Materials Procedures Committee Meeting

Meeting Date: 7/20/22 at 9:00a

Order	MP #	Champion	MP Title	Up for Vote?
1*	709.01.51	Preston	ACCEPTANCE CRITERIA FOR EPOXY COATED REINFORCING STEEL	y
		Description of Changes to MP 709.01.51	This update provides a general overhaul and streamlining of the acceptance and approval or epoxy rebar.	
2*	110.00.40	Hoskins	LAB INSPECTIONS	y
		Description of Changes to MP 110.00.40	To establish a standard format in the style, form, substance, and frequency of Materials Inspection Reports.	
3*	661.03.40	Lipscomb	CRITERIA TO APPROVE FINISHED ALUMINUM ROADWAY SIGNS.	y
		Description of Changes to 661.03.40	This MP was created to make the acceptance and approval process for finished signs more streamlined. MP 661.03.40 is dead, and will not be carried forward..but instead MP 661.02.40 will be presented as a re-write.	
4*	100.00.00	Brayack	PREPARING MATERIALS PROCEDURES	y
		Description of Changes to MP 100.00.00	Significant re-write to expand parameters, formatting and process flow for the creation and maintnenace of materials procedures.	
5*	Various	Brayack	RECONFIRMATION OF VARIOUS MPS. (At End of Packet with Directory)	y
		Description of Changes to Various MPs	This is the periodic reconfirmation of existing MPs. Other than address changes and some organization changes (Materials Section of Contract Administration), no other changes were made.	
6&	700.00.52	Moffitt	GUIDE FOR SOURCE RATING SYSTEM RELATIVE TO MAINTENANCE CONTRACTS	n
		Description of Changes to MP 700.00.52	This change updates the testing frequency for aggregate approved sources. Since we have changed to site manager we can no longer grade the producers on the last 20 samples. We now look at the weighted average of the past year. If a producer is removed from the A-1 list we have come up with a way to place them back on quicker if they begin to meet compliance. Also, the evaluation calculations are shown and explained.	
	*Up for Vote			
	&New			

Open Government Meetings Act

1. Notice on Secretary of State's Office
2. Agenda - Posted on MP Committee Webpage
3. Open Meeting - Public Can Attend
4. Mintues - Notes Taken and Posted
5. Voting - Delegates Can Vote For/Against

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

ACCEPTANCE CRITERIA FOR EPOXY COATED REINFORCING STEEL

1. SCOPE

1.1 To establish a procedure to qualify approved and non-approved coating manufacturers of epoxy coated reinforcement steel bars for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

1.3 To establish a procedure for transmitting such information to the districts and to contractors of WVDOH projects.

1.4 This procedure shall apply to epoxy coated steel furnished to West Virginia Division of Highways (WVDOH) projects and purchase orders. The Division may elect to use other control procedures when special conditions dictate.

2. APPLICABLE DOCUMENTS

a. *AASHTO M31 Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement, most recent edition.*

b. *ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars, most recent edition.*

c. ~~*AASHTO MP18 Standard Specifications for Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowel, most recent edition*~~. *WVDOH Form HL-468 – Preliminary Information for Technology/Product Evaluation.*

Commented [PCG1]: Delete AASTHO MP18 and replace with new product form

3. ACCEPTANCE PROCEDURE

3.1 With each shipment, the coating manufacturer shall provide shipping documents which contain either the coating manufacturer's "Approved Source" number or the approval number that was assigned ~~to the material as per Section 6~~.

4. ACCEPTANCE PROCEDURE FOR APPROVED SOURCE

4.1 For a manufacturer to be considered as a source of epoxy coated reinforcing steel bars, the manufacturer must submit a certification statement indicating their intention to be included on the WVDOH approved source list as an approved source of epoxy coated reinforcing steel.

4.2 The prospective source shall submit a certified statement that all material shipped to Division projects will conform to WVDOH specifications. This certified statement shall be signed by a representative of the coating manufacturer who has the authority to bind the company.

~~4.2~~4.2.1 ~~4.2.1~~ The manufacturer is to complete form HL-468 attainable from the website[1]: ~~https://transportation.wv.gov/highways/mcst/Pages/newproduct_evaluationprocedure.aspx~~ and submit it to the WVDOH Materials Control, Soils and Testing (MCS&T) Division new products email address, indicating intention to be included on the WVDOH APL as an approved source manufacturer of epoxy coated reinforcing steel bars.

Commented [PCG2]: Insert section 4.2.1 to introduce the New Product Procedure to this MP.

Commented [BDA3]: Add email address here

~~4.3 The prospective source shall have an acceptable historical record of compliance with WVDOH Specifications.~~

Commented [PCG4]: Delete Section 4.3. Check Section 4 numbering after this is deleted.

~~4.4~~4.3 All plain steel reinforcement to be coated shall be selected from an approved source list of plain reinforcement steel maintained by the WVDOH.

Commented [PCG5]: Add period end of sentence

~~4.5~~4.4 All epoxy powders used shall be selected from an approved source list of epoxy powders maintained by the WVDOH.

~~4.6~~4.5 A copy of the coating manufacturer's Concrete Reinforcing Steel Institute (CRSI) certificate must be submitted indicating conformance to CRSI specifications.

~~4.7~~4.6 Samples of epoxy coated reinforcement steel shall be obtained by WVDOH Division authorized personnel and shall have the epoxy component tested to ASTM A775 in WVDOH laboratories, unless other methods of verification such as material certifications are used should unforeseen circumstances arise.

Commented [BDA6]: From MP Committee: Clarify circumstances when second is going to be applicable or used.

~~4.8~~4.7 An inspection of the coating facility may be conducted at any time to reinforce confidence in the ability of the facility to produce a quality product.

~~4.9~~4.8 Once the above requirements are met, a laboratory approval number will be assigned to the coating facility to indicate WVDOH requirement conformance. This approval number shall be active for up to two years. Acceptance of a coater's facility can be verified by accessing the WVDOH online approved source lists.

4.9 Revocation of approved source status may result from revocation or expiration of CRSI Certification or furnishing material that does not comply with Specifications.

4.10 ~~4.11~~ The ~~WVDOH~~ Division will annually obtain three ~~(3)~~ rebar samples ~~yearly~~ from different production lots at each manufacturer on the WVDOH APL. These samples will be tested by the Division and used to evaluate whether the manufacturer will remain on the APL.

Commented [PCG7]: Add Section 4.11. This is our section to do yearly QA sampling and testing to make sure the product should remain on the APL.

4.10.1 If all three ~~none~~ of the samples meet specification requirements~~fail~~, the manufacturer will remain on the APL.

Commented [PCG8]: Look at this language again. Not sure if I like the way it sounds.

4.11.2 If one ~~(1)~~ of the three samples fails to meet specification requirements, the Division will obtain three additional rebar samples from the manufacturer~~resample~~. The Division will then test those

[1] https://transportation.wv.gov/highways/mcst/Pages/newproduct_evaluationprocedure.aspx

three samples, and if any of those three additional samples fail to meet specification requirements, the manufacturer will be removed from the APL.

~~4.10~~ 4.11.3 If more than one of the three annual ~~(1) two (2) or more~~ samples fails to meet specification requirements, the manufacturer will ~~need recertification or~~ be removed from the APL.

5. ACCEPTANCE PROCEDURE FOR NON-~~-~~APPROVED SOURCE

5.1 Epoxy coated steel bars that have been coated by a non-approved coating manufacturer shall require evaluation on a ~~lot by lot~~lot-by-lot basis under direct coverage, provided the material meets the following requirements.

5.2 A copy of the coating manufacturer's CRSI certificate must be submitted indicating current conformance to CRSI specifications.

5.3 Samples of epoxy coated reinforcement steel shall be obtained by WVDOH Division authorized personnel to be tested in WVDOH laboratories, unless other methods of verification such as material certifications are used.

5.4 The metallic component of epoxy coated steel bars shall be… ~~from an approved source as stated in Section 4.4.tested to conform to the requirements of AASHTO M31 or AASHTO MP18.~~

5.5 The epoxy component of epoxy coated steel bars shall be tested to conform to the requirement~~ ~~s of ASTM A775.

5.6 If the results of the testing reveal that the material is in full compliance with Specifications, an approval number will be issued by the Division that shall be affixed to the shipping documents.

~~5.6~~

6. DOCUMENTATION REPORT

6.1 An updated approved list of approved epoxy coated reinforcing steel bars, shall be issued once a year, but no longer than two. The list ~~, and~~ may~~can~~ be updated at any time with the addition of a new facility~~,~~ or with a removal of a facility.

6.2 A current approved list of epoxy coated reinforcing steel shall be available to all contractors, fabricators, and suppliers by accessing the West Virginia Department of Transportation Approved Source.[2]

Commented [PCG9]: correction

Commented [BDA10]: MP Committee comment: Submitted to whom

Commented [BDA11]: MP Committee - Talk about how these are to be accepted - another MP? Apl? Etc, be more specific. Difference between epoxy coating and steel bar,

Commented [PCG12]: language to read better since we already have section 4.4 tell us what these bars should be from an APL source.

Commented [PCG13]: Delte extra space between word and letter "s"

Commented [PCG14]: Make sentence read better

[2] http://transportation.wv.gov/highways/mcst/Pages/Listings_Sorted.aspx

Ron L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:Mp
~~RLS:Prl~~

Commented [PCG15]: Make sure to check all the spacing and numbers to make sure everything flows well once we accept the corrections.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PREPARING MATERIALS INSPECTION REPORTS

Commented [BDA1]: Include how this is going to be conveyed to FHWA.

1. PURPOSE

1.1 To set forth a Standard Materials Inspection Report Format

2. SCOPE

2.1 To establish a standard format in the style, form, substance, and frequency of Materials Inspection Reports

3. INSTRUCTIONS

3.1 Format - All Materials Inspection Reports shall conform to the format used herein. See attachments for templates for each section.

4. MEMORANDUM

4.1 A memorandum conforming to the format contained herein (attachment 1) shall accompany all Materials Inspection Reports

4.1.1 The memorandum shall be sent to the attention of the District Engineer or District Manager with a CC to the District Materials Supervisor and the District Construction Engineer.

4.1.2 The memorandum shall summarize the findings, observations, and deficiencies (if any) of the Inspection.

5. REPORT

Commented [BDA2]: FHWA suggestion - add an annual report - Matics to work on developing this process and to work with MD on this.

5.1 A report conforming to the format contained herein shall accompany all Materials Inspection Reports. (See attached Template for relevant section.)

6. FREQUENCY

6.1 Materials Inspections shall be conducted bi-annually in conformance with Federal Regulations (Federal Highways Administration's (FHWA's) Testing Program to Control Materials and Construction, section IV, Part 2A).

7. RESPONSE

7.1 The District Materials Supervisor shall respond within thirty (30) days of receipt of the Materials Inspection Report detailing what corrective action, if any will be taken to ensure compliance with testing procedures.

Signature Block

A

RLS:JhA
ATTACHMENTS

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

CRITERIA TO APPROVE FINISHED ALUMINUM ROADWAY SIGNS.

1. PURPOSE

1.1 To establish procedures for approving finished aluminum roadway signs or project markers acceptable for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

2. SCOPE

2.1 This procedure shall apply to all fabricators who assemble and produce aluminum roadway signs "*henceforth referred to as Fabricator*" either flat sheet or extruded and related hardware used in installation.

3. APPLICABLE DOCUMENTS

3.1 *WVDOH Specifications for roads and bridge section 661*

3.2 *WVDOH Sign Fabrication Manual.*

3.3 *WVDOH Design Guide for Signing.*

3.4 *WVDOH Approved products list "APL" for Aluminum Sheeting for traffic signs.*

3.5 *WVDOH Approved products list "APL" for retroreflective sign sheeting.*

Commented [BDA1]: Look into contract usage of temporary signs. Review 636. Dave L to check to see if this is applicable.

4. ACCEPTANCE PROCEDURE

4.1 With each shipment, of aluminum signs or sign hardware to a WVDOH project, the sign Fabricator shall provide shipping documents which contain a laboratory approval number reflecting materials have been inspected meeting quality specified by the WVDOH.

5. ACCEPTANCE PROCEDURE

5.1 For sign materials to be evaluated for acceptance, the Fabricator must comply with the following requirements.

5.2 An on-site investigation and evaluation will be conducted by a WVDOH Inspector at the Fabricator's distribution location prior to materials being shipped.

5.3 All bare aluminum blank sign material shall be obtained from the WVDOH APL for aluminum sheeting for traffic signs.

5.4 All retroreflective materials shall be obtained from the WVDOH APL for retroreflective sign sheeting.

Commented [BDA2]: Verify process for getting these on the APLs (reference the MP)

5.5 The Inspector shall verify the finished sign to be free of any visible defects to the reflective sheeting in the form of bubbling or misaligned borders or any defect in relation to the WVDOH Sign Fabrication Manual or the Design Guide for Signing issued by the WVDOH Traffic Engineering Division.

5.6 The Inspector is to verify that the finished sign matches the approved shop drawings from Traffic Engineering Division of the WVDOH

5.7 The Inspector will examine the workorder or invoice to verify items and quantities are correctly listed, and the Inspector will verify the document has listed the contract ID number to which the materials will be delivered.

5.8 The Inspector will examine the work order or invoice to verify APL numbers used for aluminum sheeting and retroreflective sheeting are listed, plus for tracking purposes the workorder or invoice must have a unique date or invoice number from the Fabricator.

5.9 If the evaluation of sign materials meets the above requirements, the Inspector shall approve the work order or invoice and issue a seven-digit Laboratory approval number indicating all sign materials and or hardware have been inspected.

5.10 If the evaluation of sign materials does not meet the above requirements, the Inspector shall issue a failing Laboratory number, plus report the reasons for not meeting specifications, Also, the Inspector shall inform the Fabricator not to ship items until the failing issues have been resolved.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PREPARING MATERIALS PROCEDURES

1. PURPOSE

1.1 To set forth instructions for drafting Materials Procedures (MP) concerning sampling, testing, reporting, and inspection.

1.1.1 To establish a numbering system for MPs.

1.1.2 To establish a styles guideline for MPs.

1.2 To establish a workflow for the creation, acceptance, and approval for MPs.

1.2.1 To setup a reconfirmation schedule for existing MPs.

1.3 To provide further guidance and clarification from that set forth in DD-105.

2. REFERENCED DOCUMENTS

2.1 *AASHTO Publications Style Manual and Process Guide*[1], *current edition.*

2.2 *WVDOH Document DD-105*[2].

3. NUMBERING GUIDELINES

3.1 A MP consists of a sequence of numbers such as 120.20.01.

3.1.1 The first set (three digits) of an MP are taken from the Standard Specifications Roads and Bridges to denote the general area to which the procedure applies.

3.1.2 The second set (two digits) of an MP are taken from the Standard Specifications Roads and Bridges denotes the particular area to which the procedure applies.

3.1.3 The third set (two digits) is defined by this Division thus:

- .00 - .09 Field Sampling
- .10 - .19 Pre-sampling (Source or Intermediate Points)
- .20 - .29 Testing
- .30 - .39 (For future designation)
- .40 - .49 Inspection
- .50 - .59 Quality Assurance System
- .60 - .69 Reporting (laboratory)
- .70 - .79 Reporting (issuance under master control)
- .80 - .89 (For future designation)
- .90 - .99 Miscellaneous

[1] https://materials.transportation.org/
[2] https://transportation.wv.gov/highways/engineering/Pages/Design-Directives.aspx

4. FORMAT GUIDELINES

4.1 The style guides for MPs shall follow the general guidelines established in Section 6.4.3 of "AASHTO Publications Style Manual and Process Guide Typography in Design." These guidelines are further refined in this document.

4.1.1 The font shall be Times New Roman, size 12, fully justified for all text except for the section title. The section title shall be all capital letters, fully justified, Times New Roman, size 12 and bold. There shall also be a horizontal line above this text.

4.1.2 The line numbering shall be as follows: "x." For a section title and "x.x" for a section paragraph. From here, follow the format of "x.x.x…" for additional layers of sub paragraphs. This document provides an example of the formatting.

4.1.3 Links shall be blue and clickable[3]. The link path shall also be included as a footnote. An example of this is demonstrated by the "blue and clickable" text and link above and the footer at the bottom of this page.

4.1.3.1 Any instances of an email address shall also be clickable and adhere the guidelines for a link.

4.1.4 Figure labels shall follow the guidelines of Section 2.1.4 of "AASHTO Publications Style Manual and Process Guide Typography in Design." This section states: "The title should be succinct noun or noun phrase that describes the figure, but does not provide unnecessary background information, nor repeat information found in the text." Do not abbreviate "Figure" and capitalize key words such; an example of this is as follows: "Conditions Determined to Be Pre-Existing."

4.1.4.1 Formatting for labels shall be the same as normal body text, except that "Figure X." shall be bold. All figure text shall be centered and located below the figure.

5. HEADER GUIDELINES

5.1 A standard numbering and indexing system shall appear in the upper right-hand corner shall of pages of all MPs. All header text shall be in "All Caps" format.

5.1.1 The letters MP shall appear first, denoting Materials Procedure. The number of the MP shall follow that text and be in the header of every page. The numbering of the MP shall follow the format as described in this document.

[3] https://transportation.wv.gov/highways/mcst/Pages/default.aspx

5.1.2 All MPs shall contain headers in manner described in this section. There are two instances of a header. If an MP has been reconfirmed, the header will follow the example in Figure 1. This includes the date the latest date the MP was approved, and the date of confirmation.

MP 700.00.00
JULY 6, 2020
RECONFIRMED: JULY 6, 2022
PAGE 1 OF 2

Figure 1 – MP Header with Approval Date and Reconfirmation Date

5.1.3 In the instance of either a new MP or an approved update to a MP, only the Director signature date (located at the end of the body section of the document) is in the header. A sample is provided in Figure 2.

MP 700.00.00
JULY 6, 2022
PAGE 1 OF 2

Figure 2 – MP Header With Approval Date

5.1.4 In the instance of an attachment, the first line of the MP header shall be in the format: MP XXX.XX.XX – ATTACHMENT. All other lines shall follow the guidelines previously described. This is demonstrated in Figure 3.

MP 100.00.00 - ATTACHMENT
JULY 6, 2020
PAGE 4 OF 5

Figure 3 – MP Attachment Header

5.1.4.1 In all instances, on all pages (do not use different first page), the text "PAGE X1 to X2" shall be last, with X1 being the current page and X2 being the total pages in the section. The main body and each attachment shall be considered a separate section (restart numbering on any new attachment instance).

---

6. MP APPROVAL PROCESS

6.1 In the instance of any MP Committee work, the champion is a person defined as the person who is the primary author, editor and/or liaison for the document. The champion is responsible for introducing and presenting the document. The champion is also responsible for addressing comments on the document.

6.2 Figure 4 provides an overview of the approval process of an MP. A larger version of this figure is provided in Attachment 1. First the document is brought to the MP committee chair (chair) by the champion. The document is distributed by the chair and discussed at the next MP committee meeting. After the document has been at a minimum of two consecutive MP meetings, the document may be approved by vote. The document is then reviewed, and if approved, signed by the Director of Materials Control, Soils and Testing Division (Director, MCS&T). The signed document is sent through DOH management for review and approval. Once the review is complete, the document is reviewed and affirmed by Federal Highways (FHWA). Once the document is affirmed by FHWA, the document is posted and distributed. If at any step an approving authority makes comments, the document is cycled back to the MP Committee meeting for review and another approval vote.

6.2.1 In the instance where a document has no content changes (editorial changes only), the MP committee may choose to vote to approve the document after one meeting. In this case, any voting member of the MP committee or the FHWA representative may veto this decision.

