action plan, which will resolve the question. When discussion on any topic begins to stray from the topic, the Chairperson shall push for a resolution or move to the next agenda item.

**Who Attends** - Attendance will be **Voting** and **Advisory** members of the Committee, as shown in the Charter. Guests (Contractors, suppliers, etc.) will attend only if invited by an IAT member for a specific Agenda topic.

**Agenda Topics** - Only persons eligible to be voting members of the IAT Committee may place topics on the agenda. Anyone else must work through these members to establish an agenda topic. The presenter of each topic shall lead the discussion on their topic and ask for a vote if necessary.

**Agenda Topic Votes** - Only voting members of the IAT may "Make a Motion" or "Second a Motion". Only voting members may participate in E-Votes (Votes by E-Mail).

**Appropriate Topics & Discussion** - Topics will normally address items listed under the **Purpose** and **Scope** of the IAT Charter. Topics that are informational and require no decision, such as updates, shall generally be avoided. These can be handled by E-Mail.

**Prioritization of IAT Agenda Items** - Agenda items for the upcoming meeting need to be submitted at least 20 calendar days before the meeting. Each agenda item will be given a number. The priority for the Agenda is:

1. The **Minutes** from the previous IAT meeting will be approved by vote.
2. The **Agenda** for the current IAT meeting will be approved by vote.
3. The **E-Votes Summary** will be submitted for IAT Minute inclusion.
4. Matters considered "**emergency**" items as determined by the Chairperson shall have the top priority.
5. **Task Group Business**. Task Groups need to inform the Committee of current status. Informational updates with discussion and votes are frequently necessary.
6. **Guests** that come for one topic and then leave shall be assigned a time slot, most likely after lunch. The guests' schedules will be taken into consideration. Discretion will be used when an excessive amount of time, minor importance, or more than one topic is requested. In some instances, guests may be placed at the end of the agenda.

7. **Old Business.** This will include items that were on the last IAT agenda but were not addressed because of lack of time. This will also include items that were not resolved at the previous IAT meeting because additional data needed to be gathered. Items not addressed at the last IAT meeting shall be considered new business.
  8. **Education & Research.** Guest speakers, video presentations, etc. will occasionally be on the Agenda to assist in the sharing of relevant current information.
1. **New Business.** The Chairperson based on the importance of the agenda item and then associated with related topics will prioritize this.
  2. **Additional Business.** Items that are **received after the deadline** for submittal. Unless these are “emergency” items, they will be placed at the end of the agenda and discussed as time permits.

## **Appendix A - Flexible Pavement Operators Group (FPOG) Charter - 18**

### **PURPOSE**

To review needed changes in the testing of flexible pavement and to share information with other flexible pavement testers. To review and aid in the development of Colorado Procedures (CPs) and Colorado Procedures - Laboratory (CP-Ls) that pertain to the Flexible Pavement.

### **MEMBERSHIP**

#### **Voting Members:**

A member of the Flexible Pavement Unit of Staff Materials designated by the Asphalt Program Manager and one representative designated by each Region Materials Engineer (RME) from each of the Regions will be allowed to vote.

<b>Voting Members:</b>	<b>Votes</b>
Flexible Pavement Unit (Staff Materials)	1
<u>Region Labs</u>	<u>6</u>
Total Votes	7

Note 1: There are (6) RMEs for the (5) Regions.

#### **Advisory Members:**

A Flexible Pavement Engineer and, as needed, CDOT employees with flexible pavement experience.

### **MEETINGS**

The MAC authorized the FPOG to meet up to four times per year, ideally between September and March. The meetings will take place in Glenwood Springs or Denver. Regions will rotate hosting the meeting. The host Region will provide a Chairman to preside at the meeting and to make arrangements for the meeting. The Flexible Pavement advisory member will serve as Secretary to assist the Host Region, to create and distribute the Agenda, to take notes at the meetings, and produce and distribute the Minutes.

### **SCOPE**

To share information and ideas related to the testing of flexible pavements  
To review ideas and approve (by simple majority) suggested changes to the following:

Colorado Procedures (CPs)  
Colorado Procedures - Laboratory (CP-Ls)

The Flexible Pavement advisory member then presents these approved changes to the Asphalt Program Manager for the MAC's consideration.

## **GUIDELINES FOR FLEXIBLE PAVEMENT OPERATORS' GROUP (FPOG) MEETINGS**

**Overview** - The focus of FPOG meetings will be to conduct the responsibilities of the FPOG as designated under the **Purpose** and **Scope** sections of the Flexible Pavement Operators' Group Charter.

**Conduct of Meeting** - The Chairman from the host Region will preside over the meeting. The agenda topics will be handled in order and discussion shall remain focused on the current topic. Additional topics added after the meeting agenda has been distributed will be discussed after the meeting agenda items have been addressed if time permits. Discussion on each topic will move toward a swift and efficient resolution of the problem. If substantial work is anticipated to resolve specific items, a task force can be formed to develop an action plan, which will resolve the question. When discussion on any topic begins to stray from the topic, the Chairman shall push for a resolution or move to the next agenda item.

**Who Attends** - Attendance will be **Voting** and **Advisory** members of the FPOG, as shown in the Charter. The RME from the host Region is encouraged to attend. Guests (Contractors, suppliers, etc.) will attend only if invited by an FPOG member for a specific Agenda topic.

**Agenda Topics** - Any FPOG member may place topics on the agenda. Anyone else must work through these members to establish an agenda topic. The presenter of each topic shall lead the discussion on their topic and ask for a vote if necessary.

**Agenda Topic Votes** – Only voting members of the FPOG may “Make a Motion” or “Second a Motion”. Only voting members may participate in E- Votes (Votes by E-Mail).

*Appropriate Topics & Discussion* - Topics will normally address items listed under the **Purpose** and **Scope** of the FPOG Charter. Topics that are informational and require no decision, such as updates, shall generally be avoided. These can be handled by E-Mail.

**Prioritization of FPOG Agenda Items** - Agenda items for the upcoming meeting need to be submitted at least 10 calendar days before the meeting to the Flexible Pavement advisory member at Staff Materials. Each agenda item will be given a number. The priority for the Agenda is:

1. The **Minutes** from the previous FPOG meeting will be approved by vote.
2. The **Agenda** for the current FPOG meeting will be approved by vote.
3. The **E-Vote Summary** will be submitted for FPOG Minute inclusion.
4. Matters considered "**emergency**" items as determined by the Chairman shall have the top priority.
5. **Task Force Business**. Task Forces need to inform the Flexible Pavement Operators' Group of current status. Informational updates with discussion and votes are frequently necessary.
6. **Guests** that come for one topic and then leave shall be assigned a time slot, most likely after lunch. The guests' schedules will be taken into consideration. Discretion will be used when an excessive amount of time, minor importance, or more than one topic is requested. In some instances, guests may be placed at the end of the agenda.

7. **Old Business.** This will include items that were on the last FPOG agenda but were not addressed because of a lack of time. This will also include items that were not resolved at the previous FPOG meeting because additional data needed to be gathered. Items not addressed at the last FPOG meeting shall be considered new business.
8. **Education & Research.** Guest speakers, video presentations, etc. will occasionally be on the Agenda to assist in the sharing of relevant current information.
9. **New Business.** The Chairman based on the importance of the agenda item and associated with related topics will prioritize this.
10. **Additional Business.** Items that are **received after the deadline** for submittal. Unless these are “emergency” items, they will be placed at the end of the agenda and discussed as time permits.

## Appendix B- Task Force Management Guide

**OVERVIEW** The activities of a task force must be managed to accomplish the purpose of the task force. Keep the focus on the purpose of the task force and accomplish the tasks necessary to achieve this purpose with a series of action items. Various materials committees (MAC, AIF Steering, CDOT-ACPA Co-op, etc.) establish the purpose of each task force. At the first meeting of the task force make sure that this purpose is clearly understood by all task force members. Avoid expanding the purpose or scope of the task force without first consulting the committee that established the task force. The committee may decide that new problems identified by the task force are low priority or should be addressed by another task force.

**PROBLEM-SOLVING** The activities of a task force are problem-solving. Keep in mind the steps in problem-solving, which are:

- Identify the problem
- Generate solutions
- Evaluate the advantages and disadvantages of each solution and make a decision
- Implement the solution
- Consider evaluating the solution one or two years later to make additional tweaks

**PRIORITIES** At the first meeting the task force should clarify priorities. Often there is an urgent need for a quick fix to the current specification followed by a longer-term effort to gather information and affect a more permanent reworking of the specification. As the work of the task force progresses make sure that the list of priorities is kept up-to-date.