6.2.2 The details of the MP committee, including the submission process, distribution practices, and current voting members is available for review in Design Directive 105 and available at the WVDOH Engineering Webpage[4]

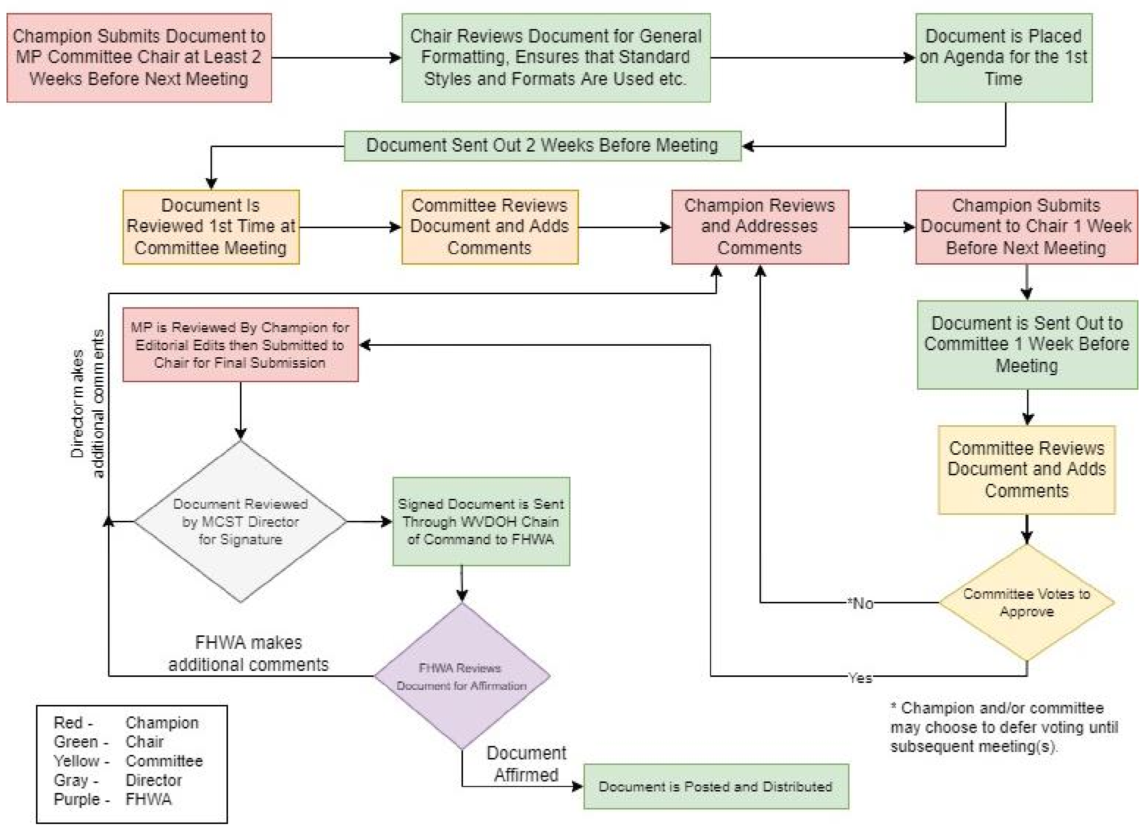


Figure 4 – MP Committee Meeting Flowchart

7. RECONFIRMATION PROCESS

7.1 Each MP shall be periodically reviewed for both relevancy and accuracy. At a minimum frequency, each MP shall be reviewed every 4 years by the applicable

[4] https://transportation.wv.gov/highways/engineering/Pages/Design-Directives.aspx

MCS&T Section Supervisor (Reconfirmation Champion). In the instances where there is no obvious Section Supervisor, the delegation of the review shall be the responsibility of the chair in liaison with the Director of MCS&T.

7.2 After reviewing the document, if the Reconfirmation Champion determines that no changes are required, they will submit the document to chair for reconfirmation. The reconfirmation shall be done by the voting members.

7.3 If approved by the Committee, the MCS&T Director shall review the document and if accepted, sign the document. Because no changes were made to this document, once the document is signed, it shall be posted and distributed.

8. POSTING AND DISTRIBUTION OF MPS

8.1 Active MPs are available on the WVDOH MCST MP Webpage[5]. The webpage shows the MP number, the title of the MP and the latest approval or reconfirmation date.

8.1.1 For each document (if appliable), an archived link is available to provide a documented history of updates. Figure 5 provides an example.

106.00.02 Archive	Procedure for Evaluation of New Products for Use In Highway Construction	November 2016

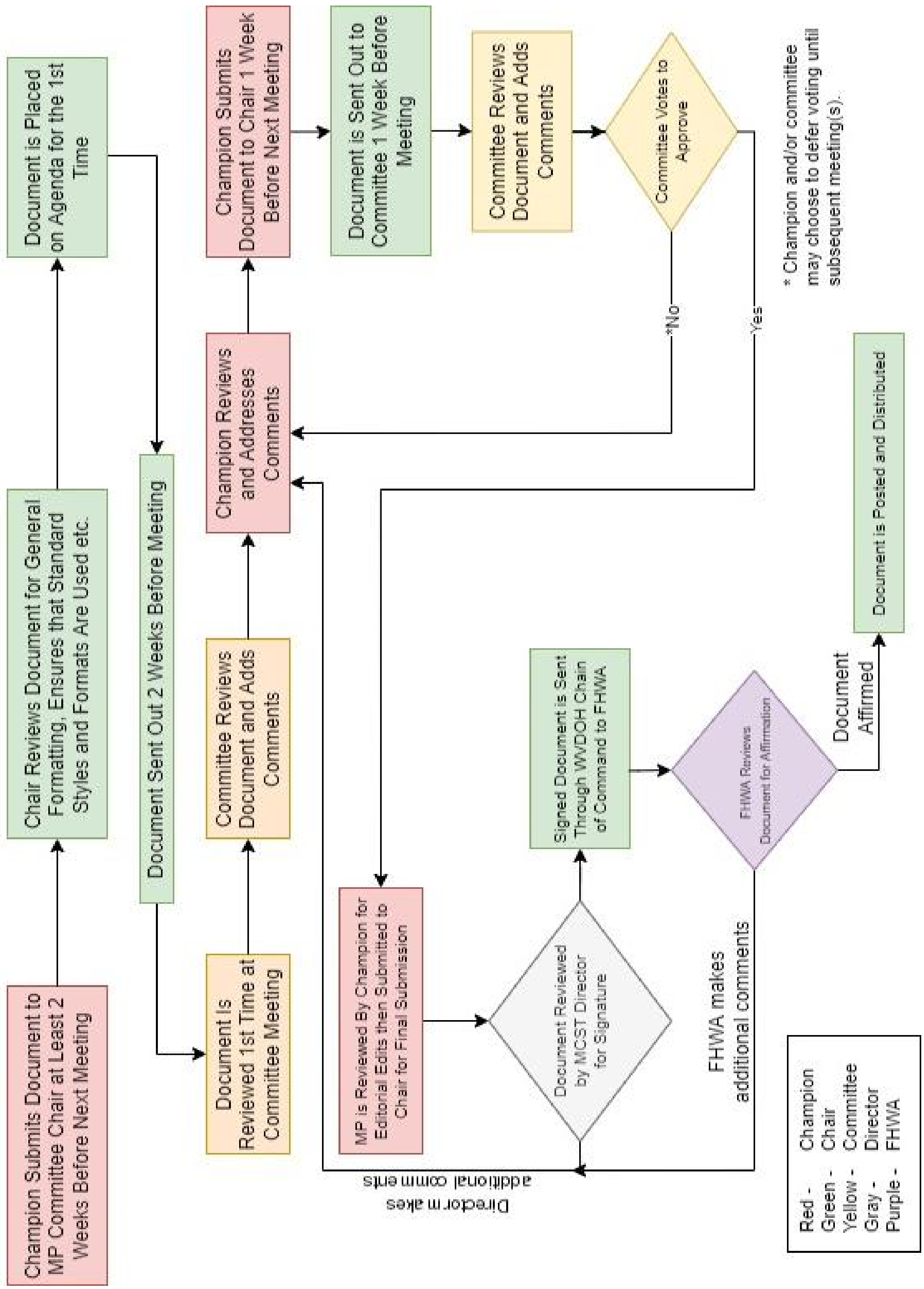
Figure 5 – MP Committee Webpage Example

8.2 When a document is affirmed by FHWA, the documents will be distributed to applicable Division Directors, District Engineer/Managers and District Material Supervisors.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

RLS:B
Attachment

[5] https://transportation.wv.gov/highways/mcst/Pages/WVDOH-Materials-Procedures.aspx



ATTACHMENT 1 – MP Committee Meeting Flowchart

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS, AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR SOURCE RATING SYSTEM RELATIVE TO MAINTENANCE CONTRACTS

1.0 PURPOSE

1.1 To set forth a standard method of source rating that will directly influence sampling and testing frequency requirements.

2.0 SCOPE

2.1 This procedure will apply only to aggregate ~~and bituminous concrete~~ sources when supplying material for Division pickup relative to Maintenance Contracts.

3.0 GENERAL COMMENTS

3.1 The capability to perform a sustained level of Quality Control in most producer plants ~~has~~ have been established. In this regard, it is desirable to pursue a Quality Assurance Program that recognizes this level of Quality Control.

4.0 DEFINITIONS

4.1 A-1 Source

4.1.1 This source must have at least 20 pieces of data ~~(~~on any combination of items ~~(~~within one~~-~~year preceding the evaluation date and have a compliance rating ~~(based on the most recent 20 pieces of data)~~ of at least 90%. The compliance rating evaluation will be based on data gathered from the preceding year.

4.1.2 The sampling and testing frequency shall be one sample per each week of shipment per item.

~~4.2 A-2 Source~~

~~4.2.1 This source shall encompass all production plants within the scope of this procedure that do not satisfy the requirements of 4.1.1.~~

~~4.2.2 The sampling and testing frequency shall be as per current specifications.~~

5.0 EVALUATION GUIDELINES

5.1 The evaluation of the level of Quality Control established by each plant will be performed and maintained current by Materials Control, Soils and Testing Division. Evaluation will be ~~monthly~~ quarterly and will be based on the availability of data and its compliance to controlling limits of acceptability.

5.2 The item data shall include all source item data and be calculated using a weighted average formula as follows:

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

5.3 In the event that a source fails to meet the compliance rating criteria the following protocol may be instated to expedite the process of reinstating the source to the A-1 list.

5.3.1 The source may request the item data used to determine if the source meets the compliance rating criteria for personal evaluation.

5.3.2 The source shall then use this data to evaluate the items and make any necessary corrections. Once the source maintains the corrections have been made it can request to be evaluated on item data collected quarterly.

5.3.3 If the quarterly data meets the compliance rating criteria the source will be returned to the A-1 source list. This process shall continue for the following three quarters at which point the source will then return to being evaluated on the preceding years item data.

~~5.2 Two lists will be generated each month:~~

~~5.2.1 Aggregate suppliers designated A-1~~

~~5.2.2 Bituminous suppliers designated A-1~~

5.3 Distribution of the updated A-1 list~~s~~ will be made available online, viewable at the WV DOH materials website under APL's quarterly. ~~to the District Materials Sections quarterly~~. ~~Further distribution will be as necessitated.~~

MP #	Directory of MPs for Reconfirmation
106.00.02	Procedure for Evaluation of New Products for Use In Highway Construction
106.00.20	West Virginia Acceptance Plan "A" Method of Estimating Percentage of Material of Construction That Will Fall Within Specification Limits
107.00.40	Determination Criteria for Monitoring Ground Vibrations in Residential Areas
107.02.22	Method of Test for Determining Photometric Requirements of Hazard Warning Lights
107.07.20	Procedure for Determining Specification Compliance of Hazard Warning Lights
107.07.21	Standard Method of Test for Determining Specific Intensity and Specific Brightness of Reflex Reflectors and Delineators
207.00.00	Procedure for Evaluating and Disposing of Bedrock Core
207.06.20	Chemical Analysis of Soil
207.07.20	Nuclear Field Density - Moisture Test for Random Material Having Less Than 40% of +3/4 Inch Material
212.01.20	STANDARD METHOD FOR DETERMINATION OF THE POINT LOAD STRENGTH INDEX OF ROCK
212.01.21	Test Method For Unconfined Compressive Strength Of Rock Core Specimens
212.02.20	Procedure for Determining a Reduced Unit Price to be Paid for Select Material for Back-Filling Which Does Not Conform to Grading Requirements of Governing Specifications
300.00.51	Procedural Guidelines for Maintaining Control Charts for Aggregate Gradation
401.02.21	Calibration of Thermometer and Pyrometer at Bituminous Concrete Mixing Plant (Replaced ML-11)
401.02.22	Design Testing of Hot-Mix Asphalt
401.02.24	Guide To Designing Hot-Mix Asphalt with Recycled Asphalt Pavement
401.02.28	Guide to Designing Hot-Mix Asphalt Using Superpave Volumetric Design
401.02.29	Guideline for Quality Control and Acceptance Requirements for Superpave Hot-Mix Asphalt
401.05.20	Compaction Testing of Hot-Mix Asphalt Pavement
402.02.20	Rapid Determination of the Polish Susceptible Carbonate Particle Content in Aggregates

403.01.50	Procedure for Determining a Reduced Unit Price To Be Paid for Penetration Macadam Which Does Not Conform to the Grading Requirements of Governing Specifications
601.03.20	Chemical Determination of Cement Content In Hardened Portland Cement Concrete
601.03.51	Standard Method for Determination of of the Total Solids In Portland Cement Concrete
601.03.52	Procedural Guidelines for Maintaining Control Charts for Portland Cement Concrete
601.04.20	Curing Concrete Test Specimens In The Field
601.11.20	Calibration and Operation of Rolling Ten Foot Straight Edge on Bridge Decks
603.06.20	Test Method for the Determination of Bond Strength Between Prestressing Steel Strand and Self-Consolidating Concrete
608.02.20	Qualitative Determination of Coating Materials On Metal
608.02.50	Quality Control of Steel Fence Posts Studded Tee Type
615.05.10	Preparing, Recording, and Transmitting Approved List of Welding Electrodes and Fluxes
616.14.50	Quality Assurance of Steel Bearing Piles Item 616, Steel Sheet Piling, Welded and Seamless Steel Pipe Piles
642.03.50	Contractor's Quality Control for Surface Waters & Sampling Procedures for Quality Determination
642.40.20	Analysis of Water
657.00.50	Method of Tensioning and Reporting Torque of Bolts for New and Replacement Breakaway Sign Supports
661.00.00	Chemical Analysis of Aluminum Alloy
661.02.40	Sampling, Inspection, and Acceptance of Signing Material
661.20.00	Procedure for Determining the Torque on Tamper Resistant Hardware
679.03.00	Total Solids In Latex Polymer Modified Concrete
700.00.01	Sampling and Testing of Materials at the Source (Replaced IM-17)
700.00.22	Procedure for Determining an Adjusted Pay Quantity Resulting From Excess Moisture in Aggregates

700.00.24	Nuclear Density Test By The Roller Pass Methods Revised December 2008
700.00.30	Certification of Batch Scales and Calibration of Standard 50 Pound Test Weights (Replaced ML-23)
700.00.50	Procedure for Monitoring the Contractor's Compaction Testing of Bituminous Concrete, Base Course, Embankment, Sub-Grade and Pipe and Structural Backfill
700.00.51	Guide for Quality Control and Acceptance Plans for Purchase Order Contracts for Stone and Aggregate and for Abrasives
700.00.52	Guide for Source Rating System Relating to Maintenance Contracts
700.00.53	Procedure for Evaluating Independent Assurance Samples With Acceptance Samples
700.00.54	Procedure for Evaluating Quality Control Sample Test Results with Verification Sample Test Results
700.00.55	Guidelines for Establishing Approved Lists of Material and Sources
700.01.01	Method of Field Sampling and Field Testing of Surface Water for Quality Determination
700.03.00	Procedure for Item Material Certification
700.03.50	Standard Method of Microscopic Determination of Air-Void Content
700.03.52	Triaxial Compressive Strength of Compacted Aggregate Specimens
700.04.10	Determining Application Rate of Ground Agricultural Limestone Based on pH Tests
700.05.10	Quality Assurance of Fertilizer at Source Fertilizer Acceptance Criteria
701.01.11	Determination of Chemical Constituents In Hydraulic Cement
702.00.20	Determining Free Moisture In Fine Aggregate Using a 26 Gram Speedy Moisture Tester
702.01.20	Method of Test for Percentage of Coal and Lightweight Pieces
702.01.25	Method of Test for Determining Mortar Strength
703.00.24	Source Control of Aggregate
703.00.28	Method of Determining Expansion Pressure of Compacted Aggregate Specimens

703.00.30	Method of Preparation and Evaluation of Aggregate for Soak Test
707.02.13	Quality Control of Steel Sign Post, Channel Bar Type
709.01.51	Acceptance Criteria for Epoxy Coated Reinforcing Steel
709.15.50	Certification of Fabricators of Corrosion Resistant Coated Dowel Bars in Basket Assembly
710.01.40	Acceptance Criteria to Designate a Wood Treatment Plant as an Approved Source of Wood Products
711.00.20	Paint Test Methods
711.00.21	Procedure for Approving Paint Formulations and Production Batches>
711.20.59	Inorganic Zinc Primer Quality Assurance Procedures
711.20.60	Intermediate Field Coat for Zinc Rich Systems
711.22.22	Zinc Rich Low VOC System
712.04.50	Quality Assurance of Guardrail Beams, Steel Guardrail Posts and Hardware (Replaced MP 707.02.12)
712.21.26	Procedure for Determining Random Location of Compaction Tests
713.01.50	Procedure for the Quality Assurance of Corrugated Metal Pipe (Replaced MP 707.02.10)
713.20.20	Silicon Content in AASHTO M-167 and M-218 Materials
715.07.20	Standard Method of Test for Determining the Quality of Water Used with Hydraulic Cement
715.27.20	Test Methods for Determining Moisture Content and Net Dry Weight of Wood Cellulose Fiber Mulches
715.28.50	Seed Acceptance Criteria

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR EVALUATING PRODUCTS FOR USE IN HIGHWAY CONSTRUCTION

1. SCOPE

1.1 Products / Processes not currently covered by the Standard Specifications or Supplemental Specifications are frequently presented to the Division by various producers or suppliers with a request that they be considered for use in our highway program. In order to facilitate handling of such requests in a uniform and expeditious manner, this Materials Procedure outlines the steps necessary for such product/process evaluation.

2. PROCEDURE

2.1 Consideration for New Product Evaluation shall be requested through completion of West Virginia Division of Highways (DOH) Form HL-468, "Preliminary Information for New Product Evaluation". Once completed, DOH Form HL-468 shall be submitted to the Materials Control, Soils and Testing Division (MCS&T) via email to the New Products Evaluation email address: DOHNewProducts@wv.gov .

The HL-468 Form can be found on the MCS&T Division's Materials Procedures Webpage[1].

2.2 Upon receipt of the completed Form HL-468, the Materials Control, Soils and Testing Division shall distribute to Districts/Divisions and/or other applicable parties for evaluation. This preliminary evaluation shall determine the need/usefulness of the product/process for various DOH applications. Any District/Division having an interest shall respond within fourteen calendar days to MCS&T. Lack of response from Districts/Divisions personnel, shall be indication of *"No Interest'.* A further, more detailed review/evaluation of the product may follow if deemed necessary and is detailed in bullet 2.2.2.

2.2.1 If the preliminary review indicates that the product may be accepted without further evaluation, the Manufacturer/Supplier shall be notified by MCS&T that no further information or testing is warranted.

2.2.1.1 Please note that such approvals may result in the need for new policies and guidance such as Standard Specifications, Special Provisions, or Design Directives and creation of such will need to be championed by the interested party and work through the applicable approval processes.

[1] https://transportation.wv.gov/highways/mcst/Pages/MP-100s.aspx

2.2.2 If the preliminary review indicates that further research or evaluation is warranted, the Manufacturer/Supplier shall be notified by MCS&T to submit additional types of information. This may include but not be limited to: samples, product specifications, certified test data, or product demonstrations. Product/Process demonstrations shall be coordinated by the Materials Control Soils and Testing Division with the results of any further testing/evaluation being submitted to all appropriate District/Division personnel for review and comment.

All comments shall be forwarded to MCS&T within fourteen calendar days. The Manufacturer/Supplier shall be notified by MCS&T of the result of these additional evaluations. Refer to bullets 2.2.1 and 2.2.1.1 if the product is acceptable and approved.

2.2.3 If the review indicates that the product is not acceptable, the Manufacturer/ Supplier shall be notified by MCS&T. The Manufacturer/Supplier shall not be permitted to submit the same product for evaluation during the same calendar year.

3. DOCUMENTATION

3.1 The Materials Control, Soils and Testing Division shall maintain a New Product Evaluation listing with the current status of all requests from the time of receipt. This listing shall include the product evaluation report number, which will provide information such as; the product name, the Manufacturer/Supplier, date of initial request, and the final action recommended. This listing will be maintained on the Division's website. Where applicable, product evaluation data will also be submitted for inclusion in the AASHTO Product Evaluation List (APEL).

3.1.1 Additionally MCS&T may evaluate the product/process after one year to determine if the performance or functionality of the product/process meets the desired results, goals or intentions of the DOH. Please note that any such evaluation may result in the product being removed from the New Product Evaluation Listing. This report will be in the form of a Materials Inspection Report (MIR) and this report will remain as part of the new products evaluation listing.

Ronald L. Stanevich, PE, Director
Materials Control, Soils & Testing Division

MP 106.00.02 Steward – Lab Support Section
RLS:Bp

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

WEST VIRGINIA ACCEPTANCE PLAN "A" METHOD OF ESTIMATING PERCENTAGE OF MATERIAL OF CONSTRUCTION THAT WILL FALL WITHIN SPECIFICATION LIMITS

1. SCOPE

1.1 This procedure provides a method of estimating the percentage of each lot or sublot of material, product, item of construction, or completed construction which may be expected to be within specified tolerances.

2. DEFINITIONS

2.1 Xi = the individual values under consideration.

2.2 n = the number of individual values under consideration.

2.3 X = the arithmetic mean, or average of values under consideration. X may be expressed as Xi/n, or the sum of the individual values divided by the number of individual values.

2.4 R = the range, or the difference between the largest and smallest values under consideration.

2.5 Q = Quality Index, found by subtracting the average, X, from the upper or lower tolerance limit and dividing by the range, R.

2.6 P = Percent within tolerance.

3. PROCEDURE

3.1 Locate n sampling positions on the lot, or sublot, in a random manner.

3.2 Make a measurement at each position, or take a test portion and make the measurement on the test portion.

3.3 Average all measurements to find X.

3.4 In cases where n is less than 10, find R by subtracting the smallest value from the largest value in the group of measurements.

3.5 In cases where n is equal to or greater than 10, arrange the measurements in the order in which they were taken and divide into subgroups of 5 each. Find R for each subgroup, add these values, and divide by the number of subgroups to find R.

3.6 Find the Upper Quality Index, QUX by subtracting the average, X, of the measurements from the upper tolerance limit, U, and dividing the result by R or R.

Qu = v (Equation 1)

3.7 Find the Lower Quality Index, QL, by subtracting the lower tolerance limit, L, from the average, X, and dividing by R or R.

QL = R or -R (Equation 2)

3.8 Estimate the percentage, Pus that will fall within the upper tolerance limit by entering the-tables of Attachment l, with Qu, using the column appropriate to the total number, n, . of measurements.

3.9 Estimate the percentage, PL, that will fall within the lower tolerance limit by entering the tables of Attachment 1, with QLS using the column appropriate to the total number, n, of measurements.

3.10 In cases where both Upper, U, and Lower, L, tolerance limits are concerned, the total percentage, P, of the lot or sublot estimated to fall within tolerances is the sum of the percentage, Pu, within the upper limit, U, and the percentage, PL, within the lower limit, L, subtracted from 100.

P (Pu + PL) - 100 (Equation 3)

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 106.00.20 Steward – Materials Control Section
RLS:B
Attachment

Table 106-2

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE
(RANGE METHOD)
(Revised 2/68)

Percent Within Tolerance	NEGATIVE VALUES OF Q_U or Q_L												
	n=3	n=4	n=5	n=6	n=7	n=10*	n=15*	n=25*	n=30*	n=35*	n=40*	n=50*	n=60*
20	0.49	0.40	0.36	0.33	0.31	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
19	0.50	0.42	0.37	0.34	0.32	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38
18	0.51	0.43	0.38	0.35	0.33	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
17	0.52	0.44	0.40	0.36	0.34	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41
16	0.53	0.46	0.41	0.38	0.36	0.42	0.42	0.42	0.43	0.43	0.43	0.42	0.42
15	0.54	0.47	0.42	0.39	0.37	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
14	0.54	0.48	0.44	0.40	0.38	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46
13	0.55	0.50	0.45	0.42	0.40	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.48
12	0.56	0.51	0.46	0.43	0.41	0.48	0.49	0.50	0.50	0.50	0.50	0.50	0.50
11	0.57	0.52	0.48	0.45	0.43	0.50	0.51	0.52	0.52	0.52	0.52	0.52	0.52
10	0.58	0.54	0.50	0.46	0.44	0.52	0.53	0.54	0.54	0.54	0.54	0.55	0.55
9	0.58	0.55	0.51	0.48	0.46	0.54	0.55	0.56	0.57	0.57	0.57	0.57	0.57
8	0.59	0.56	0.53	0.49	0.47	0.57	0.58	0.59	0.59	0.59	0.59	0.60	0.60
7	0.59	0.58	0.55	0.51	0.49	0.59	0.61	0.61	0.62	0.62	0.62	0.62	0.62
6	0.59	0.59	0.57	0.53	0.51	0.62	0.63	0.64	0.65	0.65	0.66	0.66	0.66
5	0.60	0.60	0.58	0.55	0.53	0.64	0.66	0.68	0.68	0.69	0.69	0.70	0.70
4	0.60	0.62	0.60	0.57	0.55	0.68	0.68	0.72	0.73	0.73	0.73	0.74	0.74
3	0.60	0.63	0.62	0.59	0.58	0.71	0.74	0.77	0.78	0.78	0.78	0.79	0.79
2	0.60	0.64	0.65	0.62	0.61	0.76	0.80	0.83	0.84	0.85	0.85	0.86	0.86
1	0.60	0.66	0.66	0.65	0.65	0.82	0.88	0.93	0.94	0.95	0.95	0.97	0.97

*When n ≧ 10, the samples are arranged consecutively in subgroups of five, the range (R) of each subgroup determined, and then the average range ($\overline{R}$) of all subgroups computed for use in finding Q_U or Q_L.

Table 106-3

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE
(RANGE METHOD)
(Revised 2/68)

Percent Within Tolerance	NEGATIVE VALUES OF Q_U or Q_L												
	n=3	n=4	n=5	n=6	n=7	n=10*	n=15*	n=25*	n=30*	n=35*	n=40*	n=50*	n=60*
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	0.09	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
40	0.19	0.13	0.11	0.10	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
39	0.20	0.15	0.13	0.11	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
38	0.22	0.16	0.14	0.12	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
37	0.24	0.17	0.15	0.13	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
36	0.26	0.19	0.16	0.15	0.13	0.15	0.16	0.15	0.15	0.15	0.15	0.15	0.15
35	0.27	0.20	0.17	0.16	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
34	0.29	0.21	0.18	0.17	0.15	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
33	0.31	0.23	0.19	0.18	0.16	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
32	0.32	0.24	0.21	0.19	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
31	0.34	0.26	0.22	0.20	0.18	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
30	0.36	0.27	0.23	0.21	0.19	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23
29	0.37	0.28	0.24	0.22	0.20	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
28	0.39	0.30	0.25	0.23	0.22	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
27	0.40	0.31	0.27	0.24	0.23	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27
26	0.41	0.32	0.28	0.25	0.24	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
25	0.43	0.34	0.29	0.27	0.25	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
24	0.44	0.35	0.30	0.28	0.26	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
23	0.46	0.36	0.32	0.29	0.27	0.32	0.32	0.31	0.31	0.32	0.32	0.32	0.32
22	0.47	0.38	0.33	0.30	0.28	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
21	0.48	0.39	0.34	0.31	0.29	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35

*When $n \geq 10$, the samples are arranged consecutively in subgroups of five, the range (R) of each subgroup determined, and then the average range ($\bar{R}$) of all subgroups computed for use in finding Q_U or Q_L.

Table 106-4

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE
(RANGE METHOD)
(Revised 2/68)

Percent Within Tolerance	POSITIVE VALUES OF Q_U or Q_L												
	n=3	n=4	n=5	n=6	n=7	n=10*	n=15*	n=25*	n=30*	n=35*	n=40*	n=50*	n=60*
79	0.48	0.39	0.34	0.31	0.29	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35
78	0.47	0.38	0.33	0.30	0.28	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
77	0.46	0.36	0.32	0.29	0.27	0.32	0.32	0.31	0.31	0.32	0.32	0.32	0.32
76	0.44	0.35	0.30	0.28	0.26	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
75	0.43	0.34	0.29	0.27	0.25	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
74	0.41	0.32	0.28	0.25	0.24	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
73	0.40	0.31	0.27	0.24	0.23	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27
72	0.39	0.30	0.25	0.23	0.22	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
71	0.37	0.28	0.24	0.22	0.20	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
70	0.36	0.27	0.23	0.21	0.19	0.22	0.23	0.23	0.23	0.23	0.23	0.23	0.23
69	0.34	0.26	0.22	0.20	0.18	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
68	0.32	0.24	0.21	0.19	0.17	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
67	0.31	0.23	0.19	0.18	0.16	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
66	0.29	0.21	0.18	0.17	0.15	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
65	0.27	0.20	0.17	0.16	0.14	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
64	0.26	0.19	0.16	0.15	0.13	0.15	0.16	0.15	0.15	0.15	0.15	0.15	0.15
63	0.24	0.17	0.15	0.13	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
62	0.22	0.16	0.14	0.12	0.11	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
61	0.20	0.15	0.13	0.11	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
60	0.19	0.13	0.11	0.10	0.09	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
55	0.09	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*When $n \geq 10$, the samples are arranged consecutively in subgroups of five, the range (R) of each subgroup determined, and then the average range ($\bar{R}$) of all subgroups computed for use in finding Q_U or Q_L.

Table 106-5

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE
(RANGE METHOD)
(Revised 2/68)

Percent Within Tolerance	POSITIVE VALUES OF Q_U or Q_L											
	n=3	n=4	n=5	n=6	n=7	n=10*	n=15*	n=25*	n=30*	n=35*	n=40*	n=50*	n=60*
99	0.60	0.66	0.66	0.65	0.65	0.82	0.88	0.93	0.94	0.95	0.95	0.97	0.97
98	0.60	0.64	0.65	0.62	0.61	0.76	0.80	0.83	0.84	0.85	0.85	0.86	0.86
97	0.60	0.63	0.62	0.59	0.58	0.71	0.74	0.77	0.78	0.78	0.78	0.79	0.79
96	0.60	0.62	0.60	0.57	0.55	0.68	0.68	0.72	0.73	0.73	0.73	0.74	0.74
95	0.60	0.60	0.58	0.55	0.53	0.64	0.66	0.68	0.68	0.69	0.69	0.70	0.70
94	0.59	0.59	0.57	0.53	0.51	0.62	0.63	0.64	0.65	0.65	0.65	0.66	0.66
93	0.59	0.58	0.55	0.51	0.49	0.59	0.61	0.61	0.62	0.62	0.62	0.62	0.62
92	0.59	0.56	0.53	0.49	0.47	0.57	0.58	0.59	0.59	0.59	0.59	0.60	0.60
91	0.58	0.55	0.51	0.48	0.46	0.54	0.55	0.56	0.57	0.57	0.57	0.57	0.57
90	0.58	0.54	0.50	0.46	0.44	0.52	0.53	0.54	0.54	0.54	0.54	0.55	0.55
89	0.57	0.52	0.48	0.45	0.43	0.50	0.51	0.52	0.52	0.52	0.52	0.52	0.52
88	0.56	0.51	0.46	0.43	0.41	0.48	0.49	0.50	0.50	0.50	0.50	0.50	0.50
87	0.55	0.50	0.45	0.42	0.40	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.48
86	0.54	0.48	0.44	0.40	0.38	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.46
85	0.54	0.47	0.42	0.39	0.37	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
84	0.53	0.46	0.41	0.38	0.36	0.42	0.42	0.42	0.43	0.43	0.43	0.42	0.42
83	0.52	0.44	0.40	0.36	0.34	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.41
82	0.51	0.43	0.38	0.35	0.33	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
81	0.50	0.42	0.37	0.34	0.32	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38
80	0.49	0.40	0.36	0.33	0.31	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36

*When $n \geq 10$, the samples are arranged consecutively in subgroups of five, the range (R) of each subgroup determined, and then the average range ($\overline{R}$) of all subgroups computed for use in finding Q_U or Q_L.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

DETERMININATION CRITERIA FOR MONITORING GROUND VIBRATIONS IN RESIDENTIAL AREAS

1. PURPOSE

1.1 To establish a procedure for event inspection, recording, and determination of possible damaging vibrations in structures caused by highway traffic.

2. SCOPE

2.1 This procedure shall apply to property or areas that have been requested to be instrumented to assist in the determination of possible vibration damage. The Division mayelect to use other control procedures if special conditions dictate.

3. REFFERENCED DOCUMENTS

3.1 *Other Standards:*

- Bureau of Mines Report of Investigations #8507 Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting by D.E. Siskind, M.S. Stagg, J.W. Kopp, and C.H. Dowding.
- Federal Highway Administration Report, Vibrations Induced by Construction Traffic, a historic case study by Henwood and Khamis Y. Haramy.
- 1996 Report on Estimated Airblast and Blast-Related Vibration at the Lincoln Project, Placer County, California. Green Valley, Arizona by W. L. Bender.

4. APPARATUS AND EQUIPMENT

4.1 One electronic recording seismograph capable of operation for at least three days of continuous monitoring. This device may be all self contained or have separate transducer sensors.

4.2 A power source such as a battery, or AC power outlet suitable to operate seismograph for approximately one week of continuous monitoring, if required.

4.3 A water resistant, vented protective covering to prevent moisture build-up if seismograph is used in an outside environment.

4.4 Two small sandbags weighing approximately 15 lbs each, to maintain stability in mounting seismograph when monitoring inside a structure.

4.5 A power transfer cable capable of transferring power from auxiliary battery to seismograph device.

4.6 A leveling plate to attach to the seismograph when used indoors to provide better coupling and leveling to structure.

4.7 If recording seismograph is used outside for monitoring, ground spikes may be used as per manufactures recommendations.

5. MONITORING PROCEDURES

5.1 Adjust seismograph to manufacturer’s recommendations for monitoring ground vibrations, with emphasis on setting Geo trigger minimum level at 0.5 inches per second, and Geo trigger maximum range at 10.00 inches per second. Additionally, when monitoring device is active it must be placed as level as possible.

5.2 When locating seismographic device inside or outside a structure, the most preferable method for measuring vibration is to direct couple the geophone transducer device to a structure. This may not be possible due to physical or property owner considerations.

5.3 For monitoring inside a structure or residence, place seismograph recording sensors in a non-obtrusive location away from pets or other possible interference. Place preferably on a hard surface such as a hardwood floor, using small sandbags to stabilize device if a direct coupling with structure is not possible.

5.4 If device is used for outside monitoring, use ground spikes attached to geophone sensors and firmly place in level soil, making a tight firm fit between the sensor and ground then place a 30lb sand bag on sensor to secure it, or bury geophone sensor completely, taking notice to place seismograph in area not to be disturbed by interference such as lawn mowing or children’s play areas. Additionally, locate in a manner not to attract attention and to discourage theft.

5.5 Once a location has been chosen to place geophone transducer sensors, make sure sensor transducer is oriented as per manufacturer’s specifications to possible source of vibrations.

5.6 Once geophone transducers are properly seated and power supply is sufficient, activate recording device as per manufactures specifications and begin recording data for a minimum of 24 hours, unless otherwise directed.

6. REPORT

6.1 Vibration strength determination shall be defined by the maximum rate of velocity of particle movement and referred to as Peak Particle Velocity(PPV) measured in inches per second (in/sec).

6.2 After all data is collected and evaluated, determination of the severity of vibration will be documented as listed in the table below.

Response	Ground Vibration, PPV (in/sec)
Barely to distinctly perceptible	.02 - .10
Distinctly perceptible to strongly perceptible	.10 - .50
Strongly perceptible to mildly unpleasant	.50 - 1.0
Mildly unpleasant to distinctly unpleasant	1.0 - 2.0
Distinctly unpleasant to intolerable	2.0 - 10.0

Ronald L. Stanevich, PE,
Director
Materials Control, Soils & Testing Division

MP 107.00.40 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF TEST FOR DETERMINING PHOTOMETRIC REQUIREMENTS OF HAZARD WARNING LIGHTS

1. PURPOSE

1.1 The purpose of this procedure is to establish a standard method of test for the photometric evaluation of hazard warning lights used in the control of traffic

2. SCOPE

2.1 This method of test is applicable to both the flashing and non-flashing varieties of hazard warning lights.

3. APPARATUS AND EQUIPMENT

3.1 One (1) goniometer which allows the unit under test to be rotated through fixed horizontal and vertical axes.

3.2 One (1) DC power supply with a range of 0-150 volts and 0-3 amperes.

3.3 One (1) DC digital voltmeter capable of measuring at least 150 volts and accurate to 0.1 volt.

3.4 One (1) standard lamp of known illumination at a certain specified voltage.

3.5 One (1) barrier-layer type photocell, color corrected to correspond to viewing conditions of the average human eye.

3.6 One (1) vacuum photoelectric tube and matching socket used to detect the intensity and length of flash of the unit under test.

3.7 One (1) dual channel oscilloscope which is used to display the intensity time relationship curve of the unit under test.

3.8 A means of recording the intensity time relationship curve. This can be done photographically or by means of an oscilloscope capable of holding a trace.

3.9 One (1) picoammeter has an accuracy of at least two (2) percent of full scale reading, a decade switch changes the scale ratio to permit readings over a total range from 10^{-2} to 10^{-12} amperes.

4. TEST PROCEDURES

4.1 Determination of Voltage When Flashing

4.1.1 Because of the voltage drop which occurs when the unit is flashing, the peak voltage at the lamp, when the unit is flashing, must be determined. This is done by taking voltage measurements of the batteries supplied by the manufacturer with a digital DC voltmeter accurate to 0.1 volt. These batteries are then installed in the unit being tested and the output of the lamp circuit is then connected to one channel of a dual channel oscilloscope. The rated voltage of the batteries as was determined above is then set by using a DC power supply (monitored by digital DC voltmeter) of the oscilloscope. Both channels of the oscilloscope are calibrated with reference to voltage.

When the unit under test is turned on, one channel displays the voltage level of the batteries and the other displays a decrease in this voltage level corresponding to the voltage drop exemplified by the circuit during its flash.

4.2 Intensity - Time Relationship Curve

4.2.1 This curve is obtained by placing the unit under test before a vacuum photoelectric tube. The output of the photoelectric tube is then displayed by means of a catrode ray oscilloscope when the unit under test is energized. The intensity-time characteristics are then recorded photographically or by other suitable means. For definition purposes, flash duration is defined as that time that elapses from the point at which the applied voltage reaches 90% of the peak, and that point when the voltage drops below 10% of the peak.