**IMPLEMENTATION TIMELINES** Consider timelines at which the final products will impact CDOT projects. The schedule of the Specification Committee is:

Specification Committee Schedule	
Meeting Dates	Quarterly Releases
March	February
June	May
September	August
December	November

Generally speaking, items approved by the MAC at its September Meeting, will be able to impact projects the following construction season. If urgent changes are needed, then items approved at the November MAC may make it into projects. This is possible, but not desirable. Items approved at the January MAC Meeting and beyond will not impact CDOT projects until the following construction season.

**SCHEDULING** It is not advisable to have meetings during the busy summer construction season for CDOT or industry representatives. However, after considering the implementation needs and the importance of the changes, meetings in the summer months may occur. Be sure to check with the CDOT and Industry Co-chairs for guidance on summer meetings.

It is in everyone's best interest to have as complete and comprehensive a product as possible. However, that is not realistic in many cases. It is often better to make incremental improvements. Several task forces have come up with an improved product. After experimenting with it on projects, the lessons learned are documented and a "Part 2" effort can be undertaken.

**AGENDA** Distribute a detailed agenda at least a week before each meeting. Start the agenda with a reminder of the date, time, and place of the meeting. Include a description of any decisions that need to be made with each topic. The last topic is establishing the date, time, and place of the next meeting.

**SUPPORTING INFORMATION** Distribute information to be discussed at least a week before the meeting so members have time to study that information. This information may be test data, research reports, etc. You shouldn't expect task force members to digest information just received and immediately make decisions.

**CONDUCT OF THE MEETING** As the person conducting the meeting, make sure that the discussion follows the agenda. New topics that arise may be discussed at the end of the meeting. Keep the discussion focused on the purpose of the task force. Try to base decisions on data. Sometimes data will indicate that a perceived problem does not exist. Try to draw out input from the quiet members of the task force. They may have valuable ideas. In addition, it is important to have buy-in by all task force members into whatever decisions the task force makes. Avoid having aggressive task force members dominate the discussion. The products of the task force should not only be workable but also should be a consensus that both industry and CDOT can be comfortable with. Within CDOT, task force products must have statewide buy-in. A recurring problem with CDOT standards is the lack of uniformity of statewide application that undermines the integrity and credibility of these standards.

Keep in mind that the Materials Advisory Committee and Specification Committee must approve any specification changes desired by the task force. The task force must develop the rationale and data needed to convince these technical committees.

Get commitments from task force members to do what needs to be done, to accomplish the purpose of the task force (action items). At the end of the meeting, review these action items. Define clearly who will do what by when. Finally, determine the date, time, and place of the next meeting, if possible.

**MINUTES** Someone should take notes at the meeting and produce detailed minutes. It is best for the note taker to not be the person conducting the meeting. It's too much for one person. Good minutes help avoid rehashing the same items at each meeting. Include in the minutes, decisions made on each topic. It is also good to describe areas of disagreement and any action that will be taken to resolve the disagreement. Include action items, listing who will do what by when. The final item in the minutes is the date, time, and place of the next meeting. Distribute minutes to task force members within two weeks of the meeting. It's often good to send minutes to your supervisor to keep them informed and to let them know what you're up to.

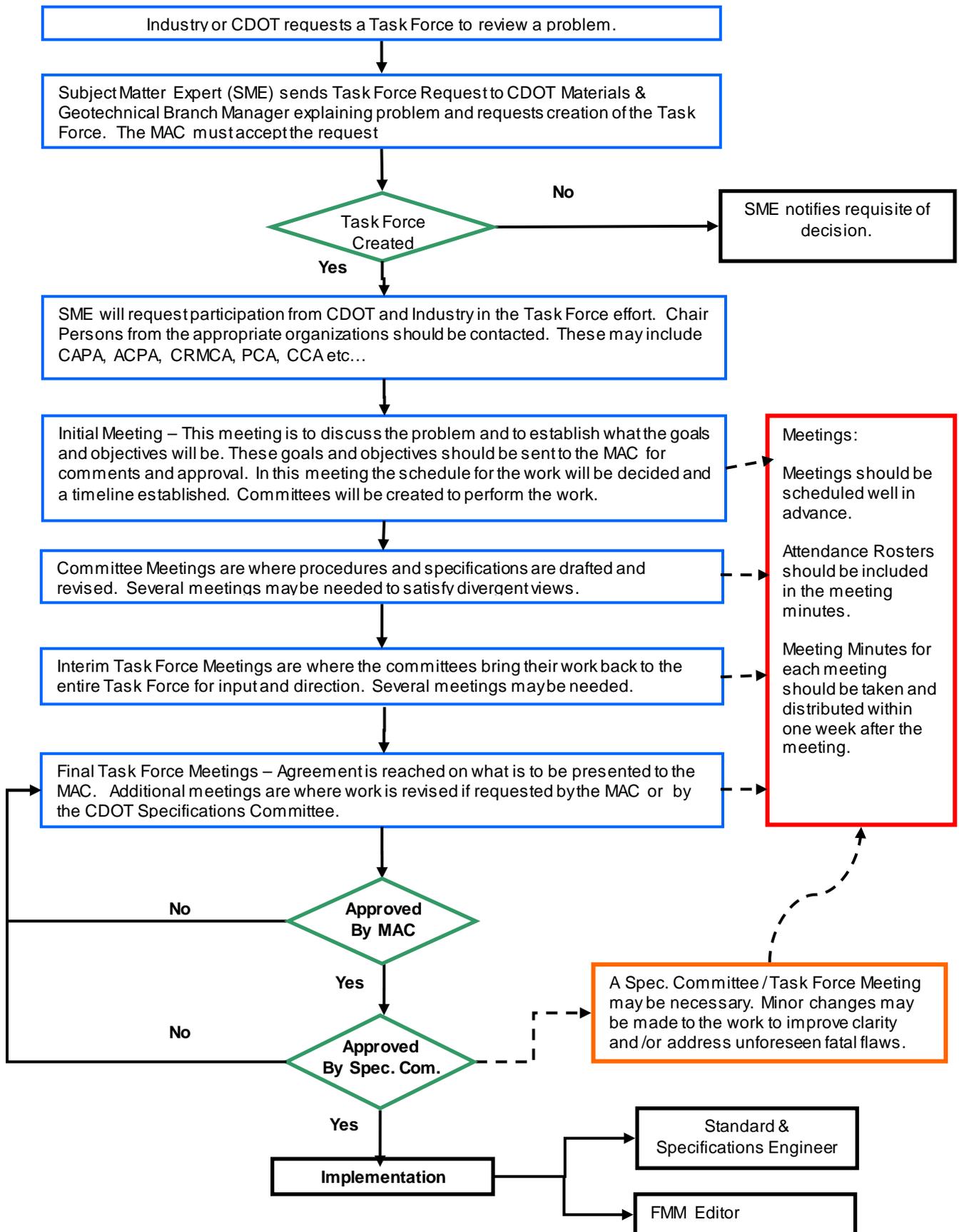
**DOCUMENT TASK FORCE RESULTS** Document the findings and changes made by the task force. This will be useful in the future to clarify the rationale behind CDOT specifications and standards. Documentation should include the purpose of the task force, problems identified, data collected, references reviewed, and finally changes made to CDOT specifications and standards. The MAC secretary shall maintain copies of this final report documenting task force results.

Some examples of successful products have been:

- Specifications and standards that are forwarded to the Specification Committee,
- Project selection guidelines that are forwarded to the Materials Advisory Committee and included in the Pavement Design Manual,
- Colorado procedures and practices that are forwarded to the Materials Advisory Committee and included in the Field Materials Manual,
- Research needs statements that are forwarded to the Research Branch for consideration as a formal research problem statement or a quick study, or

Information that is important enough to be shared broadly within CDOT is forwarded to the Project Development Area Engineers for distribution as a Construction Bulletin.