4.3 Measurements on Test Light and Calibration

4.3.1 The unit under test is now mounted on a goniometer which allows it to be rotated about fixed horizontal and vertical axes. The units electrical circuit is by-passed so that it may be operated steadily at the peak voltage previously determined, for purpose of achieving intensity distribution measurements. A barrier-layer photocell is then positioned at a distance of approximately 3 m from the unit to act as a receiving device. The photocell is then connected to a picoammeter which is capable of reading very small electrical currents.

Each light is aligned on the goniometer so that its geometrical center is on the same level as the photocell. The light is then photometrically centered by making the horizontal and vertical angular settings of the goniometer 0.0 for the position of the light which produces an equal distribution of energy to the left and right of center as well as above and below center. The goniometer is then rotated through traverses whose minimum vertical and horizontal angles are 9° left and right and 5° up and down from the assigned photometric center (0.0) and which also inscribe a symmetrically oval beam pattern. Meter readings are taken and recorded at the traverses indicated above.

Without changing distance, a standard lamp of known intensity for a given voltage is then placed on the goniometer and illuminated to its peak intensity. A meter reading of the light striking the photocell is then taken and recorded. A yellow filter with known transmission factor is then placed in front of the photocell and a second reading of the standings is taken and recorded.

4.4 Calculation of Steady State Intensity (I_S)

4.4.1 Meter readings obtained by illuminating the photocell with and without filter in front of same, are now corrected in the following manner before determining I_S:

(1) $(Mr)(F) = Cmr$

(2) $\frac{Cmr}{Mrf} = k$

(3) $\frac{Mr}{k} = Msc$

(4) Check - $(Msc)(F) = Mrf$

Where Mr = Meter reading of photocell illuminated by standard lamp.

Mrf = Meter reading with filter in front of photocell illuminated by standard lamp.

F = Correction factor of filter.

Cmr = Calculated meter reading with filter in front of photocell and illuminated by standard lamp.

k = Ratio of calculated value to actual value of photocell reading with filter and illuminated by standard lamp.

Msc = Corrected meter reading of photocell illuminated by standard lamp.

Meter readings taken at the angular traverses noted in 1.3 are now computed for Steady State Intensity values by utilizing the following formula:

$$I_S = \frac{Mt}{Msc}(S_L)\left(\frac{DT}{D_L}\right)$$

Where I_S = Steady State Intensity in candlepower.

Mt = Meter readings taken at angular traverses which inscribe a symmetrically oval beam pattern.

Msc = Corrected meter reading of photocell illuminated by standard lamp.

S_L = Rated candlepower of standard lamp.

DT = Distance from photocell to light under test.

D_L = Distance from photocell to standard lamp.

4.5 Determination of Effective Intensity (I_E)

4.5.1 Effective intensity for anti-collision lighting devices is determined from the following relationship:

$$I_E = \frac{T_2\, I(t)\, dT \;\; St_1}{0.2 + (T_2 - T_1)} \quad (1)$$

The next step is to enlarge the photograph of the intensity-time curve to a convenient size. This is done by simply plotting the steady state intensity in candlepower as the ordinate and the flash duration, as determined by the oscilloscope time base, as the abscissa on graph paper.

Referring to the formula (1) we see that the numerator of the fraction is really the total candlepower-seconds between the limits of t_1 and t_2 where the time between t_1 and t_2 is the flash time interval in seconds. The denominator of the formula is the flash time interval in seconds plus the constant 0.2.

If the graph paper is scaled in inches on which the intensity-time curve is enlarged, the formula (1) may now be reduced to:

$$I_E = \frac{\text{Areas in sq. mm x seconds/mm x candles/mm}}{(t_2 - t_1 \text{ mm}) \text{ x seconds/mm} + 0.2} \quad (2)$$

Where the area is square millimeters is the area under the curve between the limits t_1 and t_2.

The candles per millimeter is determined by the calibration of the ordinate scale.

The candles per millimeter is determined by the calibration of the ordinate scale.

The seconds per millimeter is determined by the calibration of the ordinate scale.

The seconds per millimeter is determined by the abscissa scale.

The limits t_1 and t_2 are obtained in the following manner. Since this is a maximizing formula, it is necessary to establish t_1 and t_2 at the points of the curve which give the highest effective intensity. Since it is not known where these points are, it is first necessary to make an arbitrary estimate. An estimated effective candlepower point is selected and a vertical line established at that point on the graph. From the point of the intersection of this line with the candlepower curve, perpendiculars are dropped to the base line. These perpendicular lines represent the time t_1 and t_2. The factor t_2 and t_1 can then be measured in millimeters.

The area under the intensity-time curve between the limits t_2 and t_1 is then measured with a planimeter (or other suitable means) and all collected parameters are then applied to the formula (2).

If the result is greater than the estimate, it is then necessary to make a second estimate slightly higher than the first, which will cause a decrease in the area under the curve as well as in t_2 and t_1. If the result is lower than the estimate, then the procedure is reversed.

The calculated value of the ratio of the peak candlepower to the effective candlepower is expressed as a percentage in formula (2). Since the shape of the candlepower time curve has not changed with the angle of view, this percentage value holds true for any point of the distribution curve.

It is then only necessary to apply this percentage figure to the I_S values in 4.4.1 at the angular sittings desired, to find the effective intensity values.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 107.02.22 Steward – Traffic Certification Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING SPECIFICATION COMPLIANCE OF HAZARD WARNING LIGHTS

1. PURPOSE

1.1 To provide guidance and instruction for District personnel in determining specification compliance of hazard warning lights used for control for traffic through work areas.

1.2 To establish the procedures to be followed by the Materials Control, Soils and Testing Division and district personnel in documentation of these items.

2. SCOPE

2.1 This procedure will apply to all projects.

2.2 The following sections define the procedures to be employed.

3. INSTRUCTIONS

3.1 A list containing the manufacturer's name, model number, type of flashing unit, laboratory number, and effective date will be forwarded to each District Engineer or his authorized representative by the Materials Control, Soils and Testing Division. This listing is for those models of lights which meet requirements and are acceptable for use.

3.2 The above approved list will be issued periodically to show any subsequent additions or deletions which may become necessary.

3.3 District personnel will determine if all lights used on the project are of the same manufacturer, model number and type as those which appear on the approved list and if they are correctly maintained while in use.

3.4 Coverage for hazard warning lights shall be obtained by entering the laboratory number from the appropriate approved list on the HL-440.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR DETERMINING SPECIFIC INTENSITY AND SPECIFIC BRIGHTNESS OF REFLEX REFLECTORS AND DELINEATORS

1. PURPOSE

1.1 The purpose of this procedure is to establish a standard method of test for photometrically evaluating certain types of reflectors.

2. SCOPE

2.1 This method of test is applicable to those types of reflectors which are constructed in such a manner as that set forth in the governing specifications.

3. APPARATUS AND EQUIPMENT

3.1 All photometric evaluations are to be conducted in a bench-size reflex photometer whose optional components and geometry have been scaled to be consistent with actual highway dimensions and viewing conditions. The complete photometer consists of the following individual components and/or pieces of equipment.

3.2 Housing - The housing is a rigid plastic tube, 152 mm sq and 3.4 m. The inside of the housing is painted with optical flat black enamel to eliminate errors from specularly reflected stray light. Seven openings along its length provide access to seven test stations. These stations permit measurements at different photometric distances, corresponding to actual highway observation angles. Data on seven stations are listed on the following page.

Observation Angle Station	Photometric Distance (m)	Equivalent Highway Distance, (m)
1/2°	0.6 m	61.0 m
1/3°	0.9 m	91.4 m
1/4°	1.2 m	121 m
1/5°	1.5 m	152 m
1/6°	1.8 m	183 m
1/8°	2.4 m	244 m
1/10°	3.0 m	305 m

3.3 Goniometer - This device is used to hold the reflector in position for testing. The vertical angle of the goniometer face is adjustable, making it possible to measure reflectors at any entrance angle from 0 to 50 degrees. Samples are attached to the goniometer by means of various size holding plates which may be rotated at 300 rpm to eliminate effects of orientation. The goniometer can be relocated to any of the seven test stations.

3.4 Specific Intensity Meter - This is a solid state picoameter having an accuracy of at least two percent of full scale reading. A decade switch changes the scale ratio to permit readings over a total range from 10^{-2} to 10^{-12} amperes.

3.5 Optical System - This system consists of a high intensity projection lamp, two iris diaphragms, one of which limits the amount of light entering the system and the other which varies the divergence of the beam, and a photocell in the form of a ring of 4.7 mm inside radius and 1.3 mm width. The output of the projection lamp is concentrated through a lens system coaxial with the photometer axis.

3.6 Power Unit - This contains a 150 watt voltage regulator for maintaining a constant voltage input to the photometer, a transformer for supplying current to the projection lamp, a hi-lo switch in the lamp supply circuit for controlling the degree of illumination from the lamp on-off and motor switches, and receptacles for the various leads.

3.7 Lamp - The lamp is standard 150 watt, 20 volt projection lamp, GE Type DEF.

3.8 Fan - A 115 volt blower type fan mounted on the end of the photometer circulates air past the lamp and other optical elements.

4. PHOTOMETRIC PRINCIPLE

4.1 The light output from the projection lamp is directed through a collimating and focusing lens system then through a small aperture to the reflector being tested. The light is then reflected to a photocell built in the form of a very narrow ring surrounding the aperture. The current output of the photocell is fed into a sensitive picoameter, the deflection of which is proportional to the light incident on the photocell, and therefore, to the specific intensity of the reflector. By properly adjusting the intensity of the light the meter reading can be made numerically equal to the specific intensity. Observation angle is changed by changing the location of the reflector within the photometer. Orientation angle is changed by rotating the reflector on the goniometer.

5. TEST PROCEDURE

5.1 Calibration

5.1.1 A random reflector (known as the reference reflector) from the LOT to be tested is fastened to a holding plate of the proper size and placed on the goniometer.

5.1.2 The goniometer is set to 0 degrees entrance angle.

5.1.3 Adjust the second iris diaphragm so that the beam spread is only slightly larger than the reflector.

5.1.4 Turn on the goniometer motor to spin the reflector, thus eliminating any possible effects of orientation.

5.1.5 Read the picoameter, using any scale setting which gives a convenient large scale deflection and record the result.

5.1.6 Remove the photocell from its normal position near the lamp end of the tube and mount it on the goniometer in place of the reflector. With the goniometer not spinning and still at 0 degrees entrance angle, the picoameter is read on the same scale as the referenced reflector.

5.1.7 Compute the specific intensity of the reference reflector using the following formula:

$$Sr = \frac{R\ (Dr^4)}{C\ (Dc^2)}$$

Where: Sr = Specific intensity of reference reflector in Candelas/Lux

R = Meter reading of reference reflector outlined in 5.1.5.

C = Meter reading of photocell as outlined in 5.1.6.

D = Photometric distance of observation angle station.

5.1.8 Should the meter reading from the photocell (as outlined in 5.1.6) not be on the same scale as that used in reading the referenced reflector, then the photocell should be shifted to any other station at which a usable reading is obtained on the same scale. Under this condition, the formula in 5.1.8 would be modified as follows:

$$Sr = \frac{R\ (Dr^4)}{C\ (Dc^2)}$$

Where: D_r = Photometric distance at which reference reflector is read

D_c = Photometric distance at which photocell is read.

5.2 Testing Crystal Reflectors and Delineators

5.2.1 A random reflector from the LOT to be tested is calibrated in accordance with the procedures outlined in 5.1.1 through 5.1.8 and its meter reading, scale and specific intensity recorded and computed.

5.2.2 Having computed the specific intensity of the reference reflector above, the optical system is now adjusted by means of the iris diaphragms (reference reflector sti1l in place), unti1 the meter reading is numerically equal to the computed specific intensity and on exactly the same meter scale.

5.2.3 Remove the reference reflector and place the unknown reflectors on the goniometer at the appropriate entrance and observation angles, spin and read the specific intensity (SI) directly from the meter. Record reading on worksheet.

5.3 Testing Colored Reflectors And Delineators

5.3.1 A reflector from the LOT being tested is calibrated in accordance with the procedure outlined in 5.1.1 through 5.1.8 with the exception that in 5.1.6 a color filter of known transmission factor is placed in front of the photocell. The formulas in 5.1.7 and 5.1.8 then become respectively:

(1) $Sr = \frac{R\,(D^2K)}{C}$

(2) $Sr = \frac{R}{C}\,\frac{D_r^{\,4}}{D_c^{\,2}}\,K$

Where: = Transmission factor for the filter

5.3.2 Testing is completed as outlined in steps 5.2.1 through 5.2.3.

5.4 Specific Brightness

5.4.1 Compute the specific brightness of a reflector using the following formula:

$Sb = \frac{SI}{A}$

Where: Sb = Specific Brightness

SI = Specific Intensity

A = Area of reflectance surface in square millimeter.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 107.07.21 Steward – Traffic Certification Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR EVALUATING AND DISPOSING OF BEDROCK CORE

1. PURPOSE

1.1 The purpose of this procedure is to establish a method for handling, evaluating, and disposing of rock core and associated split spoon soil samples.

2. SCOPE

2.1 This procedure will apply to all organizations taking bedrock core and split spoon soil samples, and to all projects where soil and bedrock core samples are obtained.

3. REFERENCES

3.1 *AASHTO Standards:*

- AASHTO T 206
- AASHTO T 225

4. CORE HANDLING AND CHARACTERISTICS

4.1 Rock core shall be handled with care so as not to cause breakage, disturbance, or loss of material when transferring the core from the barrel to the box. The core shall be placed in the box as described in AASHTO T 225 for purposes of determining the percent recovery, rock quality designation (RQD), estimated hardness, and compressive strength, and for photographs.

4.2 Soil obtained with the split spoon sampler in accordance with AASHTO T 206 that is to be tested shall be sealed in a metal or glass container and properly labelled with hole number, station and offset, depth of top and bottom of sample, date, and the project number. The soil samples shall be delivered to the location specified in the drilling documents.

4.3 If laboratory tests for the unconfined compressive strength of the bedrock core at specific elevations are required, each core sample selected should have a minimum length 2 to 2 1/2 times the diameter of the core. In no case will the length of the core be less than the diameter. Each sample of core is to be immediately sealed in a plastic bag and protected against shock and freezing, during storage at the drilling site and during transportation to the testing facility. The core will be delivered to the location specified on the drilling documents.

4.3.1 Each sample is to be properly labelled with hole number, date, station and offset, depth of top and bottom of sample, and the project number.

4.4 When the drilling documents require the core to be photographed, it shall be placed in a core box as directed in 4.1. The core is to be delivered to the agency requesting the photography or as specified in the boring documents.

4.5 When core is to be retained in boxes for photographing or inspection, it will be boxed as follows:

4.5.1 Core from only one boring will be stored in a single box. However, one boring may require more than one box.

4.5.2 All boxes will have the lid and bottom properly secured so that the material being stored is not lost in handling. All the lids will be secured with hinges and screws or all screws.

4.5.3 Each box will be identified with a weatherproof label indicating hole number, station and offset, date, depth of top and bottom of run in box, and number of boxes for each boring.

5. STORAGE

5.1 Soil and bedrock core will not normally be stored by the Division.

5.2 If a District, Division, or other agency requests that core from a specific project is to be saved, a location for delivery must be specified. The Division will not deliver core outside of West Virginia. It will be the responsibility of the organization requesting retention of the core to store and to dispose of the core when storage is no longer necessary.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 207.00.00 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CHEMICAL ANALYSIS OF SOIL

1. PURPOSE

1.1 To set forth methods for the chemical analysis of soil.

2. SCOPE

2.1 These procedures shall be used to determine the pH and organic content of soil. Other chemical components shall be tested as described in Standard Methods of Chemical Analysis, F. J. Welcher, Editor, Sixth Edition, pages 2310 - 2337.

3. REFERENCE DOCUMENT

3.1 *AASHTO*

- AASHTO T-267.

4. PH

4.1 Test Method: 1:1 soil-water ratio, page 2329 of previously stated reference.

4.2 Reagents

4.2.1 Distilled water, freshly boiled

4.3 Apparatus

4.3.1 pH meter capable of measuring to the nearest 0.1 pH unit

4.3.2 Buffer solutions of pH 4.0, 7.0, and 10.0

4.4 Procedure

4.4.1 Dry the finely ground soil overnight at 105 ± 4°C. Place 20 grams of the soil in a 50 milliliter beaker. Add 20 milliliters of distilled water to the soil and stir at regular intervals for 1 hour. Measure the pH of the mixture, stirring well just before placing the electrodes deep in the mixture.

4.4.2 The pH meter must be standardized prior to measuring the pH of the soil.

4.5 Calculation

4.5.1 The pH obtained on the soil-water mixture is the pH of the soil.

5. ORGANIC CONTENT

5.1 Test Method: AASHTO T-267

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 207.06.20 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

NUCLEAR FIELD DENSITY - MOISTURE TEST FOR RANDOM MATERIAL HAVING LESS THAN 40% OF + 3/4 INCH (+3/4 in. (+19 mm)) MATERIAL

1. PURPOSE

1.1 The purpose of this procedure is to determine the density and moisture content of random materials.

2. SCOPE

2.1 This method of testing is applicable to random materials used for embankments, subgrades, backfill, and soil cement base courses.

3. REFFERENCED DOCUMENTS

3.1 *AASHTO Standards:*

- AASHTO T-99, Method C

3.2 *Materials Procedures:*

- MP 712.21.26
- MP 717.04.21U.S.

4. EQUIPMENT

4.1 One complete nuclear density-moisture gauge unit meeting the requirements specified in MP 717.04.21. A copy of the manufacturer's print-out of standard counts is to be included.

4.2 One 1/30 ft^3 (0.000943 m^3) proctor mold assembly with a 5.5 LB (2.5 kg) rammer meeting the requirements of AASHTO T-99.

4.3 One steel foundation plate having minimum dimensions of 15 in. x 15 in. x 5/8 in. (380 mm x 380 mm x 16 mm) or a 200 LB (91 kg) block of concrete.

4.4 One extruder for removing specimens from proctor mold.

4.5 One balance having a capacity of at least 10 kg and sensitive to 1.0 g.

4.6 One stove for drying moisture samples.

4.7 One 32 oz. (900 g) ballpeen hammer or equivalent.

4.8 Two pans with a capacity to hold 10 LB (4500 g) of material.

4.9 One pan suitable for drying moisture samples.

4.10 One wire brush

4.11 One 3/4 in. (19 mm) U.S. Standard Sieve

4.12 One scoop

4.13 One ruler or tape measure

4.14 One measuring tape (should be a minimum of 50 ft (15 m))

4.15 One 2 in. (50 mm) approximate size paint brush

4.16 One 18 in. (450 mm) chisel or equivalent

4.17 One draw knife

4.18 Supply of data sheets and attached tables

4.19 One appropriate vehicle for transporting nuclear gauge and test equipment

5. PERSONNEL TRAINING

5.1 All personnel performing the testing must have the minimum training requirements specified in MP 717.04.21.

5.2 All personnel must know and follow the requirements of the Nuclear Regulatory Commission.

6. ROUNDING OF DATA

6.1 Test values and calculations are to be rounded according to the following procedure:

6.1.1 If the figure following the last significant number to be retained is larger than five, increase the last significant number to be retained by one.

6.1.2 If the figure following the last significant number to be retained is five, and there are no figures beyond five except zeros, the last significant number to be retained is increased by one if odd, or left unchanged if even.

6.1.3 If the figure following the last significant number to be retained is five and there are figures following the five, the last significant number to be retained is increased by one.

6.1.4 If the figure following the last significant number to be retained is less than five, the significant number is left unchanged. Test values and calculations shall be rounded to the following nearest significant digit.

Station Number:	1 ft. (0.1 m)
Offset:	1 ft. (0.1 m)
Lift Thickness:	1/2 in. (10 mm)
Depth Below Grade:	1 ft. (0.1 m)
Dry Density (DA):	1 LB/ft^3 (10 kg/m^3)
Moisture (MA):	1 LB/ft^3 (10 kg/m^3)
Dry Density - 19 mm material (DB):	1 LB/ft^3 (10 kg/m^3)
Moisture (MB):	1%
Excavated Material + Pan (CA):	1 g
Pan (CB):	1 g
Excavated Material (CC):	1 g
+3/4 in. (+19 mm) Material + Pan (CD):	1 g
Pan (CE):	1 g
+3/4 in. (+19 mm) Material (CF):	1 g
+3/4 in. (+19 mm) Material (CG):	1%
Weight of Soil + Mold (PA):	1 g
Mold (PC):	1 g
Weight of Soil (PD):	1 g
Wet Density (PE):	1 LB/ft^3 (10 kg/m^3)
Dry Density (PF):	1 LB/ft^3 (10 kg/m^3)
Wet Weight + Pan (SA):	1 g
Pan (SB):	1 g
Wet Weight (SC):	1 g
Dry Weight + Pan (SD):	1 g
Dry Weight (SE):	1 g
Moisture (SF):	1 g
Moisture (SG):	1%
Optimum Moisture (OA):	1%
Maximum Density (DC):	1 LB/ft^3 (10 kg/m^3)
Relative Density (DE):	1%
Average DE (X):	0.1%
Target (T):	1%
Quality Index (L):	0.01
Within Tolerance (DF):	1%
Minimum Percent for 100% Pay (DG):	1%

7. PREPARATION FOR TESTING

7.1 Weigh the pans and proctor mold and record the weights on the sides of the equipment. The weights should be checked at least on a monthly basis.

7.2 All test data is to be recorded on the attached form.

7.3 Standardization of the nuclear gauge

7.3.1 Warm up the gauge for a minimum of 2 minutes.

7.3.2 Standardization of the gauge must be performed away from metal and other objects.

7.3.3 Clean the top of the standard block and the bottom of the gauge with a cloth.

7.3.4 Place the gauge on the standard block with the gauge turned the correct way. For the Troxler 3411 gauge, the scaler end of the gauge must be tight against the standard block flange.

7.3.5 Make the necessary adjustments on the gauge for standardization and take a four-minute count for density and moisture.

7.3.6 Compare the standard counts to the manufacturer's standard counts. The standard count must be within ±2% for density and ±4% for moisture from the manufacturer's standards.

7.3.7 If the gauge is not within the specified tolerances for either moisture or density, repeat Section 7.3.5 - 7.3.6. If the gauge will not standardize for either moisture or density after 4 attempts, there is probably something wrong with the gauge. There may be electronics problems, the gauge needs calibrated, or a stability check needs to be performed. Refer to MP 717.04.21 for a more detailed explanation. In any case, do not use a gauge for testing that will not properly standardize.

7.3.8 When a gauge is used for testing pipe or structure backfill in a trench, first check the standardization of the gauge according to Sections 7.3.1 - 7.3.6. If the gauge is functioning properly, then standardize the gauge in the trench. The standard counts in the trench are used for testing in the trench only and the tolerances would not be applied to the standard counts taken in the trench. When the gauge is moved to a non-trench condition for testing, new standard counts would be required.

7.3.9 Gauges are to be standardized before testing and at least every four hours during testing.

7.4 Record the project number, item number, etc.

7.5 The lot number has the following prefix letter designations based on the use of the material:

Embankment - F
Subgrade - S
Base - B
Pipe and Structure Backfill - P

7.6 Randomly locate the test site according to MP 712.21.26.

8. PROCEDURE

8.1 Density and moisture determination

8.1.1 Smooth the test site selected for testing. Fill any voids in the surface using the fines scraped from the surface. Avoid adding excessive fines that would form a build-up on the surface (no more than 1/8 in. (3 mm)).

8.1.2 Place the guide plate on the test site. Next, place the drive rod in the plate guide and while standing on the plate, drive the rod at least 2 in. (50 mm) deeper than the location where the end of the gauge source rod will be when testing. The gauge source rod can be extended in 2 in. (50 mm) increments. The source rod must be as deep as possible within the lift but must not extend beyond the lift. For example, a 5 inch (125 mm) lift would be tested with the source rod in the 100 mm position and the hole would be 8 inch (150 mm) deep. Carefully remove the drive rod to prevent material from falling into the hole.

8.1.3 Place the gauge over the test site and insert the source rod to the desired depth. Pull the gauge tight against the side of the hole toward the scaler. Make sure the gauge is sitting flush on the material.

8.1.4 Take a one-minute density and moisture reading. Record the dry density (DA) and moisture (MA).

8.2 Determination of the percent of + 3/4 in. (+3/4 in. (+19 mm)) material

8.2.1 Excavate approximately 4500 g of material immediately beneath the test site. Excavate the material from the test hole toward the scaler end of the gauge and to the depth of the position where the source rod was located. Keep the excavated material covered to prevent moisture loss.

8.2.2 Zero the scales. The scales are to be located in an enclosed area of the vehicle that is protected from air movement. The scales are to be checked for zero before each weighing. Weigh the excavated material (CA).

8.2.3 All of the material weighed in 8.2.2 shall be passed over the 3/4 in. (19 mm) sieve. Break up any clumps of soil that are retained on the sieve and clean the fines from the + 3/4 in. (+3/4 in. (+19 mm)) material.

8.2.4 Weigh the +3/4 in. (+19 mm) material (CD) obtained in 8.2.3.

8.2.5 Calculate the percent of +3/4 in. (+19 mm) material (CG) by using the equations on the form. If the percent of +3/4 in. (+19 mm) material is 40% or more, terminate the test. Refer to MP 717.04.21 for instructions for dealing with the material.

8.2.6 Determine the bulk specific gravity (CH) of the dominant +3/4 in. (+19 mm) material by using the values from the following table:

	Bulk Specific Gravity
Soft Shale:	2.4
Hard Shale:	2.5
Sandstone:	2.5
Gravel:	2.6
Limestone:	2.7
Red Shale (Iron Bearing)	2.7

8.3 Determination of the dry density of the -3/4 in. (-19 mm) material and percent field moisture.

8.3.1 The dry density of the -3/4 in. (-19 mm) material (DB) can be calculated by the equation on the form or obtained from the tables for converting total dry density to density of the -3/4 in. (-19 mm) material. The index with the tables explains how to use the tables.

8.3.2 Calculate the percent field moisture (MB) by the equation on the form.

8.4 One-point proctor

8.4.1 Place the proctor mold with collar and base attached on the foundation plate. The foundation plate must be firmly seated so that it does not rock when compacting the material. Mix the -3/4 in. (-19 mm) material obtained in 8.2.3. Form a specimen by compacting the material in the mold in three equal layers (38 mm ± 7 mm). Each layer is compacted by 25 uniformly distributed blows with the metal rammer dropped freely from a height of 305 mm. Stand on the edges of the mold base while compacting the specimen. The rammer must be held vertically.

8.4.2 After the specimen has been made, remove the extension collar. The sample must not extend more than 13 mm above nor be below the top of the mold. A new specimen shall be made if it is too high or low. Carefully trim the material flush with the top of the mold by using the draw knife. Fill any voids in the surface with the fines obtained from the trimming. Use the paint brush to clean the fines from the outside of the mold. Remove the mold base and by holding the mold vertically, visually check the bottom of the mold to determine if the material extends beyond the mold. Do not turn the mold upside down nor trim the bottom. If the material extends beyond the bottom of the mold, perform another specimen with special precautions to seat and tighten the mold to the base.

8.4.3 Weigh the soil plus mold (PA). Record the values in the first column (left of dashed line) in the one-point proctor section.

8.4.4 Remove the specimen from the mold by using the extruder. Place the specimen back in the remaining -3/4 in. (-19 mm) material.

8.4.5 Perform the calculations using the equations on the form to determine the dry density of the one-point proctor (PE).

8.5 Determination of the maximum density and optimum moisture

8.5.1 To determine the maximum density and optimum moisture, plot the percent field moisture (MB) and the dry density of the one-point proctor (PE) on the maximum density-optimum moisture table (copy attached). The values at the intersection of the density line and moisture column are the maximum density (DC) and optimum moisture (OA). If there are no values given, the sample is either too wet or too dry to determine the maximum density and optimum moisture. When the plotted point is to the right of the maximum densities and optimum moistures, the sample is too wet and when the plotted value is to the left, the sample is too dry.

8.5.2 If the sample is found to be too wet, air dry the -3/4 in. (-19 mm) material to decrease the moisture content between four percentage points below optimum and optimum moisture. The sample is dried by spreading the sample on a sheet of metal, canvas, etc. Do not dry the sample on a stove. If the sample is too dry, add water to increase the moisture content to the above moisture range. Care should be taken not to over dry or add too much water to the sample.

8.5.3 Rerun one-point proctor

8.5.3.1 Once the sample has been air dried or water added, thoroughly mix the sample and perform another one-point proctor according to 8.4.1 - 8.4.4. Record the data in the second column (right of dashed line) in the one-point proctor section.

8.5.3.2 Calculate the wet density of the rerun one-point proctor (PE) by using the equations on the form.

8.5.4 Stove dried moisture

8.5.4.1 Scoop out a representative sample between 200 g and 400 g from the sample in 8.5.3.1. The moisture determination can be made in conjunction with making the rerun one-point proctor specimen. Place the sample in the pan for drying samples and determine the sample weight plus pan (SA).

8.5.4.2 Adjust the stove flame to a low heat so that the sample will not oxidize during drying. Occasionally stir the sample and be very careful not to lose any of the sample. Once the sample appears dry, weigh the sample and record the weight. Place the sample back on the stove and dry for approximately two minutes. Weigh the sample and compare the two weights. The weights should be the same (constant). If there is a decrease in weight, reheat the sample again for two minutes and weigh. Continue this process until two consecutive weighings are the same and this weight is dry weight plus pan (SD).

8.5.4.3 By using the equations on the form, calculate the percent moisture (SG).

8.5.5 Use the percent moisture (SG) from the stove dried moisture to calculate the dry density of the rerun one-point proctor (PE).

8.5.6 Plot the dry density of the rerun one-point proctor (PE) and the percent stove dried moisture (SG) on the maximum density-optimum table to obtain the maximum density (DC) and the optimum moisture (OA).

9. MOISTURE EVALUATION

9.1 Obtain the ± moisture tolerance (OB) from the project's governing specifications.

9.2 To determine the acceptable moisture range, add the plus tolerance and subtract the minus tolerance from the optimum moisture. The field moisture (MB) must be within this range for the moisture to meet specifications. If the moisture fails specifications, corrective action is required.

10. DENSITY EVALUATION

10.1 Calculate the percent relative density (DE) by the equation on the form.

10.2 If the percent relative density (DE) is 105 or more, the test results may be in error. Plot the dry density of the -3/4 in. (-19 mm) material (DB) and the percent field moisture (MB) on the maximum density-optimum moisture table to check the validity of the test results. The plotted point should fall on or to the left of the darkened blocks (zero air voids). Another method of checking the test results is to calculate the maximum moisture content possible (zero air voids) by the following equation:

Maximum moisture content possible (English) = (62.4/DB - .373)100
Maximum moisture content possible (Metric) = (1000/DB - 0.373)100
When the test results are equal to or less than the above evaluation, the results are acceptable.

10.3 When the conditions in 10.2 are not met, perform another complete test, including a one-point proctor, at a new random location. The checks in 10.2 would again be made if the test results are 105% or more. If the conditions in 10.2 are still not met, obtain a sample and determine the specific gravity of both the +3/4 in. (+19 mm) and -3/4 in. (-19 mm) material, performed separately. Then recalculate the test results using the specific gravity of the +3/4 in. (+19 mm) material to determine the dry density of the -3/4 in. (-19 mm) material (DB). If the percent relative density is still 105% or more, perform the following calculation using the specific gravity of the -3/4 in. (-19 mm) material.

Maximum moisture content = (62.4/DB - 1/Sp. Gr.)100
Maximum moisture content = (1000/DB - 1/Sp. Gr.)100
The field moisture (MB) must be equal to or less than the maximum moisture content (new zero air voids). If the test results still appear to be invalid, an immediate investigation must be conducted.

11. LOT EVALUATION

11.1 Five tests are required for a lot evaluation. Each test shall be performed according to previous sections of this procedure.

11.2 Calculate the average relative density (x) for the five tests in the lot.

11.3 Obtain the target percentage of dry density (T) from the project's governing specifications.

11.4 Determine the range (R) of the relative densities (DE) by subtracting the smallest value from the largest.

11.5 Calculate the quality index (QL) by using the equation on the form.

11.6 Enter the table for estimating the percent of a lot within tolerance (copy attached). Determine the percent within tolerance (DF) which corresponds to the QL value calculated in 11.5 above.

11.7 Obtain the minimum percent for 100% pay (DG) from the project's governing specifications.

11.8 In order for a lot to meet specifications for density, the percent within tolerance (DF) must be equal to or greater than the percent for 100% pay (DG). Corrective action is required to bring a failing lot into specification requirements.

12. GENERAL REQUIREMENTS

12.1 In order for a lot to meet specifications, the requirements in 9.2 and 11.8 must be met.

12.2 The maximum density, optimum moisture, and percent of +3/4 in. (+19 mm) material may be used for subsequent tests in a lot if the -3/4 in. (-19 mm) material does not change. When the material changes, the determination of new control data is required. There must be at least one, one-point proctor, for each lot.

12.3 If the test results indicate that the material meets specifications and the material exhibits pumping or displacing action under the weight of construction equipment, the test results are probably in error. Obtain a sample of the material and determine the maximum density and optimum moisture according to AASHTO T99, Method C. Until the laboratory test results are obtained, the material in question would be dried and re-compacted until the pumping stops. The area would then be retested and this moisture content used as the upper limit for moisture during the interim period.

12.4 During the compaction of soil cement base course, if the material starts to shear, cease rolling even though the required specifications for compaction are not met. The material is accepted for compaction and the proper documentation in the project's records would be made.

12.5 Independent tests for similarity checks can be recorded on the form. Use only the applicable sections of the form.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 207.07.20 Steward – Asphalt Section
RLS:J
ATTACHMENTS

Attachment 1 TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE

Quality Index (QL) Positive Values	Percent Within Tolerance
.66	99
.65	98
.62	97
.60	96
.58	95
.57	94
.55	93
.53	92
.51	91
.50	90
.48	89
.46	88
.45	87
.44	86
.42	85
.41	84
.40	83
.38	82
.37	81
.36	80
.34	79
.33	78
.32	77
.30	76
.29	75
.28	74
.27	73
.25	72
.24	71
.23	70
.22	69
.21	68
.19	67
.18	66
.17	65
.16	64
.15	63
.14	62
.13	61
.11	60
.10	59
.09	58
.08	57
.07	56
.06	55
.05	54
.04	53
.02	52
.01	51
.00	50

Quality Index (QL) Negative Values	Percent Within Tolerance
.00	50
.01	49
.02	48
.04	47
.05	46
.06	45
.07	44
.08	43
.09	42
.10	41
.11	40
.13	39
.14	38
.15	37
.16	36
.17	35
.18	34
.19	33
.21	32
.22	31
.23	30
.24	29
.25	28
.27	27
.28	26
.29	25
.30	24
.32	23
.33	22
.34	21
.36	20
.37	19
.38	18
.40	17
.41	16
.42	15
.44	14
.45	13
.46	12
.48	11
.50	10
.51	9
.53	8
.55	7
.57	6
.58	5
.60	4
.62	3
.63	2
.66	1

Attachment 2

MAXIMUM DENSITY-OPTIMUM MOISTURE TABLE

DRY DENSITY OF ONE POINT PROCTOR

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
130			131 9																	
129		131 9	130 9	129 9																
128		130 9	130 9	128 10																
127	131 9	130 9	128 10	127 10	127 10															
126	131 9	130 9	128 10	127 10	126 10															
125	130 9	128 10	127 10	126 10	125 10															
124		128 10	126 10	125 11	125 11	124 11														
123		127 10	126 10	124 11	123 11	123 11														
122		126 10	125 11	124 11	123 11	122 12														
121		126 11	125 11	123 12	122 12	121 12	121 12													
120		125 11	124 11	122 12	121 12	120 12	120 12													
119			123 12	122 12	120 12	120 12	119 13													
118			122 12	120 12	120 12	119 13	118 13	118 13												
117				120 12	119 13	118 13	117 13	117 13												
116				119 13	118 13	117 13	117 13	116 14												
115				118 13	117 13	116 14	116 14	115 14	115 14											
114				117 13	116 14	116 14	115 14	114 14	114 14											
113					116 14	115 14	114 14	114 14	113 15											
112					115 14	115 14	113 15	113 15	112 15	112 15										
111					115 14	113 15	112 15	112 15	111 15	111 16										
110					113 15	112 15	112 15	111 15	111 16	110 16										
109						112 15	111 16	110 16	110 16	109 16	109 16									
108						111 16	110 16	110 16	109 16	109 17	108 17									
107							110 16	109 17	108 17	108 17	107 17	107 17								
106							109 17	108 17	107 17	107 17	106 18	106 18								
105							108 17	107 17	107 17	106 18	106 18	105 18	105 18							
104								107 17	106 18	105 18	105 18	104 19	104 19							
103								106 18	105 18	105 19	104 19	103 19	103 19	103 19						
102								105 18	105 19	104 19	103 19	103 20	102 20	102 20	102 20					
101									104 19	103 19	102 20	102 20	101 20	101 20	101 21					
100									103 19	102 20	101 20	101 21	100 21	100 21	100 21	100 21				
99									102 20	101 20	101 21	100 21	100 21	99 21	99 22	99 22				
98										100 21	100 21	99 221	99 22	98 22	98 22	98 22	98 22			
97										100 21	99 21	99 22	98 22	98 22	98 22	97 22	97 23			
96											99 22	98 22	98 22	98 22	97 23	97 23	96 23			
95											99 22	98 22	97 23	97 23	96 23	95 24	95 24	85 24		
94											98 22	97 23	96 23	95 24	95 24	95 24	94 24	94 24	94 24	
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

PERCENT MOISTURE

Attachment 3

TABLES FOR CONVERTING

TOTAL DRY DENSITY TO DENSITY

OF THE -3/4 in. (-19 mm) MATERIAL

INSTRUCTIONS FOR USING THE TABLES

To use the tables, locate in the index the page number corresponding to the specific gravity (CH), the total dry density (DA), and the percent of +3/4 in. (+19 mm) material (CG). Turn to the selected page and locate the total dry density in the left column and read across the page to the column corresponding to the percent of +3/4 in. (+19 mm) material. The percents of +3/4 in. (+19 mm) material are listed across the top of the page. The value at the intersection is the dry density of the -3/4 in. (-19 mm) material (DB).

EXAMPLE:

Given: Specific Gravity = 2.5
Percent of +3/4 in. (+19 mm) material = 29
Total Dry Density = 1 970 kg/m^3

Turn to the index with the values and select Page 20. Next, turn to Page 20 and notice that a specific gravity of 2.5 is listed at the top of the page. Read down the left column and locate 1 970 kg/m3. Then read across the page to the column corresponding to 29%. The value of 1 880 kg/m3 at the intersection is the dry density of the -3/4 in. (-19 mm) material.