**The Task Force Process and Best Practices**



## Appendix C - Personnel Roster, Staff Materials & Region Materials - 21

### Central Materials Laboratory, 4670 North Holly Street, Unit A, Denver CO 80216- 6408

<u>Office/ Name</u>	<u>Title</u>	<u>Telephone</u>
<b>Materials &amp; Geotechnical</b>		
<b><u>Branch</u></b>		
Wieden, Craig	Materials & Geotechnical Engineer	303-398-6501
Gonzalez, Norma	Program Assistant	303-398-6502
	FAX	303-398-6504
<b>Asphalt Pavement</b>		
<b><u>Program</u></b>		
Stanford, Michael	Asphalt Pavement Engineer	303-398-6576
Trojan, Jason	Asphalt Support Engineer	303-398-6525
Lam, Johnny	Flexible Pavement & European Lab Manager	303-398-6533
Stephenson, Gregg	Bituminous - Chemical Lab Manager	303-398-6531
<b>Concrete Pavement Program &amp; etc., Soils &amp; Physical</b>		
<b><u>Properties Labs</u></b>		
Prieve, Eric	Concrete & Phy Prop. Engineer	303-398-6542
		(Cell) 303-204-8926
Niculae, Valentino	Concrete Support Engineer	303-398-6549
Roffe, Tony	Concrete Pavement Lab Manager	303-398-6541
		(Cell) 303-204-8926
Tchouban, Bryan	Soils Lab Manager	303-398-6590
Smith, Paul	CDOT Radiation Safety Officer (RSO), Pavement Deflection Technician [FWD], & M/D Gauge Calibration Tech	303-398-6547
		(Cell) 303-319-9557
Jiron, Kelvin	High Speed Profiler (HSP)	303-398-6548
<b>Pavement</b>		
<b><u>Design Program</u></b>		
Perkins, Melody	Pavement Design Engineer	303-398-6562
Goodale, Hailey	Pavement Design Support Engineer	303-398-6562
Keith Uren	Pavement Design Support Engineer	
Trujillo, Ed	Materials Publication Manager, MAC Secretary, Product Evaluation Coordinator (PEC)	303-398-6566
Hernandez, Tony	Materials Documentation Manager (Accreditations & Form #250s)	303-398-6563
<b>HQ OIT/Apps</b>		
<b><u>Site Manager/LIMS</u></b>		
	<b><u>Title</u></b>	<b><u>Telephone</u></b>
Brooks, Kyle	Site Manager Materials Trainer, QC/IA Program Manager	303-398-6528
Clark, Cheryle	Site Manager Materials / LIMS Support	303-398-6564

**Central Materials Laboratory, 4670 North Holly Street, Unit A, Denver CO 80216- 6408**

<b><u>Materials &amp; Geotechnical</u></b>	<b><u>Title</u></b>	<b><u>Telephone</u></b>
<b><u>Pavement Management Program</u></b>		
Conroy, Laura	Pavement Management Engineer	303-398-6579
Farrokhyar, Ali	Project Level Pavement Management	303-398-6577
Scoville, Janeth	Pavement Management	303-398-6580
Vacant	Network Level Pavement Manager	303-398-6565
<b><u>Soils &amp; Geotechnical Program</u></b>		
Thomas, David	Program Manager	303-398-6604
		Cell 303-807-7457
Nasiatka, Dave	Geotechnical Engineer	303-398-6586
		Cell 303-895-6485
Russell, Christopher	Geotechnical Engineer (Soils and PDA)	303-398-6587
		Cell 720-308-5462
Tarsar, Madeline	Geotechnical Engineer	303-398-6606
Pomeroy, Jamie	Geotechnical Engineer	303-398-6512
Zak, Steven	Drill Crew Foreman	303-365-7142
		Cell 720-793-4767
<b><u>Geohazards Program</u></b>		
Vacant	Program Manager	303-398-6601
		Cell 303-921-2634
Group, Robert	Engineering Geologist	303-398-6589
Taylor, D. (Beau)	Engineering Geologist	303-398-6588
Oester, Nicole	Engineering Geologist	303-398-6603

**Region 1 Materials Laboratory, 4670 North Holly Street, Unit B & C, Denver CO 80216- 6408**

<u>Office/ Name</u>	<u>Title</u>	<u>Location</u>	<u>Telephone</u>
<b><u>Region 1a, North &amp; Central Programs / Independent Assurance</u></b>			
Henry, Stephen	Region Materials Engineer	North Holly	303-398-6703
Mize, Issa	Asst. Region Materials Engineer	North Holly	303-398-6701
Jones, Macy	Pavement Designer	North Holly	303-398-6801
Ryal, Travis	Pavement Designer	North Holly	303-398-6507
Kelly, Brian M.	IA / Lab Manager	North Holly	303-398-6704
Collins, Robert	IA / Lab Technician	North Holly	303-398-6706
Robertson, Lane	IA / Lab Technician	North Holly	303-398-6705
FAX			303-398-6781

<u>Office/ Name</u>	<u>Title</u>	<u>Location</u>	<u>Telephone</u>
<b><u>Region 1b, South &amp; West Programs / Owner Acceptance</u></b>			
Chang, James	Region Materials Engineer	North Holly	303-398-6702
			(Cell) 303-883-0500
Hussain, Shamshad	Asst. Region Materials Engineer	North Holly	303-398-6802
			(Cell) 303-916-0890
Kevin Moore	Pavement Design	North Holly	303-398-6803
Gallegos, Michael	Region 1 Lab Manager	North Holly	303-398-6805
			(Cell) 303-918-6134
Jones, Robert "Brett"	Region 1 Lab Technician	North Holly	303-398-6806
Young, Ronald	Region 1 Lab Technician	North Holly	303-398-6807
	Region 1 Lab Technician	North Holly	
FAX			303-398-6781

**Region 2 Materials Laboratory (Pueblo) 5615 Wills Blvd., Pueblo Colorado, 81008**  
**\* Region 2 (Colorado Springs) 1480 Quail Lake Loop, Colorado Springs Co. 80906**  
**Region 2 (Lamar) 2402 S. Main, Lamar Co. 81052**

**Region 2**

Pieper, Jody	Region Materials Engineer	5615 Wills		719-562-5532
			(Cell)	719-248-2323
Mero, Jeri	Asst. Region Materials Engineer	5615 Wills		719-562-5509
			(Cell)	719-248-2323
Bergles, Robert "Buster"	Region 2 Lab Manager	5615 Wills		719-546-5778
			(Cell)	719-251-7834
Raebel, Richard "Rick"	Materials Document. Coordinator/ Region 2 Pavement Manager	5615 Wills		719-546-5787
			(Cell)	719-251-9112
Smith, Charles "Chuck"	IAT Lab	5615 Wills		719-546-5776
			(Cell)	719-251-7839
Armendariz, Mike	Region 2 Lab Technician Mobile Lab Technician	5615 Wills		719-546-5776
				719-546-5776
Vela, Derek	Region 2 Lab Technician	5615 Wills		719-546-5776
Schreiber, Mike	Colorado Springs Lab	*		719-227-3230
			(Cell)	719-688-2089
Story, Daniel "Dan"	Lamar Lab	2402 S. Main		719-336-3228
			(Microwave)	719-688-5447
			(Cell)	719-688-2095
Materials Lab FAX				
Colorado Springs FAX		*		719-227-3298
Lamar FAX		2402 S. Main		719-546-5701

**Region 3 2328 G Road, Grand Junction Co. 81501**  
**Region 3 (Materials Lab) 2328 G Road, Grand Junction Co. 81505**

**Region 3**

Golden, Coulter	Region Materials Engineer	2328 G Road	970-683-7561 (Cell) 970-901-7530
Vacant	Asst. Region Materials Engineer	2328 G Road	970-683-7563 (Cell) 719-661-2444
Mulumba, Jolene	Pavement Manager	2328 G Road	970-683-7567 (Cell) 970-642-8379
Kelly, Jen	IAT Lab	2328 G Road	970-683-7562 (Cell) 970-200-2880
Phipps, Darren	IAT Lab	2328 G Road	970-683-7566 (Cell) 970-623-9612

**Office/ Name****Title****Location****Telephone**

Rosedahl, Andy	Region 3 Lab	2328 G Road	970-683-7570 (Cell) 970-250-4769
Rowell, Dawn	Region 3 Lab	2328 G Road	970-683-7572
Walz, Chance	Region 3 Lab	2328 G Road	970-683-7571 (Cell) 970-986-9635
Morgan, Cindy	Finals Administrator / Materials Coordinator	2328 G Road	970-683-7575 (Cell) 970-270-2724
Villotti, JoAnn FAX	Data Technician	328 G Road	970-683-7560 970-683-7579

**Region 4 3971 W. Service Rd., Evans Co. 80620-2623**

**Region 4**

Heimmer, Steve	Region Materials Engineer	Region 4	970-350-2380 (Cell) 970-381-1446
Babaft Moore	Asst. Region Materials Engineer	Region 4	970-350-2380
Vacant	Asst. Region Materials Engineer	Region 4	970-350-2382 (Cell) 970-381-3447
Moore, Brandon	Pavement Manager	Region 4	970-350-2383 (Cell) 970-290-8252
Gonser, Steve	Lab Manager	Region 4	970-350-2384
Cloephil, Brett	Lab Technician	Region 4	970-350-2385
Folino, Dante	Lab Technician	Region 4	970-350-2246 (Cell) 720-877-5381
Mayhew, Todd	IAT Lab	Region 4	970-350-2334 (Cell) 970-380-0123
Davila, Paul	IAT Lab	Region 4	970-350-2381 (Cell) 970-397-2894
FAX		Region 4	970-350-2390

**Region 5 20581 US Highway 160 Durango Co. 81301**  
**Region 5 (Alamosa) 1205 West Ave. Alamosa, Co. 81101**

**Region 5**

Webb, Tim	Region Materials Engineer	Durango (Cell)	970-385-1625
Kemp, Beaux	Pavement Management Pavement Management	Durango (Cell)	970-385-1627
Murphy, Patrick	IA Lab Manager	Durango (Cell)	970-385-1624 970-759-5300
Wisner, Lisa	Lab Technician	Durango	970-385-1628
Morgan, Heather	Lab Technician	Durango	970-385-1658
Ramirez, Jacob	IAT Lab	Alamosa (Cell)	719-587-6520 719-588-3031
FAX		Durango	970-385-1610
FAX		Alamosa	719-587-6521

## Appendix D - Definitions-21

**NOTE:** Definitions applicable to a specific material may be found in the respective chapter.

**Acceptance Program** - All factors that comprise CDOT's determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection.

**Accredited Laboratory** - A laboratory that is accredited by the AASHTO Accreditation Program.

**Anionic** - Negatively charged, i.e. emulsions

**Batch** - A unit or subdivision of a lot, such as a mixer load of concrete, a batch of bituminous mix, or a square yard of the base course.

**Bias** - Constant error in one direction, which causes the average test result to be offset from the true average value.

**Calibration** - The act or process of determining the relationship between a set of standard units of measure and the output of an instrument or test procedure

**Cationic** - Positively charged, i.e. emulsions

**Central Laboratory Check Samples and Tests.** Random representative samples submitted to CDOT's Central and/or Region Laboratory to additionally evaluate the quality of field-produced products and materials, and to perform tests not within the capabilities of the Field and/or Region Laboratories.

**Check Sample** - A Replicate Sample, usually from Project Samples or Verification Samples, which is submitted to the Central or Region Laboratory for an independent check. Independent checks on HBP include Hveem Stability (CP-L5105), Lottman (CP-L5109), and Air Voids (CP-L5105). For Superpave mixes S, SX, and SG independent checks include volumetric properties at  $N_{design}$  and Hveem Stability (CP-L5106). The purpose of these samples is for the Central or Region Laboratory to verify the acceptability and quality of field-produced material and to perform tests that are not within the capabilities of the field.

**Coefficient of Variation** - The Standard Deviation is divided by the mean.

$$CV = \frac{\sigma}{\bar{X}}$$

**Comparative Sample** - One of several samples resulting from a closely controlled small Batch or increment which has been thoroughly mixed and then reduced by quartering or splitting into a number of Replicate Samples. For CDOT purposes the Central Laboratory will make Groups of Comparative Samples on various materials. One or more will be sent to each participating Region's Laboratory for testing to determine the acceptability of procedures, methods, and equipment.

**Control Chart** - Chart or graph, usually conspicuously displayed in the field materials laboratory where an up-to-date plot of Control and Verification Test results is kept.

**Control Sample** - A sample taken during the process from any of the components for a manufactured (constructed) product before being incorporated into the final mixture, or a sample taken from the final mixture or product before the material has reached its final position and condition in the completed construction.

**Correlation** - A statistical relation between two or more variables such that systematic changes in the value of one variable are accompanied by systematic changes in the other.

**Designated Agent** - An employee or employees of the State, local agency, or a consultant or independent laboratory which is employed, paid by, and/or directly accountable to CDOT or a public agency excluding the contractors' or vendors' personnel.

**F-test** - Compares the population variances.

**Group** - Replicate Test Specimens taken from the same Batch Sample.

**Independent Assurance Program (IA)** - Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Independent Assurance Sampling-Testing and Witnessing of Testing or Sampling** - A sample taken and tested, or a sample that is witnessed only at a random location or time, the point to be designated by: Region Laboratory personnel, or project personnel, or CDOT's designated agent not associated with Project Verification Sampling and Testing; or the Contractor's (or his representative) not associated with Project Quality Control Sampling and Testing; or by an FHWA Engineer. The person who designates the point for sampling and who performs the actual test may physically do the sampling or project testing personnel may do the sampling in the presence of the IA person. Certain specified IA samples may be witnessed only. These samples are to be taken in the presence of both the project and IA personnel. These samples shall be taken by the contractor's personnel or his representative. For more details and information, see the CDOT, Quality Assurance Program for Construction and Materials Sampling and Testing.

**Lot** - An isolated quantity of material from a single source. A measured amount of construction material is assumed to be produced by the same process.

**Mix Verification Testing** – After the mix design has been approved and production commences, the Department will perform a minimum of three volumetric verification tests to verify that the field-produced HMA conforms to the approved mix design.

**Nominal** – Representative value of a measurable property determined under a set of conditions, by which a product may be described.

**Nominal Maximum** - The size of aggregate in the smallest sieve opening through which the entire amount of specification aggregate is permitted to pass.

**Note:** For Item 403, the Nominal Maximum size should be defined as one sieve size larger than the first sieve to retain more than ten percent of the aggregate.

**Nominal Value** – A value assigned for convenient designation; existing in name only. An example is "2 by 4" lumber and a one-inch pipe.

**Owner Acceptance** – Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Owner Verification Testing** – Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Practice** – A definitive procedure for performing one or more specific operations or functions that do not produce a test result.

**Precision** - A generic concept related to the closeness of agreement between test results obtained under prescribed like conditions from the measurement process being evaluated.

**Process Control** – Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Professional Engineer Seals** – Obtained or used by license holders in the State of Colorado and shall be capable of leaving an impression representation on the engineering work. For size and type specifications, see Subsection 5.5.1 of the Bylaws and Rules from the Colorado State Board of Licensure for Professional Engineers and Professional Land Surveyors.

**Professional Engineer Stamps** – Obtained or used by license holders in the State of Colorado and shall be capable of leaving a permanent ink impression. The permanent inked impression can be done with a variety of stamps including the traditional rubber stamp and pad, self-inking, and pre-inked stamp all leaving a permanent inked impression. For size and type specifications, see Subsection 5.5.1 of the Bylaws and Rules from the Colorado State Board of Licensure for Professional Engineers and Professional Land Surveyors.

**Proficiency Samples** - Homogeneous samples that are distributed and tested by two or more laboratories.

**Quality Assurance (QA)** - Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Quality Control (QC)** - Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Qualified Laboratories** - Refer to Definitions (Section 3) within the Quality Assurance Procedures Chapter.

**Random Sample** - A sample drawn from a Lot in which each increment in the lot has an equal probability of being chosen.

**Random Sample, Stratified** - When a Lot is subdivided into approximately equal Sub-lots and samples are selected from each sub-lot by a Random process.

**Reasonable Conformance** - When construction and materials substantially comply with the plans and specifications. Clearly stated acceptance plans assist the Project Engineer in making his decision as to reasonable conformance.

**Recycled Pavement** – When used in the context of cold in-place recycled pavement or hot in-place recycled pavement, the asphaltic material is reworked within the footprint of the roadway without removing it off-site.

**Repeatability** - The range within which repeated measurements are made by the same operator on the same apparatus on Replicate Test Specimens. Essentially, the precision of the test.

**Replicate Samples or Test Specimens** - Multiple Samples or Test Specimens as nearly identical as possible, under the stated conditions, usually from a thoroughly mixed larger sample that has been reduced in size by quartering or splitting.

**Reproducibility** - The range within which check measurements by different operators on different apparatus should agree under definitely stated conditions. Usually performed on Test Specimens from Replicate Samples.