INDEX

PERCENT OF +3/4 in. (+19 mm) MATERIAL	TOTAL DRY DENSITY	PAGE NUMBER
Specific Gravity of 2.4		
1 - 10	1280 - 1770	1
1 - 10	1780 - 2260	2
1 - 10	2270 - 2560	3
11 - 20	1280 - 1770	4
11 - 20	1780 - 2260	5
11 - 20	2270 - 2560	6
21 - 30	1280 - 1770	7
21 - 30	1780 - 2260	8
21 - 30	2270 - 2560	9
31 - 40	1280 - 1770	10
31 - 40	1780 - 2260	11
31 - 40	2270 - 2560	12
Specific Gravity of 2.5		
1 - 10	1280 - 1770	13
1 - 10	1780 - 2260	14
1 - 10	2270 - 2560	15
11 - 20	1280 - 1770	16
11 - 20	1780 - 2260	17
11 - 20	2270 - 2560	18
21 - 30	1280 - 1770	19
21 - 30	1780 - 2260	20
21 - 30	2270 - 2560	21
31 - 40	1280 - 1770	22
31 - 40	1780 - 2260	23
31 - 40	2270 - 2560	24
Specific Gravity of 2.6		
1 - 10	1280 - 1770	25
1 - 10	1780 - 2260	26
1 - 10	2270 - 2560	27
11 - 20	1280 - 1770	28
11 - 20	1780 - 2260	29
11 - 20	2270 - 2560	30
21 - 30	1280 - 1770	31
21 - 30	1780 - 2260	32
21 - 30	2270 - 2560	33
31 - 40	1280 - 1770	34
31 - 40	1780 - 2260	35
31 - 40	2270 - 2560	36
Specific Gravity of 2.7		
1 - 10	1280 - 1770	37
1 - 10	1780 - 2260	38
1 - 10	2270 - 2560	39
11 - 20	1280 - 1770	40
11 - 20	1780 - 2260	41
11 - 20	2270 - 2560	42
21 - 30	1280 - 1770	43
21 - 30	1780 - 2260	44
21 - 30	2270 - 2560	45
31 - 40	1280 - 1770	46
31 - 40	1780 - 2260	47
31 - 40	2270 - 2560	48

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

	PERCENT of + 3/4 MATERIAL									
DD	1	2	3	4	5	6	7	8	9	10
80	79	79	78	78	77	77	76	75	75	74
81	80	80	79	79	78	78	77	77	76	75
82	81	81	80	80	79	79	78	78	77	76
83	83	82	81	81	80	80	79	79	78	78
84	84	83	83	82	81	81	80	80	79	79
85	85	84	84	83	83	82	81	81	80	80
86	86	85	85	84	84	83	83	82	81	81
87	87	86	86	85	85	84	84	83	83	82
88	88	87	87	86	86	85	85	84	84	83
89	89	88	88	87	87	86	86	85	85	84
90	90	89	89	88	88	87	87	86	86	85
91	91	90	90	89	89	88	88	87	87	86
92	92	91	91	90	90	89	89	89	88	88
93	93	92	92	91	91	91	90	90	89	89
94	94	93	93	92	92	92	91	91	90	90
95	95	94	94	93	93	93	92	92	91	91
96	96	95	95	95	94	94	93	93	92	92
97	97	96	96	96	95	95	94	94	94	93
98	98	97	97	97	96	96	95	95	95	94
99	99	98	98	98	97	97	97	96	96	95
100	100	99	99	99	98	98	98	97	97	96
101	101	100	100	100	99	99	99	98	98	98
102	102	101	101	101	100	100	100	99	99	99
103	103	102	102	102	101	101	101	100	100	100
104	104	103	103	103	103	102	102	102	101	101
105	105	104	104	104	104	103	103	103	102	102
106	106	105	105	105	105	104	104	104	103	103
107	107	106	106	106	106	105	105	105	105	104
108	108	108	107	107	107	106	106	106	106	105
109	109	109	108	108	108	108	107	107	107	106
110	110	110	109	109	109	109	108	108	108	108
111	111	111	110	110	110	110	109	109	109	109
112	112	112	111	111	111	111	111	110	110	110
113	113	113	112	112	112	112	112	111	111	111
114	114	114	113	113	113	113	113	112	112	112
115	115	115	114	114	114	114	114	114	113	113
116	116	116	116	115	115	115	115	115	114	114
117	117	117	117	116	116	116	116	116	116	115
118	118	118	118	117	117	117	117	117	117	116
119	119	119	119	118	118	118	118	118	118	118
120	120	120	120	120	119	119	119	119	119	119

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

PERCENT of + 3/4 MATERIAL

DD	1	2	3	4	5	6	7	8	9	10
121	121	121	121	121	120	120	120	120	120	120
122	122	122	122	122	121	121	121	121	121	121
123	123	123	123	123	123	122	122	122	122	122
124	124	124	124	124	124	124	123	123	123	123
125	125	125	125	125	125	125	124	124	124	124
126	126	126	126	126	126	126	126	125	125	125
127	127	127	127	127	127	127	127	127	127	126
128	128	128	128	128	128	128	128	128	128	128
129	129	129	129	129	129	129	129	129	129	129
130	130	130	130	130	130	130	130	130	130	130
131	131	131	131	131	131	131	131	131	131	131
132	132	132	132	132	132	132	132	132	132	132
133	133	133	133	133	133	133	133	133	133	133
134	134	134	134	134	134	134	134	134	134	134
135	135	135	135	135	135	135	135	135	135	135
136	136	136	136	136	136	136	136	136	136	136
137	137	137	137	137	137	137	137	137	138	138
138	138	138	138	138	138	138	138	139	139	139
139	139	139	139	139	139	139	140	140	140	140
140	140	140	140	140	140	141	141	141	141	141
141	141	141	141	141	141	142	142	142	142	142
142	142	142	142	142	143	143	143	143	143	143
143	143	143	143	143	144	144	144	144	144	144
144	144	144	144	145	145	145	145	145	145	145
145	145	145	145	146	146	146	146	146	146	146
146	146	146	146	147	147	147	147	147	147	148
147	147	147	147	148	148	148	148	148	149	149
148	148	148	149	149	149	149	149	149	150	150
149	149	149	150	150	150	150	150	150	151	151
150	150	150	151	151	151	151	151	152	152	152
151	151	151	152	152	152	152	152	153	153	153
152	152	152	153	153	153	153	154	154	154	154
153	153	153	154	154	154	154	155	155	155	155
154	154	154	155	155	155	155	156	156	156	156
155	155	155	156	156	156	156	157	157	157	158
156	156	156	157	157	157	158	158	158	158	159
157	157	158	158	158	158	159	159	159	159	160
158	158	159	159	159	159	160	160	160	161	161
159	159	160	160	160	160	161	161	161	162	162
160	160	161	161	161	161	162	162	162	163	163

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

	PERCENT of + 3/4 MATERIAL									
DD	11	12	13	14	15	16	17	18	19	20
80	74	73	72	72	71	70	69	69	68	67
81	75	74	73	73	72	71	71	70	69	68
82	76	75	75	74	73	73	72	71	70	70
83	77	76	76	75	74	74	73	72	72	71
84	78	77	77	76	76	75	74	74	73	72
85	79	79	78	77	77	76	75	75	74	73
86	80	80	79	79	78	77	77	76	75	75
87	81	81	80	80	79	78	78	77	76	76
88	83	82	81	81	80	80	79	78	78	77
89	84	83	83	82	81	81	80	80	79	78
90	85	84	84	83	83	82	81	81	80	80
91	86	85	85	84	84	83	83	82	81	81
92	87	87	86	86	85	84	84	83	83	82
93	88	88	87	87	86	86	85	84	84	83
94	89	89	88	88	87	87	86	86	85	85
95	90	90	90	89	89	88	87	87	86	86
96	92	91	91	90	90	89	89	88	88	87
97	93	92	92	91	91	90	90	89	89	88
98	94	93	93	92	92	92	91	91	90	90
99	95	95	94	94	93	93	92	92	91	91
100	96	96	95	95	94	94	93	93	93	92
101	97	97	96	96	96	95	95	94	94	93
102	98	98	98	97	97	96	96	95	95	95
103	99	99	99	98	98	98	97	97	96	96
104	101	100	100	99	99	99	98	98	97	97
105	102	101	101	101	100	100	100	99	99	98
106	103	102	102	102	101	101	101	100	100	100
107	104	104	103	103	103	102	102	102	101	101
108	105	105	104	104	104	103	103	103	102	102
109	106	106	106	105	105	105	104	104	104	103
110	107	107	107	106	106	106	106	105	105	105
111	108	108	108	108	107	107	107	106	106	106
112	110	109	109	109	109	108	108	108	107	107
113	111	110	110	110	110	109	109	109	109	108
114	112	112	111	111	111	111	110	110	110	110
115	113	113	112	112	112	112	112	111	111	111
116	114	114	114	113	113	113	113	113	112	112
117	115	115	115	115	114	114	114	114	114	113
118	116	116	116	116	116	115	115	115	115	115
119	117	117	117	117	117	117	116	116	116	116
120	119	118	118	118	118	118	118	117	117	117

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

← PERCENT of + 3/4 MATERIAL →

DD	11	12	13	14	15	16	17	18	19	20
121	120	120	119	119	119	119	119	119	118	118
122	121	121	121	120	120	120	120	120	120	120
123	122	122	122	122	121	121	121	121	121	121
124	123	123	123	123	123	123	122	122	122	122
125	124	124	124	124	124	124	124	124	123	123
126	125	125	125	125	125	125	125	125	125	125
127	126	126	126	126	126	126	126	126	126	126
128	128	127	127	127	127	127	127	127	127	127
129	129	129	129	129	129	128	128	128	128	128
130	130	130	130	130	130	130	130	130	130	130
131	131	131	131	131	131	131	131	131	131	131
132	132	132	132	132	132	132	132	132	132	132
133	133	133	133	133	133	133	133	133	133	133
134	134	134	134	134	134	134	134	134	135	135
135	135	135	135	136	136	136	136	136	136	136
136	137	137	137	137	137	137	137	137	137	137
137	138	138	138	138	138	138	138	138	138	138
138	139	139	139	139	139	139	139	139	139	140
139	140	140	140	140	140	140	140	141	141	141
140	141	141	141	141	141	142	142	142	142	142
141	142	142	142	142	143	143	143	143	143	143
142	143	143	144	144	144	144	144	144	144	145
143	144	145	145	145	145	145	145	145	146	146
144	146	146	146	146	146	146	147	147	147	147
145	147	147	147	147	147	148	148	148	148	148
146	148	148	148	148	149	149	149	149	149	150
147	149	149	149	149	150	150	150	150	151	151
148	150	150	150	151	151	151	151	152	152	152
149	151	151	152	152	152	152	153	153	153	153
150	152	152	153	153	153	153	154	154	154	155
151	153	154	154	154	154	155	155	155	156	156
152	154	155	155	155	156	156	156	156	157	157
153	156	156	156	156	157	157	157	158	158	158
154	157	157	157	158	158	158	159	159	159	160
155	158	158	158	159	159	159	160	160	160	161
156	159	159	160	160	160	161	161	161	162	162
157	160	160	161	161	161	162	162	163	163	163
158	161	162	162	162	163	163	163	164	164	165
159	162	163	163	163	164	164	165	165	165	166
160	163	164	164	165	165	165	166	166	167	167

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

← PERCENT of + 3/4 MATERIAL →

DD	21	22	23	24	25	26	27	28	29	30
80	66	65	65	64	63	62	61	60	59	58
81	67	67	66	65	64	63	62	61	60	59
82	69	68	67	66	65	65	64	63	62	61
83	70	69	68	68	67	66	65	64	63	62
84	71	71	70	69	68	67	66	65	64	64
85	73	72	71	70	69	69	68	67	66	65
86	74	73	72	72	71	70	69	68	67	66
87	75	74	74	73	72	71	70	70	69	68
88	76	76	75	74	73	73	72	71	70	69
89	78	77	76	75	75	74	73	72	72	71
90	79	78	78	77	76	75	75	74	73	72
91	80	79	79	78	77	77	76	75	74	74
92	81	81	80	79	79	78	77	77	76	75
93	83	82	81	81	80	79	79	78	77	76
94	84	83	83	82	81	81	80	79	79	78
95	85	85	84	83	83	82	81	81	80	79
96	86	86	85	85	84	83	83	82	81	81
97	88	87	87	86	85	85	84	83	83	82
98	89	88	88	87	87	86	86	85	84	84
99	90	90	89	89	88	87	87	86	86	85
100	92	91	91	90	89	89	88	88	87	86
101	93	92	92	91	91	90	90	89	88	88
102	94	94	93	93	92	92	91	90	90	89
103	95	95	94	94	93	93	92	92	91	91
104	97	96	96	95	95	94	94	93	93	92
105	98	97	97	97	96	96	95	95	94	94
106	99	99	98	98	97	97	96	96	95	95
107	100	100	100	99	99	98	98	97	97	96
108	102	101	101	100	100	100	99	99	98	98
109	103	103	102	102	101	101	101	100	100	99
110	104	104	103	103	103	102	102	102	101	101
111	105	105	105	104	104	104	103	103	103	102
112	107	106	106	106	105	105	105	104	104	104
113	108	108	107	107	107	106	106	106	105	105
114	109	109	109	108	108	108	107	107	107	106
115	111	110	110	110	109	109	109	108	108	108
116	112	112	111	111	111	110	110	110	110	109
117	113	113	113	112	112	112	112	111	111	111
118	114	114	114	114	113	113	113	113	112	112
119	116	115	115	115	115	115	114	114	114	114
120	117	117	116	116	116	116	116	115	115	115

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

PERCENT of + 3/4 MATERIAL

DD	21	22	23	24	25	26	27	28	29	30
121	118	118	118	118	117	117	117	117	117	116
122	119	119	119	119	119	119	118	118	118	118
123	121	121	120	120	120	120	120	120	119	119
124	122	122	122	122	121	121	121	121	121	121
125	123	123	123	123	123	123	122	122	122	122
126	124	124	124	124	124	124	124	124	124	124
127	126	126	126	125	125	125	125	125	125	125
128	127	127	127	127	127	127	127	127	126	126
129	128	128	128	128	128	128	128	128	128	128
130	130	129	129	129	129	129	129	129	129	129
131	131	131	131	131	131	131	131	131	131	131
132	132	132	132	132	132	132	132	132	132	132
133	133	133	133	133	133	133	133	133	133	134
134	135	135	135	135	135	135	135	135	135	135
135	136	136	136	136	136	136	136	136	136	136
136	137	137	137	137	137	137	138	138	138	138
137	138	138	139	139	139	139	139	139	139	139
138	140	140	140	140	140	140	140	140	141	141
139	141	141	141	141	141	142	142	142	142	142
140	142	142	142	143	143	143	143	143	143	144
141	143	144	144	144	144	144	144	145	145	145
142	145	145	145	145	145	146	146	146	146	146
143	146	146	146	147	147	147	147	147	148	148
144	147	147	148	148	148	148	149	149	149	149
145	149	149	149	149	149	150	150	150	150	151
146	150	150	150	150	151	151	151	152	152	152
147	151	151	152	152	152	152	153	153	153	154
148	152	153	153	153	153	154	154	154	155	155
149	154	154	154	154	155	155	155	156	156	156
150	155	155	155	156	156	156	157	157	157	158
151	156	156	157	157	157	158	158	158	159	159
152	157	158	158	158	159	159	159	160	160	161
153	159	159	159	160	160	160	161	161	162	162
154	160	160	161	161	161	162	162	163	163	164
155	161	162	162	162	163	163	164	164	164	165
156	162	163	163	164	164	165	165	165	166	166
157	164	164	165	165	165	166	166	167	167	168
158	165	165	166	166	167	167	168	168	169	169
159	166	167	167	168	168	169	169	170	170	171
160	167	168	168	169	169	170	170	171	172	172

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

← PERCENT of + 3/4 MATERIAL →

DD	31	32	33	34	35	36	37	38	39	40
80	57	56	54	53	52	51	50	48	47	45
81	58	57	56	55	54	52	51	50	49	47
82	60	59	57	56	55	54	53	51	50	49
83	61	60	59	58	57	56	54	53	52	50
84	63	62	60	59	58	57	56	55	53	52
85	64	63	62	61	60	59	58	56	55	54
86	65	64	63	62	61	60	59	58	57	55
87	67	66	65	64	63	62	61	60	58	57
88	68	67	66	65	64	63	62	61	60	59
89	70	69	68	67	66	65	64	63	62	60
90	71	70	69	68	67	66	65	64	63	62
91	73	72	71	70	69	68	67	66	65	64
92	74	73	72	72	71	70	69	68	67	65
93	76	75	74	73	72	71	70	69	68	67
94	77	76	75	75	74	73	72	71	70	69
95	78	78	77	76	75	74	73	72	71	70
96	80	79	78	78	77	76	75	74	73	72
97	81	81	80	79	78	77	77	76	75	74
98	83	82	81	81	80	79	78	77	76	75
99	84	84	83	82	81	81	80	79	78	77
100	86	85	84	84	83	82	81	81	80	79
101	87	87	86	85	84	84	83	82	81	80
102	89	88	87	87	86	85	85	84	83	82
103	90	89	89	88	87	87	86	85	85	84
104	92	91	90	90	89	88	88	87	86	85
105	93	92	92	91	91	90	89	89	88	87
106	94	94	93	93	92	91	91	90	90	89
107	96	95	95	94	94	93	92	92	91	90
108	97	97	96	96	95	95	94	93	93	92
109	99	98	98	97	97	96	96	95	94	94
110	100	100	99	99	98	98	97	97	96	95
111	102	101	101	100	100	99	99	98	98	97
112	103	103	102	102	101	101	100	100	99	99
113	105	104	104	103	103	102	102	101	101	100
114	106	106	105	105	104	104	104	103	103	102
115	107	107	107	106	106	106	105	105	104	104
116	109	109	108	108	107	107	107	106	106	105
117	110	110	110	109	109	109	108	108	108	107
118	112	112	111	111	111	110	110	110	109	109
119	113	113	113	112	112	112	111	111	111	110
120	115	114	114	114	114	113	113	113	112	112

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.4

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
121	116	116	116	115	115	115	115	114	114	114
122	118	117	117	117	117	116	116	116	116	115
123	119	119	119	118	118	118	118	118	117	117
124	121	120	120	120	120	120	119	119	119	119
125	122	122	122	122	121	121	121	121	121	120
126	123	123	123	123	123	123	123	122	122	122
127	125	125	125	125	124	124	124	124	124	124
128	126	126	126	126	126	126	126	126	126	125
129	128	128	128	128	127	127	127	127	127	127
130	129	129	129	129	129	129	129	129	129	129
131	131	131	131	131	131	131	131	131	130	130
132	132	132	132	132	132	132	132	132	132	132
133	134	134	134	134	134	134	134	134	134	134
134	135	135	135	135	135	135	135	135	135	135
135	136	137	137	137	137	137	137	137	137	137
136	138	138	138	138	138	138	138	139	139	139
137	139	139	140	140	140	140	140	140	140	140
138	141	141	141	141	141	141	142	142	142	142
139	142	142	143	143	143	143	143	143	144	144
140	144	144	144	144	144	145	145	145	145	145
141	145	145	146	146	146	146	146	147	147	147
142	147	147	147	147	147	148	148	148	149	149
143	148	148	149	149	149	149	150	150	150	150
144	149	150	150	150	151	151	151	151	152	152
145	151	151	152	152	152	152	153	153	153	154
146	152	153	153	153	154	154	154	155	155	155
147	154	154	154	155	155	156	156	156	157	157
148	155	156	156	156	157	157	158	158	158	159
149	157	157	157	158	158	159	159	160	160	160
150	158	159	159	159	160	160	161	161	162	162
151	160	160	160	161	161	162	162	163	163	164
152	161	162	162	162	163	163	164	164	165	165
153	163	163	163	164	164	165	165	166	167	167
154	164	164	165	165	166	166	167	168	168	169
155	165	166	166	167	167	168	169	169	170	170
156	167	167	168	168	169	170	170	171	171	172
157	168	169	169	170	171	171	172	172	173	174
158	170	170	171	172	172	173	173	174	175	175
159	171	172	172	173	174	174	175	176	176	177
160	173	173	174	175	175	176	177	177	178	179

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

	PERCENT of + 3/4 MATERIAL									
DD	1	2	3	4	5	6	7	8	9	10
80	79	79	78	78	77	76	76	75	74	74
81	80	80	79	79	78	77	77	76	75	75
82	81	81	80	80	79	78	78	77	77	76
83	82	82	81	81	80	80	79	78	78	77
84	83	83	82	82	81	81	80	79	79	78
85	84	84	83	83	82	82	81	80	80	79
86	85	85	84	84	83	83	82	82	81	80
87	86	86	85	85	84	84	83	83	82	81
88	88	87	86	86	85	85	84	84	83	83
89	89	88	88	87	86	86	85	85	84	84
90	90	89	89	88	88	87	86	86	85	85
91	91	90	90	89	89	88	88	87	86	86
92	92	91	91	90	90	89	89	88	88	87
93	93	92	92	91	91	90	90	89	89	88
94	94	93	93	92	92	91	91	90	90	89
95	95	94	94	93	93	92	92	91	91	90
96	96	95	95	94	94	93	93	92	92	91
97	97	96	96	95	95	94	94	93	93	93
98	98	97	97	96	96	95	95	95	94	94
99	99	98	98	97	97	97	96	96	95	95
100	100	99	99	98	98	98	97	97	96	96
101	101	100	100	99	99	99	98	98	97	97
102	102	101	101	101	100	100	99	99	99	98
103	103	102	102	102	101	101	100	100	100	99
104	104	103	103	103	102	102	101	101	101	100
105	105	104	104	104	103	103	103	102	102	101
106	106	105	105	105	104	104	104	103	103	103
107	107	106	106	106	105	105	105	104	104	104
108	108	107	107	107	106	106	106	105	105	105
109	109	108	108	108	108	107	107	107	106	106
110	110	109	109	109	109	108	108	108	107	107
111	111	110	110	110	110	109	109	109	108	108
112	112	111	111	111	111	110	110	110	109	109
113	113	113	112	112	112	111	111	111	111	110
114	114	114	113	113	113	113	112	112	112	111
115	115	115	114	114	114	114	113	113	113	113
116	116	116	115	115	115	115	114	114	114	114
117	117	117	116	116	116	116	115	115	115	115
118	118	118	117	117	117	117	117	116	116	116
119	119	119	118	118	118	118	118	117	117	117
120	120	120	119	119	119	119	119	118	118	118

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	1	2	3	4	5	6	7	8	9	10
121	121	121	120	120	120	120	120	120	119	119
122	122	122	122	121	121	121	121	121	120	120
123	123	123	123	122	122	122	122	122	122	121
124	124	124	124	123	123	123	123	123	123	123
125	125	125	125	124	124	124	124	124	124	124
126	126	126	126	126	125	125	125	125	125	125
127	127	127	127	127	126	126	126	126	126	126
128	128	128	128	128	128	127	127	127	127	127
129	129	129	129	129	129	128	128	128	128	128
130	130	130	130	130	130	130	129	129	129	129
131	131	131	131	131	131	131	131	130	130	130
132	132	132	132	132	132	132	132	132	131	131
133	133	133	133	133	133	133	133	133	133	133
134	134	134	134	134	134	134	134	134	134	134
135	135	135	135	135	135	135	135	135	135	135
136	136	136	136	136	136	136	136	136	136	136
137	137	137	137	137	137	137	137	137	137	137
138	138	138	138	138	138	138	138	138	138	138
139	139	139	139	139	139	139	139	139	139	139
140	140	140	140	140	140	140	140	140	140	140
141	141	141	141	141	141	141	141	141	141	141
142	142	142	142	142	142	142	142	142	142	143
143	143	143	143	143	143	143	143	143	144	144
144	144	144	144	144	144	144	145	145	145	145
145	145	145	145	145	145	145	146	146	146	146
146	146	146	146	146	146	147	147	147	147	147
147	147	147	147	147	148	148	148	148	148	148
148	148	148	148	148	149	149	149	149	149	149
149	149	149	149	149	150	150	150	150	150	150
150	150	150	150	151	151	151	151	151	151	151
151	151	151	151	152	152	152	152	152	152	153
152	152	152	152	153	153	153	153	153	153	154
153	153	153	153	154	154	154	154	154	155	155
154	154	154	155	155	155	155	155	155	156	156
155	155	155	156	156	156	156	156	157	157	157
156	156	156	157	157	157	157	157	158	158	158
157	157	157	158	158	158	158	158	159	159	159
158	158	158	159	159	159	159	160	160	160	160
159	159	159	160	160	160	160	161	161	161	161
160	160	160	161	161	161	161	162	162	162	163

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

	PERCENT of + 3/4 MATERIAL									
DD	11	12	13	14	15	16	17	18	19	20
80	73	72	71	71	70	69	68	67	67	66
81	74	73	73	72	71	70	69	69	68	67
82	75	74	74	73	72	71	71	70	69	68
83	76	76	75	74	73	73	72	71	70	69
84	77	77	76	75	75	74	73	72	72	71
85	79	78	77	76	76	75	74	74	73	72
86	80	79	78	78	77	76	75	75	74	73
87	81	80	79	79	78	77	77	76	75	74
88	82	81	81	80	79	79	78	77	76	76
89	83	82	82	81	80	80	79	78	78	77
90	84	84	83	82	82	81	80	80	79	78
91	85	85	84	83	83	82	82	81	80	79
92	86	86	85	85	84	83	83	82	81	81
93	88	87	86	86	85	85	84	83	83	82
94	89	88	88	87	86	86	85	84	84	83
95	90	89	89	88	88	87	86	86	85	84
96	91	90	90	89	89	88	88	87	86	86
97	92	92	91	90	90	89	89	88	88	87
98	93	93	92	92	91	91	90	89	89	88
99	94	94	93	93	92	92	91	91	90	89
100	95	95	94	94	93	93	92	92	91	91
101	97	96	96	95	95	94	94	93	92	92
102	98	97	97	96	96	95	95	94	94	93
103	99	98	98	97	97	96	96	95	95	94
104	100	99	99	99	98	98	97	97	96	96
105	101	101	100	100	99	99	98	98	97	97
106	102	102	101	101	100	100	100	99	99	98
107	103	103	102	102	102	101	101	100	100	99
108	104	104	104	103	103	102	102	102	101	101
109	106	105	105	104	104	104	103	103	102	102
110	107	106	106	106	105	105	104	104	104	103
111	108	107	107	107	106	106	106	105	105	104
112	109	109	108	108	108	107	107	106	106	106
113	110	110	109	109	109	108	108	108	107	107
114	111	111	111	110	110	110	109	109	109	108
115	112	112	112	111	111	111	110	110	110	109
116	113	113	113	113	112	112	112	111	111	111
117	114	114	114	114	113	113	113	113	112	112
118	116	115	115	115	115	114	114	114	113	113
119	117	117	116	116	116	116	115	115	115	114
120	118	118	117	117	117	117	116	116	116	116

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	11	12	13	14	15	16	17	18	19	20
121	119	119	119	118	118	118	118	117	117	117
122	120	120	120	120	119	119	119	119	118	118
123	121	121	121	121	120	120	120	120	120	119
124	122	122	122	122	122	121	121	121	121	121
125	123	123	123	123	123	123	122	122	122	122
126	125	124	124	124	124	124	124	124	123	123
127	126	126	125	125	125	125	125	125	125	124
128	127	127	127	126	126	126	126	126	126	126
129	128	128	128	128	128	127	127	127	127	127
130	129	129	129	129	129	129	129	128	128	128
131	130	130	130	130	130	130	130	130	130	129
132	131	131	131	131	131	131	131	131	131	131
133	132	132	132	132	132	132	132	132	132	132
134	134	134	134	133	133	133	133	133	133	133
135	135	135	135	135	135	135	135	134	134	134
136	136	136	136	136	136	136	136	136	136	136
137	137	137	137	137	137	137	137	137	137	137
138	138	138	138	138	138	138	138	138	138	138
139	139	139	139	139	139	139	139	139	139	139
140	140	140	140	140	140	141	141	141	141	141
141	141	142	142	142	142	142	142	142	142	142
142	143	143	143	143	143	143	143	143	143	143
143	144	144	144	144	144	144	144	144	144	144
144	145	145	145	145	145	145	145	145	146	146
145	146	146	146	146	146	146	147	147	147	147
146	147	147	147	147	148	148	148	148	148	148
147	148	148	148	149	149	149	149	149	149	149
148	149	149	150	150	150	150	150	150	151	151
149	150	151	151	151	151	151	151	152	152	152
150	152	152	152	152	152	152	153	153	153	153
151	153	153	153	153	153	154	154	154	154	154
152	154	154	154	154	155	155	155	155	155	156
153	155	155	155	156	156	156	156	156	157	157
154	156	156	156	157	157	157	157	158	158	158
155	157	157	158	158	158	158	159	159	159	159
156	158	159	159	159	159	160	160	160	160	161
157	159	160	160	160	160	161	161	161	162	162
158	161	161	161	161	162	162	162	163	163	163
159	162	162	162	163	163	163	163	164	164	164
160	163	163	163	164	164	164	165	165	165	166

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	21	22	23	24	25	26	27	28	29	30
80	65	64	63	62	61	60	59	58	57	55
81	66	65	64	63	62	61	60	59	58	57
82	67	66	65	65	64	63	62	61	59	58
83	69	68	67	66	65	64	63	62	61	60
84	70	69	68	67	66	65	64	63	62	61
85	71	70	69	68	68	67	66	65	64	63
86	72	72	71	70	69	68	67	66	65	64
87	74	73	72	71	70	69	68	67	66	65
88	75	74	73	72	72	71	70	69	68	67
89	76	75	75	74	73	72	71	70	69	68
90	77	77	76	75	74	73	73	72	71	70
91	79	78	77	76	76	75	74	73	72	71
92	80	79	78	78	77	76	75	74	74	73
93	81	81	80	79	78	77	77	76	75	74
94	82	82	81	80	80	79	78	77	76	75
95	84	83	82	82	81	80	79	79	78	77
96	85	84	84	83	82	81	81	80	79	78
97	86	86	85	84	84	83	82	81	81	80
98	88	87	86	86	85	84	83	83	82	81
99	89	88	88	87	86	86	85	84	83	83
100	90	89	89	88	88	87	86	86	85	84
101	91	91	90	90	89	88	88	87	86	85
102	93	92	91	91	90	90	89	88	88	87
103	94	93	93	92	92	91	90	90	89	88
104	95	95	94	93	93	92	92	91	90	90
105	96	96	95	95	94	94	93	92	92	91
106	98	97	97	96	96	95	94	94	93	93
107	99	98	98	97	97	96	96	95	95	94
108	100	100	99	99	98	98	97	97	96	95
109	101	101	101	100	100	99	99	98	97	97
110	103	102	102	101	101	100	100	99	99	98
111	104	104	103	103	102	102	101	101	100	100
112	105	105	104	104	104	103	103	102	102	101
113	107	106	106	105	105	104	104	104	103	103
114	108	107	107	107	106	106	105	105	104	104
115	109	109	108	108	108	107	107	106	106	105
116	110	110	110	109	109	109	108	108	107	107
117	112	111	111	111	110	110	109	109	109	108
118	113	113	112	112	112	111	111	111	110	110
119	114	114	114	113	113	113	112	112	112	111
120	115	115	115	115	114	114	114	113	113	113

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	21	22	23	24	25	26	27	28	29	30
121	117	116	116	116	116	115	115	115	114	114
122	118	118	117	117	117	117	116	116	116	115
123	119	119	119	118	118	118	118	117	117	117
124	120	120	120	120	120	119	119	119	119	118
125	122	122	121	121	121	121	120	120	120	120
126	123	123	123	122	122	122	122	122	121	121
127	124	124	124	124	124	123	123	123	123	123
128	126	125	125	125	125	125	125	124	124	124
129	127	127	127	126	126	126	126	126	126	125
130	128	128	128	128	128	127	127	127	127	127
131	129	129	129	129	129	129	129	129	128	128
132	131	131	130	130	130	130	130	130	130	130
133	132	132	132	132	132	131	131	131	131	131
134	133	133	133	133	133	133	133	133	133	133
135	134	134	134	134	134	134	134	134	134	134
136	136	136	136	136	136	136	136	136	135	135
137	137	137	137	137	137	137	137	137	137	137
138	138	138	138	138	138	138	138	138	138	138
139	139	139	140	140	140	140	140	140	140	140
140	141	141	141	141	141	141	141	141	141	141
141	142	142	142	142	142	142	142	142	143	143
142	143	143	143	143	144	144	144	144	144	144
143	145	145	145	145	145	145	145	145	145	145
144	146	146	146	146	146	146	146	147	147	147
145	147	147	147	147	148	148	148	148	148	148
146	148	148	149	149	149	149	149	149	150	150
147	150	150	150	150	150	150	151	151	151	151
148	151	151	151	151	152	152	152	152	152	153
149	152	152	153	153	153	153	153	154	154	154
150	153	154	154	154	154	154	155	155	155	155
151	155	155	155	155	156	156	156	156	157	157
152	156	156	156	157	157	157	157	158	158	158
153	157	157	158	158	158	159	159	159	159	160
154	158	159	159	159	160	160	160	161	161	161
155	160	160	160	161	161	161	162	162	162	163
156	161	161	162	162	162	163	163	163	164	164
157	162	163	163	163	164	164	164	165	165	165
158	164	164	164	165	165	165	166	166	166	167
159	165	165	165	166	166	167	167	167	168	168
160	166	166	167	167	168	168	168	169	169	170

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
80	54	53	52	50	49	48	46	45	43	42
81	56	55	53	52	51	49	48	47	45	43
82	57	56	55	54	52	51	50	48	47	45
83	59	57	56	55	54	52	51	50	48	47
84	60	59	58	57	55	54	53	51	50	48
85	62	60	59	58	57	56	54	53	52	50
86	63	62	61	60	58	57	56	55	53	52
87	64	63	62	61	60	59	57	56	55	53
88	66	65	64	63	61	60	59	58	56	55
89	67	66	65	64	63	62	61	59	58	57
90	69	68	67	66	65	63	62	61	60	58
91	70	69	68	67	66	65	64	63	61	60
92	72	71	70	69	68	67	65	64	63	62
93	73	72	71	70	69	68	67	66	65	63
94	75	74	73	72	71	70	69	67	66	65
95	76	75	74	73	72	71	70	69	68	67
96	77	77	76	75	74	73	72	71	70	68
97	79	78	77	76	75	74	73	72	71	70
98	80	80	79	78	77	76	75	74	73	72
99	82	81	80	79	78	77	77	76	75	73
100	83	82	82	81	80	79	78	77	76	75
101	85	84	83	82	81	81	80	79	78	77
102	86	85	85	84	83	82	81	80	79	78
103	88	87	86	85	85	84	83	82	81	80
104	89	88	88	87	86	85	84	84	83	82
105	90	90	89	88	88	87	86	85	84	83
106	92	91	91	90	89	88	88	87	86	85
107	93	93	92	91	91	90	89	88	88	87
108	95	94	94	93	92	92	91	90	89	88
109	96	96	95	94	94	93	92	92	91	90
110	98	97	97	96	95	95	94	93	93	92
111	99	99	98	97	97	96	96	95	94	93
112	101	100	100	99	98	98	97	97	96	95
113	102	102	101	100	100	99	99	98	97	97
114	104	103	103	102	101	101	100	100	99	98
115	105	105	104	104	103	102	102	101	101	100
116	106	106	106	105	105	104	104	103	102	102
117	108	107	107	107	106	106	105	105	104	103
118	109	109	109	108	108	107	107	106	106	105
119	111	110	110	110	109	109	108	108	107	107
120	112	112	111	111	111	110	110	109	109	108

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.5

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
121	114	113	113	113	112	112	111	111	111	110
122	115	115	114	114	114	113	113	113	112	112
123	117	116	116	116	115	115	115	114	114	113
124	118	118	117	117	117	117	116	116	116	115
125	119	119	119	119	118	118	118	117	117	117
126	121	121	120	120	120	120	119	119	119	118
127	122	122	122	122	121	121	121	121	120	120
128	124	124	123	123	123	123	123	122	122	122
129	125	125	125	125	125	124	124	124	124	123
130	127	127	126	126	126	126	126	126	125	125
131	128	128	128	128	128	127	127	127	127	127
132	130	130	129	129	129	129	129	129	129	128
133	131	131	131	131	131	131	130	130	130	130
134	133	132	132	132	132	132	132	132	132	132
135	134	134	134	134	134	134	134	134	134	133
136	135	135	135	135	135	135	135	135	135	135
137	137	137	137	137	137	137	137	137	137	137
138	138	138	138	138	138	138	138	138	138	138
139	140	140	140	140	140	140	140	140	140	140
140	141	141	141	141	141	142	142	142	142	142
141	143	143	143	143	143	143	143	143	143	143
142	144	144	144	144	145	145	145	145	145	145
143	146	146	146	146	146	146	146	147	147	147
144	147	147	147	147	148	148	148	148	148	148
145	148	149	149	149	149	149	150	150	150	150
146	150	150	150	150	151	151	151	151	152	152
147	151	152	152	152	152	152	153	153	153	153
148	153	153	153	154	154	154	154	155	155	155
149	154	155	155	155	155	156	156	156	156	157
150	156	156	156	157	157	157	157	158	158	158
151	157	157	158	158	158	159	159	159	160	160
152	159	159	159	160	160	160	161	161	161	162
153	160	160	161	161	161	162	162	163	163	163
154	162	162	162	163	163	163	164	164	165	165
155	163	163	164	164	165	165	165	166	166	167
156	164	165	165	166	166	167	167	167	168	168
157	166	166	167	167	168	168	169	169	170	170
158	167	168	168	169	169	170	170	171	171	172
159	169	169	170	170	171	171	172	172	173	173
160	170	171	171	172	172	173	173	174	175	175

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

	PERCENT of + 3/4 MATERIAL									
DD	1	2	3	4	5	6	7	8	9	10
80	79	79	78	77	77	76	75	75	74	73
81	80	80	79	78	78	77	76	76	75	74
82	81	81	80	79	79	78	77	77	76	75
83	82	82	81	81	80	79	79	78	77	76
84	83	83	82	82	81	80	80	79	78	77
85	84	84	83	83	82	81	81	80	79	79
86	85	85	84	84	83	82	82	81	80	80
87	86	86	85	85	84	83	83	82	81	81
88	87	87	86	86	85	85	84	83	83	82
89	88	88	87	87	86	86	85	84	84	83
90	89	89	88	88	87	87	86	85	85	84
91	90	90	89	89	88	88	87	86	86	85
92	91	91	90	90	89	89	88	88	87	86
93	92	92	91	91	90	90	89	89	88	87
94	94	93	92	92	91	91	90	90	89	89
95	95	94	94	93	92	92	91	91	90	90
96	96	95	95	94	94	93	92	92	91	91
97	97	96	96	95	95	94	94	93	92	92
98	98	97	97	96	96	95	95	94	94	93
99	99	98	98	97	97	96	96	95	95	94
100	100	99	99	98	98	97	97	96	96	95
101	101	100	100	99	99	98	98	97	97	96
102	102	101	101	100	100	99	99	98	98	97
103	103	102	102	101	101	100	100	100	99	99
104	104	103	103	102	102	102	101	101	100	100
105	105	104	104	103	103	103	102	102	101	101
106	106	105	105	104	104	104	103	103	102	102
107	107	106	106	106	105	105	104	104	103	103
108	108	107	107	107	106	106	105	105	105	104
109	109	108	108	108	107	107	106	106	106	105
110	110	109	109	109	108	108	108	107	107	106
111	111	110	110	110	109	109	109	108	108	107
112	112	111	111	111	110	110	110	109	109	109
113	113	112	112	112	111	111	111	110	110	110
114	114	113	113	113	112	112	112	111	111	111
115	115	114	114	114	114	113	113	113	112	112
116	116	115	115	115	115	114	114	114	113	113
117	117	116	116	116	116	115	115	115	114	114
118	118	117	117	117	117	116	116	116	116	115
119	119	119	118	118	118	117	117	117	117	116
120	120	120	119	119	119	119	118	118	118	117