**Sample** - A small part of a Sub-lot or Batch, which represents the whole. A sample may be divided into several Test Specimens.

**Split Sample** - A sample taken and evenly divided to be tested by two or more individuals or laboratories.

**Standard Deviation (s)** - A measure of the dispersion of measurements from their average; the square root of the quantity of individual deviations from the mean, squared, summed, and divided by the number of samples minus 1.

$$s = \sqrt{\frac{\sum(\bar{X} - X)^2}{n - 1}}$$

**Standardization** - The adjustment of an instrument, before use, to an arbitrary reference value, or to a device that has been calibrated.

**State personnel** - An employee or employees of CDOT.

**Sub-lot** - The largest, clearly identifiable subdivision of a Lot. Usually specified in the Field Materials Manual Sampling Schedule as the largest quantity that may be represented by a single sample.

**System Basis, IA** - A system where the minimum frequency is based on a unit of material production and/or a unit of time.

**t-test** - Compares the population means.

**Test Method** – A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

**Test Portion** – The part of a material sample required for testing.

**Test Specimen** - That part of a material Sample that is prepared and tested. Usually obtained by reducing the sample by quartering, splitting, or taking an aliquot (usually a liquid portion removed from the whole) quantity.

**Variation** - Differences, due to any cause, in measured values of a measurable characteristic.

**Vendor** - A supplier of materials incorporated into the project, which is not the contractor. May or may not be the Manufacturer.

**Verification Sampling and Testing** - Sampling and testing performed to validate the quality of the product for acceptance.

**Verification Sample** - A sample used to decide the acceptability of the material being sampled. Reasonable Conformance and amount of payment will be based on this sample. The specifications designate the point of verification sampling. Refer to the Schedule.

**Viscosity** - Low viscosity = more fluid, High viscosity = more stiff

**Witness** – To witness is to observe an act of work, verifying that the work was performed and performed correctly. After observation, the witness is to testify by written and verbal communication protocols to CDOT Engineer in charge.

## Appendix E – Acronyms-21

3R	Resurfacing, Restoration, Rehabilitation
AAP	AASHTO Accreditation Program
AASHTO	American Association of State Highway and Transportation Officials
ABC	Aggregate Base Course
AC	Asphalt Content
ACI	American Concrete Institute
ACPA	American Concrete Pavement Association
ACPA	American Concrete Pipe Association
AI	Asphalt Institute
AIF	Asphalt Industry Forum
AMPT	Asphalt Materials Performance Test
AMRL	AASHTO Materials Reference Laboratory
APA	Asphalt Pavement Analyzer
APL	Approved Product List
AQL	Asphalt Quality Level
AV	APL – QML Verification
ARA	Asphalt Rejuvenating Agent
ARF	Access Request Form
ASTM	American Society of Testing and Materials
ATSSA	American Traffic Safety Services Association
BMP	Best Management Practices
CAGE	Colorado Association Geotechnical Engineers
CAPA	Colorado Asphalt Pavement Association
CAR	CDOT Application for Reporting
CBC	Concrete Box Culvert
CCA	Colorado Contractors Association
CCRL	Cement and Concrete Reference Laboratory
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CIP	Complete-in-Place
CIPR	Cold-in-Place Recycle
CIR	Cold-in-Place Recycle
COC	Certificate of Compliance
CM/GC	Construction Manager / General Contractor
CMO	Contract Modification Order
CP	Colorado Procedure
CP-L	Colorado Procedure – Laboratory

CPM	Counts Per Minute
CQL	Concrete Quality Level
CRS	Colorado Revised Statutes
CRSI	Concrete Reinforcing Steel Institute
CTP	Check Testing Program
CTR	Certified Test Reports
CTS	Compaction Test Section
D/A	Dust to Asphalt
DMS	Dynamic Message Sign
DRB	Dispute Resolution Board
DSR	Dynamic Shear Rheometer
EIS	Environmental Impact Statement
EOR	Engineer of Record
EPA	Environmental Protection Agency
EPE	Expert Product Evaluator
FAA	Fine Aggregate Angularity
FAPG	Federal-Aid Policy Guide
FDR	Full Depth Reclamation
FHWA	Federal Highway Administration
FIPI	Finding In the Public Interest
FIR	Field Inspection Review
FMM	Field Materials Manual
FOR	Final Office Review
FPOG	Flexible Pavement Operators Group
FQC	Field Quality Control
FWD	Falling Weight Deflectometer
HAZMAT	Hazardous Material
HBP	Hot Bituminous Pavement
HIPR	Hot-in-Place Recycle
HIR	Hot-in-Place Recycle
HITEC	Highway Innovative Technology Evaluation Center
HMA	Hot Mix Asphalt
HSP	High-Speed Profiler
IA	Independent Assurance Program
IAT	Independent Assurance Sampling and Testing
I/D P	Incentive/Disincentive Payment
IGA	Inter-Governmental Agreement
IRI	International Roughness Index
JMF	Job Mix Formula
JSA	Job Safety Analysis

LabCAT	Laboratory for Certification of Asphalt Technicians
LA	Local Agency
LACA	Local Agency Certification Acceptance
LCCA	Life Cycle Cost Analysis
LIMS	Laboratory Information Management System
LMTP	Laboratory Manual of Test Procedures
LOI	Loss on Ignition
LOS	Level of Service
LPA	Local Public Agency
MAC	Materials Advisory Committee
MCR	Minor Contract Revision
MLOS	Maintenance Level of Service
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MQL	Moving Quality Level
MRI	Mean Roughness Index
MSDS	Materials Safety Data Sheets
MUTCD	Manual on Uniform Traffic Control Devices
NCAT	National Center for Asphalt Technology
NCHRP	National Cooperative Highway Research Program
NDT	Non-Destructive Testing
NEPA	National Environmental Protection Act
NHS	National Highway System
NICET	National Institute for Certification of Engineering Technologies
NIST	National Institute of Standards and Technology
NOV	Notice of Violation
NPCA	National Precast Concrete Association
NPS	Non-Project Specific
NTPEP	National Transportation Product Evaluation Program
OA	Owner Acceptance
OGFC	Open Grade Friction Course
OIT	Office of Information Technology
OVT	Owner Verification Testing
PC	Process Control
PCCP	Portland Cement Concrete Pavement
PDAC	Project Delivery Advisory Committee
PEC	Product Evaluation Coordinator
PF	Pay Factor
PG	Performance Graded
PPM	Parts Per Million

ProMIS	Project Management Information System
PS&E	Plans, Specifications, and Estimate
PSI	Preliminary Site Investigation
PSP	Project Special Provision
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
QCP	Quality Control Plan
QIC	Quality Implementation Council
QL	Quality Level
QML	Qualified Manufacturers List
QPM	Quality Pavement Management
RAP	Reclaimed Asphalt Pavement (previously Recycled)
RAS	Reclaimed Asphalt Shingles
RE	Resident Engineer
RECP	Rolled Erosion Control Product
RIC	Research Implementation Council
RMAEC	Rocky Mountain Asphalt Education Center
RME	Region Materials Engineer
ROD	Record of Decision
ROW	Right of Way
RSAR	Roadway Surface Accomplishment Report
RSO	Radiation Safety Officer
RTD	Region Transportation Director
RTFO	Rolling Thin Film Oven
SHRP	Strategic Highway Research Program
SMA	Stone Matrix Asphalt
SME	Subject Matter Expert
SMM	SiteManager® Materials
SOW	Scope of Work
SpG	Specific Gravity
SSD	Saturated Surface Dry
SSP	Standard Special Provision
SUPERPAVE	Superior Performing Asphalt Pavements
TCLP	Toxicity Characteristic Leaching Procedure
TCP	Traffic Control Plan
TRM	Turf Reinforcement Mat
VCA	Voids in Coarse Aggregate
VFA	Voids Filled with Asphalt

VMA	Voids in the Mineral Aggregate
VMA	Viscosity Modifying Admixture
VTM	Voids in Total Mix
WASHTO	Washington Association of State Highway and Transportation Officials
WAQTC	Western Alliance for Quality Transportation Construction
WCTG	Western Cooperative Test Group
WMA	Warm Mix Asphalt

## Appendix F - Significant Publications-21

- AASHTO, Guide for Design of Pavement Structures
- American Concrete Institute
- Asphalt Institute, Performance Graded Asphalt Binder Specifications, and Testing Superpave Series No. 1 (SP-1)
- Asphalt Institute, Superpave Level 1 Mix design
- Asphalt Institute, Superpave Series No. 2 (SP-2)
- Department of Natural Resources, Construction Materials Rules, and Regulations
- CDOT, Construction Manual
- CDOT, Cost Data Books
- CDOT Field Materials Manual (FMM)
- CDOT Independent Assurance Manual (IA)
- CDOT, Local Agency Manual
- CDOT, Life Cycle Cost Analysis State-of-the-Practice
- CDOT, M & S Standards
- CDOT, Pavement Design Manual (PDM)
- CDOT, Pipe Material Selection Guide
- CDOT, Laboratory Manual of Test Procedures (LMTP)
- CDOT, Standard Specifications for Road and Bridge Construction
- Metropolitan Government Pavement Engineers Council (MGPEC) Pavement Design Standards and Construction Specification Manual

- Portland Cement Association, Design, and Control of Concrete Mixes, Thirteenth Edition

## **Appendix G - Colorado Procedures - Laboratory Numeric Order-20**

### **CP-Ls 2100      Chemical Unit Testing**

- CP-L 2103    Determining the Sulfate Ion Content in Water or Water-Soluble Sulfate Ion Content in Soil
- CP-L 2104    Determining the Chloride Ion Content in Water or Water-Soluble Chloride Ion Content in Soil

### **CP-Ls 2200      Bituminous Testing**

- CP-L 2202    Test of Protective Covering for Bridge Deck Waterproofing Membrane
- CP-L 2203    Pliability and Thickness of Prefabricated Reinforced Membrane
- CP-L 2210    Determining Toughness and Tenacity of Rubberized Asphaltic Materials
- CP-L 2211    Elastic Recovery
- CP-L 2212    Residue by Evaporation of Asphalt Emulsion
- CP-L 2213    Coating of Bitumen-Aggregate Mixtures
- CP-L 2214    Verification of Binder Acidity
- CP-L 2215    Effect of Heat and Air on a Moving Film of Asphalt

### **CP-Ls 3100      Soils Testing**

- CP-L 3101    DELETED > Replaced by AASHTO T 190 on 01-14-2016
- CP-L 3102    DELETED > Replaced by CP-L 3101 on 01-14-2013
- CP-L 3103    Specific Gravity of Soils
- CP-L 3104    Determining the Durability of Shales for Use as Embankments
- CP-L 3105    Grain Size Analysis of Soil for AASHTO Classification
- CP-L 3106    Grain Size Analysis of Soil for Unified Soil Classification System
- CP-L 3107    Determining the Resilient Modulus of Cohesive (Type 2) Soils

### **CP-Ls 3200      Geology Testing**

- CP-L 3201    Continuous Penetration Test

### **CP-Ls 4100      Concrete Testing**

- CP-L 4101    Preparing Concrete Blocks for Testing Sealants, for Joints and Cracks
- CP-L 4102    Specific Gravity and Absorption of Fine Aggregate
- CP-L 4103    Unrestrained Shrinkage of Concrete

**CP-Ls 4200 Physical Properties Testing**

- CP-L4209 Physical Testing of Quicklime, Hydrated Lime, and Limestone
- CP-L4211 Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- CP-L4215 Determination of Percent Moisture in Rock Salt
- CP-L4216 Determination of Salt Content of Sanding Materials

**CP-Ls 4300**

- CP-L4301 Surface Abrasion Resistance of Polyester Concrete
- CP-L4302 Methods of Test for Bonding Strength of Polyester Concrete to Concrete

**CP-Ls 5100 Flexible Pavement Testing**

- CP-L5100 HMA Testing Troubleshooting Guide
- CP-L5101 Verification of Laboratory Equipment Used to Test Bituminous Mixtures
- CP-L5106 Resistance to Deformation of Bituminous Mixtures by Means of Hveem Apparatus
- CP-L5109 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
- CP-L5110 Resilient Modulus Test ( $M_R$ )
- CP-L5111 Determining the Percent of Recycling Agent to Use for Cold Recycling of Asphalt Concrete
- CP-L5112 Hamburg Wheel-Track Testing of Compacted Bituminous Mixtures
- CP-L5114 French Rut Testing of Compacted Bituminous Mixtures
- CP-L5115 Preparing and Determining the Density of Bituminous Mixture Test Specimens Compacted by the Superpave Gyrotory Compactor
- CP-L5116 Linear Kneading Compaction of Bituminous Mixtures
- CP-L5117 Superpave Design for Hot Mix Asphalt
- CP-L5120 Determination of the Asphalt Binder Content of Bituminous Mixtures by the Ignition Method
- CP-L5140 Mix Design for Hot In-Place Recycling of Asphalt Pavements
- CP-L5145 Contractor Asphalt Mix Design Approval Procedures Utilizing RAP Millings from the Same Project
- CP-L5150 Adjusting Moisture Requirement to Hydrate Lime in Asphalt Mixes

**CP-Ls 5300 Nuclear Unit Testing**

- CP-L5301 Leak Wipe Procedure for Nuclear Gauges
- CP-L5302 Calibration of CDOT Nuclear Moisture / Density Gauges
- CP-L5303 Calibration Check of CDOT Nuclear Moisture / Density Gauges
- CP-L5304 Calibration of CDOT Nuclear Thin Layer Density Gauges
- CP-L5305 Leak Wipe Analysis for Nuclear Gauges
- CP-L5306 Certification of Consultant Nuclear Moisture / Density and Thin Layer Density Gauges

**Note:** CP-Ls 5900 series, Inspection, was transferred to the Staff Bridge Branch for their posting before the printing of the 2005 Laboratory Manual of Test Procedures publication.

### Appendix H - Metric Conversion Tables-20

**Conversion Factors - U.S. to Metric S.I.**

Quantity	The U.S.	Metric Unit (SI)	Multiply by
<b>Length</b>	mile	kilometer (km)	1.609 344
	yard	meter (m)	0.914 4
	foot	meter (m)	0.304 8
	foot	millimeter (mm)	304.8
	inch	millimeter (mm)	25.4
<b>Area</b>	acre	Hectares (ha)	0.404 685 6
	square yard	square meter (m <sup>2</sup> )	0.836 127 36
	square foot	square meter (m <sup>2</sup> )	0.092 903 04
	square inch	square millimeter (mm <sup>2</sup> )	645.16
<b>Volume</b>	cubic yard	cubic meter (m <sup>3</sup> )	0.764 555
	cubic foot	cubic meter (m <sup>3</sup> )	0.028 316 8
	cubic inch	cubic millimeter (mm <sup>3</sup> )	16 387.064
	gallon	Liter (L)	3.785 41
<b>Mass</b>	ton	metric ton (t)	0.907 184
	pound	kilogram (kg)	0.453 592
	ounce	gram (g)	28.3495
<b>Temperature</b>	°Fahrenheit	°Celsius	(°F-32) 5/9
<b>Pressure</b>	psi	kilopascals (kPa)	6.894 76

**Conversion Factors - Metric S.I. to the U.S.**

Quantity	Metric Unit (SI)	The U.S.	Multiply by
<b>Length</b>	kilometer (km)	mile	0.621 371
	meter (m)	yard	1.093 6
	meter (m)	foot	3.280 84
	millimeter (mm)	foot	0.003 28
	millimeter (mm)	inch	0.039 37

<b>Area</b>	Hectares (ha)	acre	2.471 054
	square meter (m <sup>2</sup> )	squareyard	1.195 99
	square meter (m <sup>2</sup> )	squarefoot	10.763 91
	square millimeter (mm <sup>2</sup> )	squareinch	0.001 55
<b>Volume</b>	cubic meter (m <sup>3</sup> )	cubic yard	1.307 95
	cubic meter (m <sup>3</sup> )	cubic foot	35.314 72
	cubic millimeter (mm <sup>3</sup> )	cubic inch	0.000 061
	Liter (L)	gallon	0.264 172
<b>Mass</b>	metric ton (t)	ton	1.102 31
	kilogram (kg)	pound	2.204 62
	gram (g)	ounce	0.035 274
<b>Temperature</b>	°Celsius	°Fahrenheit	(°C x 1.8) + 32
<b>Pressure</b>	kilopascals (kPa)	psi	0.145 038

**Metric Decimal Prefixes**

Prefix	Magnitude	Expression
kilo	10 <sup>3</sup>	1000 (one thousand)
milli	10 <sup>-3</sup>	0.001 (one thousandth)

For more information on Metric S.I. units see CDOT's *Metric Conversion Manual*. Other good references include AASHTO R1-91 and ASTM E 380-92.

**Sieve Sizes, English versus Metric**

<u>English</u>	<u>Metric</u>
3"	76.2 mm
2 ½ "	63.5 mm
2 "	50.8 mm
1 ½ "	38.1 mm
1 "	25.4 mm
¾ "	19.0 mm
½ "	12.7 mm
⅜ "	9.51 mm
# 4	4.75 mm
# 8	2.36 mm
# 16	1.18 mm
# 30	600 mu
# 50	300 mu
# 100	150 mu
# 200	75 mu

### Appendix I - Materials Testing Accuracy Criteria-20

The following table is the official testing accuracy criteria for the Colorado Department of Transportation and shall be strictly adhered to.

	MEASURE TO NEAREST	REPORT TO NEAREST	
<b>SOILS</b>	Sieve Analysis		
	(Except -#200).....	1.0 g.....	1%
	Minus No. 200.....	0.1 g.....	0.1%
	Atterberg Limits.....	0.01 g.....	1%
	Density.....	----	0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> )
	Relative Compaction.....	0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> ).....	0.1%
	Moisture Content		
	D/M Gauge.....	0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> ).....	0.1%
	Dry Weight.....	0.1 g.....	0.1%
	<b>BASE AGGREGATES</b>	Sieve Analysis	
(Except -#200).....		1.0 g.....	1%
Minus No. 200.....		0.1 g.....	0.1%
Atterberg Limits.....		0.1 g.....	1%
Density.....		----	0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> )
Relative Compaction.....		0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> ).....	0.1%
Moisture Content			
D/M Gauge.....		0.1 lb/ft <sup>3</sup> (1 kg/m <sup>3</sup> ).....	0.1%
Dry Weight.....		0.1 g.....	0.1%
<b>CONCRETE</b>		Sieve Analysis	
	(Except -#200).....	1.0 g.....	1%
	Minus No. 200.....	0.1 g.....	0.1%
	(*)Sand Equivalent.....	0.1.....	1 (*)
	Moisture in Aggregate.....	0.1 g.....	0.1%
	Air Content.....	----	0.1%
	Fineness Modulus.....	----	0.01
	Slump.....	----	1/4 inch (5 mm)
	Compressive Strength.....	1 psi (0.01 MPa).....	10 psi (0.1 MPa)
	Flexural Strength.....	1 psi (0.01 MPa).....	5 psi (0.05 MPa)
	Thickness.....	0.05 in (1.3 mm).....	0.1 in (2.5 mm)
	<b>BITUMINOUS PVMT.</b>	Moisture in Mix.....	0.1 g.....
Sieve Analysis			
(Except -#200).....		1.0 g.....	1%
Minus No. 200.....		0.1 g.....	0.1%
Asphalt Content			
(CP-L 5120).....		0.1 g.....	0.01%
(CP 85).....		1.0 g.....	0.01%
Hveem Stability.....		----	1
Voids in Mineral Aggregate.....		----	0.1%
Air Voids.....		----	0.1%
Lottman TSR.....		----	1%
Lottman Wet TS.....		1 lb.f (1 N).....	1 psi (1 KPa)
Lottman Dry TS.....		1 lb.f (1 N).....	1 psi (1 KPa)
Filler.....		0.1 g.....	0.1%
Specific Gravity.....		0.1 g.....	0.001
Specific Gravity			
D/M Gauge.....		----	0.001
Relative Compaction.....		0.01.....	0.1%

(\* )Report to the next highest whole number per CP 37.

## **UNDERSTANDING CALCULATIONS AND ROUNDING IN MS EXCEL**

### **UNDERSTANDING THE DIFFERENCE BETWEEN DISPLAYED VALUES AND UNDERLYING VALUES**

A Microsoft Excel® numeric cell entry can maintain precision to only a maximum of 15 digits. This means you can enter numbers longer than 15 digits into a cell, but Excel converts any digits after 15 to zeros.

The values that appear in formatted cells are called *displayed values*; the values that are stored in cells and appear in the formula bar are called *underlying values*. The number of digits that appear in a cell, its displayed value, depending on the width of the column and any formatting that you have applied to the cell.

When performing calculations, Excel always uses the underlying value, not the displayed value.

### **UNDERSTANDING THE ROUND FUNCTION**

MS Excel® ROUND function rounds a number to a specified number of decimal places, rounding digits less than 5 down and digits greater than or equal to 5 up. For example, the formula =ROUND(123.4567,3) returns 123.457. The number 123.457 is now the underlying value. Therefore, when performing calculations, the rounding function changes the values of the numbers that operate on.

### **UNDERSTANDING CDOT FORMS**

CDOT paper worksheet forms were made to conserve space and paper. The forms may have one or more test methods/procedures incorporated into the forms. Because of space limitations, it is not referenced to which method/procedure the test results are being reported. It is up to the material tester to determine which test methods/procedures are being tested and documented. Rounding, of intermediate results, is to be performed if the result is referencing a specific stand-alone test method/procedure that was reported previously. For example, if a moisture content has a designated AASHTO or ASTM test method/procedure, the results were rounded and documented previously. The following calculations on the form are to use the rounded moisture content. Then the final reported result is to be rounded and reported. If the moisture content was not reported previously but was calculated as an intermediate result, then use the underlying value.

Caution is needed when developing computerized worksheets using MS Excel® from CDOT forms. Each stand-alone AASHTO, ASTM, CDOT CP, or CPL has a rounded reported result. Computerized worksheets are to be analyzed that incorporate stand-alone test methods/procedures or if the intermediate result (underlying value) is to be used.

### **ROUNDING OF TEST DATA FOR DETERMINING CONFORMANCE WITH SPECIFICATIONS**

When calculating a test result from observed values and test data, rounding of intermediate values and quantities shall be avoided. As far as practicable with the calculating device used, carry out all calculations with the observed values exactly and round only the final result, which is reported as specified. Any final results used in further calculations shall be considered an intermediate quantity and the unrounded value is used.

**EXAMPLE:**

Find final results for Moisture Content, Dry Density and Percent Compaction:

- A = Observed wet weight of the moisture sample  
 = 182.4 gr.  
 B = Observed dry weight of the moisture sample  
 = 166.8 gr.  
 MD = Moisture/density relationship  
 = 115.4 pcf  
 WD = Observed wet density value  
 = 119.3 pcf  
 MC = Moisture Content (%)  
 DD = Dry density (pcf)  
 C = compaction (%)

$$MC = \frac{(A - B) * 100}{B} = \frac{(182.4 - 166.8) * 100}{166.8} = 9.4\%$$

Unrounded is 9.35252

$$DD = \frac{(WD * 100)}{(100 + MC)} = \frac{(119.3 * 100)}{(100 + 9.35252)} = 109.1 \text{ pcf}$$

Unrounded is 109.09671

$$C = \frac{DD}{MD} = \frac{109.09671}{115.4} = 94.53 \rightarrow 95\%$$

% compaction, a passing test

Recalculated using rounded MC:

$$DD = \frac{(WD * 100)}{(100 + MC)} = \frac{(119.3 * 100)}{(100 + 9.4)} = 109.0 \text{ pcf}$$

Unrounded is 109.04936

Recalculated using rounded DD:

$$C = \frac{DD}{MD} = \frac{109.0}{115.4} = 94.45 \rightarrow 94\%$$

% compaction less than 95 thus, a failing test

**Caution** When you change the precision of the calculations in a workbook by using the displayed (formatted) values, Excel permanently changes any constant values on the worksheets in the workbook. If you later choose to calculate with full precision, the original underlying values cannot be restored. It is advised to use full precision. If it is desired to use precision as displayed follow these default settings for the Excel workbook.

Excel 2007 & more current:

1. Click the **Office Button**, click **Excel Options**, and then click the **Advance** tab in the left column.
2. **When calculating this workbook**, select the **Set precision as a displayed** check box.

### Appendix J - Laboratory Test Time-21

The time listed is the interval from sample submittal at the Materials and Geotechnical Branch to the issuance of a report. Time spent while the sample is in transit is not included. Time spent while the report is in transit is not included. Test Time does not include weekends or state holidays.

ITEM NO.	DESCRIPTION	TEST TIME (WORKING DAYS)
203	<b>EMBANKMENT</b>	
	Gradation, Atterberg Limits, Moisture-Density Curve, Specific Gravity, R-Value, and Classification.....	16
	(This test time excludes a preliminary soil survey with more than 10 samples. Call for actual turnaround time.)	
	Sulfate testing.....	5
	Chloride testing.....	15
	Soil Resistivity testing.....	6
	pH testing.....	5
	Pipe Type Material Selection testing.....	15
206	<b>STRUCTURE BACKFILL, BED COURSE &amp; FILTER MATERIAL</b>	
	Class 1: Gradation, Atterberg Limits, Moisture-Density Curve and Specific Gravity.....	13
	Class 2: Gradation, Atterberg Limits, Moisture-Density Curve and Specific Gravity.....	14
	Bed Course: Gradation.....	5
	Filter Materials: Gradation.....	5
	Sulfate testing per the Schedule.....	5
	Chloride testing.....	15
	Soil Resistivity testing.....	6
	pH testing.....	5
301	Deleted	
304	<b>AGGREGATE BASE COURSE</b>	
	Gradation, Atterberg Limits, Moisture-Density Curve.....	15
	Gradation, Atterberg Limits, Moisture-Density Curve, Abrasion.....	16
	Gradation, Atterberg Limits, Moisture-Density Curve, and R-Value.....	20
	Gradation, Atterberg Limits, Moisture-Density Curve, Abrasion and R-Value.....	21
307	<b>HYDRATED LIME &amp; LIME TREATED SUBGRADE</b>	
	Hydrated Lime: Gradation.....	5
	Lime Treated Subgrade: Gradation, Atterberg Limits, PH, Optimum Lime Content, Moisture-Density Curve, and Unconfined Compression.....	20

ITEM NO.	DESCRIPTION	TEST TIME (WORKING DAYS)
403	<b>HOT MIX ASPHALT PAVEMENT</b>	
	Asphalt Content, Gradation, Stability, Lottman .....	7
	Gradation, Atterberg Limits, Specific Gravity .....	10
	Gradation, Atterberg Limits, Specific Gravity, Abrasion, Fractured Faces .....	12
	EuroLab: French and /or German Wheel Tracking Devices.....	9
409	<b>COVER COAT MATERIAL</b>	
	Gradation, Abrasion, Fractured Faces.....	6
411	<b>BITUMEN</b>	
	Asphalt Cement (not performance graded), Emulsion .....	5
	Performance Graded Asphalt Binder, Verification Testing.....	3
	Performance Graded Asphalt Binder, Complete Testing.....	6
412	<b>PORTLAND CEMENT CONCRETE PAVEMENT</b>	
	Aggregate Gradation & Abrasion.....	6
	Compressive Strength of Information Cylinders.....	*
	Compressive Strength at 7 Days.....	*
	Compressive Strength at 28 Days .....	*
	Compressive Strength of Drilled Cores .....	*
	Flexural Strength at 28 Days.....	*
	Mix Design, Review.....	3
	Sand Equivalent.....	5
	Note: * = The number of stipulated days plus 1 day for the report.	
504	<b>MECHANICALLY STABILIZED EARTH WALLS</b>	
	Gradation, Atterberg Limits, Moisture-Density Curve, Classification, Specific Gravity, and Direct Shear .....	14
506	<b>RIPRAP</b>	
	Specific Gravity.....	3
515	<b>WATERPROOFING MEMBRANE</b>	
	Various Laboratory Tests.....	11
601	<b>STRUCTURAL CONCRETE</b>	
	Aggregate, Gradation & Abrasion.....	6
	Aggregate Soundness with Sodium Sulfate.....	10
	Compressive Strength of Information Cylinders.....	1 *
	Compressive Strength at 7 Days.....	5 *
	Compressive Strength at 28 Days .....	20 *
	Compressive Strength of Drilled Cores .....	2 *
	Mix Design, Review.....	3 *
	Note: * = The number of stipulated days plus 1 day for the report.	
602	<b>REINFORCING STEEL</b>	
	Prestressing Strand.....	6

## **Appendix K - Establishing Lots or Process Control on the Project-20**

A lot is any well-defined quantity of material produced by essentially the same process through continuous production.

The standard size lot consists of 5 samples, but a lot may include as few as 3 or as many as 7 samples due to changes in production or when total quantities require more or less than 5 tests.

Establishing lots is not difficult when the production process and materials sources are uniform. When production begins under good process control and there is little need for plant adjustment, the first 5 samples should be used to establish the quantity represented by the first lot. Thereafter, each lot should contain 5 samples. More than a single day's run may be included if there is no significant change in the production process or raw material.

When the production process is erratic or out-of-control, establishing lots becomes a problem.

Often, the first few samples at the beginning of the production run will be erratic or off-target, and several major adjustments may be required before production is resumed. In such cases, these first few samples should be Lot No. 1. Then, after production levels out, 5 sample lots are to be used.

After the 5 sample lots have become routine, only a major production change or a quantity of material for which more or less than 5 samples are required should be cause for altering the number of tests.

## **Appendix L - Random Sampling-20**

The most important factor in obtaining information to enforce specifications is the action of sampling. It must be understood that unless the samples are chosen by probability sampling, the statistical methods may not be entirely applicable. Stratified Random Sampling should be used for this process. This is a method of random sampling that causes the samples to be spread more uniformly throughout the lot.

A predetermined schedule for random sampling should be developed for each project. If requested, the Central Laboratory will supply a schedule for random sampling. A random sampling schedule can also be developed using ASTM D 3665 and/or ASTM E 105 before the start of testing. See also CP 75.

It is realized that where scattered piecework is being done, such as tapers and gores, it may not always be possible to strictly conform to the above procedure. Judgment must be used and a reasonable attempt made to select samples without bias. Bituminous materials ordinarily shipped to the project in tank trucks are sampled in a slightly different manner than for most other materials. See Chapter 400 of the Field Materials Manual for a detailed description of the sampling and acceptance verification plan.

The location or time of sampling must be selected by a random method. This means the location or time of sampling must be predetermined without bias, such as by the use of a table of random numbers. Every load, ton, or square yard in the sub-lot must have an equal probability of being chosen. This means the sample location or time chosen must be accessible. It is not possible to obtain a probability sample from a stockpile of aggregates because samples cannot be taken from the interior of the pile. To sample such material properly, it must be sampled at randomly determined intervals either as it is placed in the pile or removed from the pile.

## Appendix M - Sample-Processing Procedure-20

Samples that are received, tested, and reported by the CENTRAL LABORATORY, are processed in the following manner:

### IDENTIFICATION

All materials and samples must be logged-in. Samples must be identified as to DATE RECEIVED, ITEM NUMBER, CONTRACT ID, PROJECT NUMBER, and NUMBER OF SAMPLES.

### SELECTION

The selection of samples is handled by field project personnel. Staff Materials is responsible for the testing of samples submitted by field personnel. The only exceptions to this are samples of asphalt cement and liquid asphalt. In this case, one sample out of five is selected at random. If this sample meets specifications, the other four are discarded. If not, the other four samples are tested and reported.

### CONDITIONING-

Samples that require conditioning will be conditioned per the appropriate test procedure.

### STORAGE

Samples will be stored in the proper environment before testing. An example of this is concrete cylinders, which must be stored (cured) in a 100% humidity environment.

### RETENTION

Samples of all materials will be retained for at least 2 weeks or until all issues are resolved. There is no retention of concrete cylinders.

### DISPOSAL

All materials which are not hazardous will be placed in the large roll-on / roll-off trash receptacle immediately behind the Laboratory. Hazardous materials will be handled per the Staff Materials procedure for handling hazardous materials.

## Appendix N - Use of Laboratory Check Tests on More Than One Project-20

Results of Laboratory Check Tests can be used and referenced to more than one project if the RME allows it and if the following criteria are met:

The source (pit, plant, supplier, and design mix) of material must be the same.

Construction must occur at approximately the same time on each project.

Example: Placing asphalt pavements on two separate projects from the same supplier. (Asphalt cement, portland cement, ARA additives, etc.)

Document the referenced laboratory check test on a CDOT Form #157 listing:

- The Project Number from which the tests were referenced.
- Check Test ID Number (unique for this activity)
- The plant where the material was produced.
- All of the ingredients in the product.
- The date the material was placed (on both projects).
- The Design Mix Number (if applicable).