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	1	2	3	4	5	6	7	8	9	10
121	121	121	120	120	120	120	119	119	119	119
122	122	122	121	121	121	121	120	120	120	120
123	123	123	122	122	122	122	122	121	121	121
124	124	124	123	123	123	123	123	122	122	122
125	125	125	124	124	124	124	124	123	123	123
126	126	126	125	125	125	125	125	125	124	124
127	127	127	127	126	126	126	126	126	125	125
128	128	128	128	127	127	127	127	127	127	126
129	129	129	129	128	128	128	128	128	128	127
130	130	130	130	129	129	129	129	129	129	129
131	131	131	131	131	130	130	130	130	130	130
132	132	132	132	132	131	131	131	131	131	131
133	133	133	133	133	132	132	132	132	132	132
134	134	134	134	134	134	133	133	133	133	133
135	135	135	135	135	135	135	134	134	134	134
136	136	136	136	136	136	136	135	135	135	135
137	137	137	137	137	137	137	137	136	136	136
138	138	138	138	138	138	138	138	138	138	137
139	139	139	139	139	139	139	139	139	139	139
140	140	140	140	140	140	140	140	140	140	140
141	141	141	141	141	141	141	141	141	141	141
142	142	142	142	142	142	142	142	142	142	142
143	143	143	143	143	143	143	143	143	143	143
144	144	144	144	144	144	144	144	144	144	144
145	145	145	145	145	145	145	145	145	145	145
146	146	146	146	146	146	146	146	146	146	146
147	147	147	147	147	147	147	147	147	147	147
148	148	148	148	148	148	148	148	148	149	149
149	149	149	149	149	149	149	149	150	150	150
150	150	150	150	150	150	150	151	151	151	151
151	151	151	151	151	151	152	152	152	152	152
152	152	152	152	152	152	153	153	153	153	153
153	153	153	153	153	154	154	154	154	154	154
154	154	154	154	154	155	155	155	155	155	155
155	155	155	155	156	156	156	156	156	156	156
156	156	156	156	157	157	157	157	157	157	157
157	157	157	157	158	158	158	158	158	158	159
158	158	158	158	159	159	159	159	159	160	160
159	159	159	160	160	160	160	160	160	161	161
160	160	160	161	161	161	161	161	161	162	162

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

	PERCENT of + 3/4 MATERIAL									
DD	11	12	13	14	15	16	17	18	19	20
80	72	71	71	70	69	68	67	66	65	64
81	73	73	72	71	70	69	68	67	67	66
82	74	74	73	72	71	70	70	69	68	67
83	76	75	74	73	72	72	71	70	69	68
84	77	76	75	74	74	73	72	71	70	69
85	78	77	76	76	75	74	73	72	71	71
86	79	78	78	77	76	75	74	74	73	72
87	80	79	79	78	77	76	76	75	74	73
88	81	81	80	79	78	78	77	76	75	74
89	82	82	81	80	80	79	78	77	76	76
90	83	83	82	81	81	80	79	78	78	77
91	85	84	83	83	82	81	80	80	79	78
92	86	85	84	84	83	82	82	81	80	79
93	87	86	86	85	84	84	83	82	81	81
94	88	87	87	86	85	85	84	83	83	82
95	89	88	88	87	87	86	85	85	84	83
96	90	90	89	88	88	87	86	86	85	84
97	91	91	90	90	89	88	88	87	86	86
98	92	92	91	91	90	89	89	88	87	87
99	94	93	92	92	91	91	90	89	89	88
100	95	94	94	93	92	92	91	91	90	89
101	96	95	95	94	94	93	92	92	91	91
102	97	96	96	95	95	94	94	93	92	92
103	98	98	97	97	96	95	95	94	94	93
104	99	99	98	98	97	97	96	95	95	94
105	100	100	99	99	98	98	97	97	96	96
106	101	101	101	100	100	99	98	98	97	97
107	103	102	102	101	101	100	100	99	99	98
108	104	103	103	102	102	101	101	100	100	99
109	105	104	104	104	103	103	102	102	101	101
110	106	106	105	105	104	104	103	103	102	102
111	107	107	106	106	105	105	104	104	104	103
112	108	108	107	107	107	106	106	105	105	104
113	109	109	109	108	108	107	107	106	106	106
114	110	110	110	109	109	109	108	108	107	107
115	112	111	111	110	110	110	109	109	108	108
116	113	112	112	112	111	111	111	110	110	109
117	114	113	113	113	112	112	112	111	111	111
118	115	115	114	114	114	113	113	113	112	112
119	116	116	115	115	115	114	114	114	113	113
120	117	117	117	116	116	116	115	115	115	114

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	11	12	13	14	15	16	17	18	19	20
121	118	118	118	117	117	117	117	116	116	116
122	119	119	119	119	118	118	118	117	117	117
123	121	120	120	120	120	119	119	119	118	118
124	122	121	121	121	121	120	120	120	120	119
125	123	123	122	122	122	122	121	121	121	121
126	124	124	123	123	123	123	123	122	122	122
127	125	125	125	124	124	124	124	124	123	123
128	126	126	126	126	125	125	125	125	125	124
129	127	127	127	127	127	126	126	126	126	126
130	128	128	128	128	128	128	127	127	127	127
131	130	129	129	129	129	129	129	128	128	128
132	131	131	130	130	130	130	130	130	129	129
133	132	132	132	131	131	131	131	131	131	131
134	133	133	133	133	132	132	132	132	132	132
135	134	134	134	134	134	134	133	133	133	133
136	135	135	135	135	135	135	135	135	134	134
137	136	136	136	136	136	136	136	136	136	136
138	137	137	137	137	137	137	137	137	137	137
139	139	138	138	138	138	138	138	138	138	138
140	140	140	140	140	140	139	139	139	139	139
141	141	141	141	141	141	141	141	141	141	141
142	142	142	142	142	142	142	142	142	142	142
143	143	143	143	143	143	143	143	143	143	143
144	144	144	144	144	144	144	144	144	144	144
145	145	145	145	145	145	145	145	145	146	146
146	146	146	146	147	147	147	147	147	147	147
147	148	148	148	148	148	148	148	148	148	148
148	149	149	149	149	149	149	149	149	149	149
149	150	150	150	150	150	150	150	150	150	151
150	151	151	151	151	151	151	151	152	152	152
151	152	152	152	152	152	153	153	153	153	153
152	153	153	153	154	154	154	154	154	154	154
153	154	154	155	155	155	155	155	155	155	156
154	155	156	156	156	156	156	156	156	157	157
155	157	157	157	157	157	157	158	158	158	158
156	158	158	158	158	158	159	159	159	159	159
157	159	159	159	159	160	160	160	160	160	161
158	160	160	160	160	161	161	161	161	162	162
159	161	161	161	162	162	162	162	163	163	163
160	162	162	163	163	163	163	164	164	164	164

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	21	22	23	24	25	26	27	28	29	30
80	63	62	61	60	59	58	57	56	54	53
81	65	64	63	61	60	59	58	57	56	55
82	66	65	64	63	62	61	60	58	57	56
83	67	66	65	64	63	62	61	60	59	57
84	68	67	66	65	64	63	62	61	60	59
85	70	69	68	67	66	65	64	63	61	60
86	71	70	69	68	67	66	65	64	63	62
87	72	71	70	69	68	67	66	65	64	63
88	73	73	72	71	70	69	68	67	66	65
89	75	74	73	72	71	70	69	68	67	66
90	76	75	74	73	72	71	70	69	68	67
91	77	76	76	75	74	73	72	71	70	69
92	79	78	77	76	75	74	73	72	71	70
93	80	79	78	77	76	76	75	74	73	72
94	81	80	79	79	78	77	76	75	74	73
95	82	82	81	80	79	78	77	76	75	75
96	84	83	82	81	80	80	79	78	77	76
97	85	84	83	83	82	81	80	79	78	77
98	86	85	85	84	83	82	81	81	80	79
99	87	87	86	85	84	84	83	82	81	80
100	89	88	87	86	86	85	84	83	83	82
101	90	89	89	88	87	86	86	85	84	83
102	91	91	90	89	88	88	87	86	85	85
103	92	92	91	90	90	89	88	88	87	86
104	94	93	92	92	91	90	90	89	88	87
105	95	94	94	93	92	92	91	90	90	89
106	96	96	95	94	94	93	92	92	91	90
107	97	97	96	96	95	94	94	93	92	92
108	99	98	98	97	96	96	95	94	94	93
109	100	99	99	98	98	97	97	96	95	95
110	101	101	100	100	99	98	98	97	97	96
111	103	102	102	101	100	100	99	99	98	97
112	104	103	103	102	102	101	101	100	99	99
113	105	105	104	104	103	103	102	101	101	100
114	106	106	105	105	104	104	103	103	102	102
115	108	107	107	106	106	105	105	104	104	103
116	109	108	108	108	107	107	106	106	105	105
117	110	110	109	109	108	108	107	107	106	106
118	111	111	111	110	110	109	109	108	108	107
119	113	112	112	111	111	111	110	110	109	109
120	114	114	113	113	112	112	112	111	111	110

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	21	22	23	24	25	26	27	28	29	30
121	115	115	114	114	114	113	113	113	112	112
122	116	116	116	115	115	115	114	114	114	113
123	118	117	117	117	116	116	116	115	115	115
124	119	119	118	118	118	117	117	117	116	116
125	120	120	120	119	119	119	118	118	118	117
126	122	121	121	121	120	120	120	119	119	119
127	123	123	122	122	122	121	121	121	121	120
128	124	124	124	123	123	123	123	122	122	122
129	125	125	125	125	124	124	124	124	123	123
130	127	126	126	126	126	126	125	125	125	125
131	128	128	127	127	127	127	127	126	126	126
132	129	129	129	129	128	128	128	128	128	127
133	130	130	130	130	130	130	129	129	129	129
134	132	132	131	131	131	131	131	131	130	130
135	133	133	133	133	132	132	132	132	132	132
136	134	134	134	134	134	134	133	133	133	133
137	135	135	135	135	135	135	135	135	135	135
138	137	137	137	136	136	136	136	136	136	136
139	138	138	138	138	138	138	138	138	137	137
140	139	139	139	139	139	139	139	139	139	139
141	141	141	140	140	140	140	140	140	140	140
142	142	142	142	142	142	142	142	142	142	142
143	143	143	143	143	143	143	143	143	143	143
144	144	144	144	144	144	144	144	144	145	145
145	146	146	146	146	146	146	146	146	146	146
146	147	147	147	147	147	147	147	147	147	147
147	148	148	148	148	148	148	149	149	149	149
148	149	149	150	150	150	150	150	150	150	150
149	151	151	151	151	151	151	151	151	152	152
150	152	152	152	152	152	153	153	153	153	153
151	153	153	153	154	154	154	154	154	154	155
152	154	155	155	155	155	155	155	156	156	156
153	156	156	156	156	156	157	157	157	157	157
154	157	157	157	158	158	158	158	158	159	159
155	158	158	159	159	159	159	160	160	160	160
156	160	160	160	160	160	161	161	161	161	162
157	161	161	161	161	162	162	162	163	163	163
158	162	162	163	163	163	163	164	164	164	165
159	163	164	164	164	164	165	165	165	166	166
160	165	165	165	165	166	166	166	167	167	167

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
80	52	50	49	48	46	45	43	42	40	38
81	53	52	51	49	48	46	45	43	42	40
82	55	53	52	51	49	48	46	45	43	41
83	56	55	54	52	51	49	48	46	45	43
84	58	56	55	54	52	51	49	48	46	45
85	59	58	57	55	54	53	51	50	48	46
86	60	59	58	57	55	54	53	51	50	48
87	62	61	60	58	57	56	54	53	51	50
88	63	62	61	60	59	57	56	54	53	51
89	65	64	63	61	60	59	57	56	55	53
90	66	65	64	63	62	60	59	58	56	55
91	68	67	66	64	63	62	61	59	58	56
92	69	68	67	66	65	63	62	61	60	58
93	71	70	68	67	66	65	64	62	61	60
94	72	71	70	69	68	67	65	64	63	61
95	74	73	71	70	69	68	67	66	64	63
96	75	74	73	72	71	70	69	67	66	65
97	76	75	74	73	72	71	70	69	68	66
98	78	77	76	75	74	73	72	71	69	68
99	79	78	77	76	75	74	73	72	71	70
100	81	80	79	78	77	76	75	74	73	71
101	82	81	80	79	79	78	76	75	74	73
102	84	83	82	81	80	79	78	77	76	75
103	85	84	83	83	82	81	80	79	78	76
104	87	86	85	84	83	82	81	80	79	78
105	88	87	86	86	85	84	83	82	81	80
106	89	89	88	87	86	85	84	83	82	81
107	91	90	89	89	88	87	86	85	84	83
108	92	92	91	90	89	88	88	87	86	85
109	94	93	92	92	91	90	89	88	87	86
110	95	95	94	93	92	92	91	90	89	88
111	97	96	95	95	94	93	92	92	91	90
112	98	98	97	96	95	95	94	93	92	91
113	100	99	98	98	97	96	96	95	94	93
114	101	100	100	99	99	98	97	96	96	95
115	103	102	101	101	100	99	99	98	97	96
116	104	103	103	102	102	101	100	100	99	98
117	105	105	104	104	103	103	102	101	101	100
118	107	106	106	105	105	104	103	103	102	101
119	108	108	107	107	106	106	105	104	104	103
120	110	109	109	108	108	107	107	106	105	105

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.6

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
121	111	111	110	110	109	109	108	108	107	106
122	113	112	112	111	111	110	110	109	109	108
123	114	114	113	113	112	112	111	111	110	110
124	116	115	115	114	114	113	113	112	112	111
125	117	117	116	116	115	115	115	114	114	113
126	118	118	118	117	117	117	116	116	115	115
127	120	120	119	119	119	118	118	117	117	116
128	121	121	121	120	120	120	119	119	119	118
129	123	123	122	122	122	121	121	121	120	120
130	124	124	124	123	123	123	122	122	122	121
131	126	125	125	125	125	124	124	124	123	123
132	127	127	127	126	126	126	126	125	125	125
133	129	128	128	128	128	128	127	127	127	126
134	130	130	130	129	129	129	129	129	128	128
135	132	131	131	131	131	131	130	130	130	130
136	133	133	133	133	132	132	132	132	132	131
137	134	134	134	134	134	134	134	133	133	133
138	136	136	136	136	135	135	135	135	135	135
139	137	137	137	137	137	137	137	137	137	136
140	139	139	139	139	139	138	138	138	138	138
141	140	140	140	140	140	140	140	140	140	140
142	142	142	142	142	142	142	142	142	142	141
143	143	143	143	143	143	143	143	143	143	143
144	145	145	145	145	145	145	145	145	145	145
145	146	146	146	146	146	146	146	146	146	146
146	147	148	148	148	148	148	148	148	148	148
147	149	149	149	149	149	149	149	150	150	150
148	150	150	151	151	151	151	151	151	151	151
149	152	152	152	152	152	153	153	153	153	153
150	153	153	154	154	154	154	154	154	155	155
151	155	155	155	155	155	156	156	156	156	156
152	156	156	157	157	157	157	157	158	158	158
153	158	158	158	158	159	159	159	159	160	160
154	159	159	160	160	160	160	161	161	161	161
155	160	161	161	161	162	162	162	162	163	163
156	162	162	163	163	163	163	164	164	164	165
157	163	164	164	164	165	165	165	166	166	166
158	165	165	166	166	166	167	167	167	168	168
159	166	167	167	167	168	168	169	169	169	170
160	168	168	168	169	169	170	170	171	171	171

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

PERCENT of + 3/4 MATERIAL

DD	1	2	3	4	5	6	7	8	9	10
80	79	79	78	77	76	76	75	74	73	72
81	80	80	79	78	77	77	76	75	74	74
82	81	81	80	79	79	78	77	76	75	75
83	82	82	81	80	80	79	78	77	77	76
84	83	83	82	81	81	80	79	78	78	77
85	84	84	83	82	82	81	80	79	79	78
86	85	85	84	83	83	82	81	81	80	79
87	86	86	85	84	84	83	82	82	81	80
88	87	87	86	85	85	84	83	83	82	81
89	88	88	87	87	86	85	85	84	83	82
90	89	89	88	88	87	86	86	85	84	84
91	90	90	89	89	88	87	87	86	85	85
92	91	91	90	90	89	88	88	87	86	86
93	92	92	91	91	90	89	89	88	88	87
94	93	93	92	92	91	91	90	89	89	88
95	94	94	93	93	92	92	91	90	90	89
96	95	95	94	94	93	93	92	91	91	90
97	96	96	95	95	94	94	93	93	92	91
98	97	97	96	96	95	95	94	94	93	92
99	99	98	97	97	96	96	95	95	94	94
100	100	99	99	98	97	97	96	96	95	95
101	101	100	100	99	99	98	97	97	96	96
102	102	101	101	100	100	99	99	98	97	97
103	103	102	102	101	101	100	100	99	99	98
104	104	103	103	102	102	101	101	100	100	99
105	105	104	104	103	103	102	102	101	101	100
106	106	105	105	104	104	103	103	102	102	101
107	107	106	106	105	105	104	104	103	103	102
108	108	107	107	106	106	105	105	104	104	104
109	109	108	108	107	107	106	106	106	105	105
110	110	109	109	108	108	108	107	107	106	106
111	111	110	110	109	109	109	108	108	107	107
112	112	111	111	110	110	110	109	109	108	108
113	113	112	112	112	111	111	110	110	110	109
114	114	113	113	113	112	112	111	111	111	110
115	115	114	114	114	113	113	112	112	112	111
116	116	115	115	115	114	114	114	113	113	112
117	117	116	116	116	115	115	115	114	114	114
118	118	117	117	117	116	116	116	115	115	115
119	119	118	118	118	117	117	117	116	116	116
120	120	119	119	119	119	118	118	118	117	117

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

PERCENT of + 3/4 MATERIAL

DD	1	2	3	4	5	6	7	8	9	10
121	121	120	120	120	120	119	119	119	118	118
122	122	121	121	121	121	120	120	120	119	119
123	123	122	122	122	122	121	121	121	121	120
124	124	124	123	123	123	122	122	122	122	121
125	125	125	124	124	124	124	123	123	123	122
126	126	126	125	125	125	125	124	124	124	124
127	127	127	126	126	126	126	125	125	125	125
128	128	128	127	127	127	127	126	126	126	126
129	129	129	128	128	128	128	128	127	127	127
130	130	130	129	129	129	129	129	128	128	128
131	131	131	130	130	130	130	130	129	129	129
132	132	132	131	131	131	131	131	131	130	130
133	133	133	133	132	132	132	132	132	131	131
134	134	134	134	133	133	133	133	133	133	132
135	135	135	135	134	134	134	134	134	134	134
136	136	136	136	135	135	135	135	135	135	135
137	137	137	137	137	136	136	136	136	136	136
138	138	138	138	138	137	137	137	137	137	137
139	139	139	139	139	139	138	138	138	138	138
140	140	140	140	140	140	139	139	139	139	139
141	141	141	141	141	141	141	140	140	140	140
142	142	142	142	142	142	142	142	141	141	141
143	143	143	143	143	143	143	143	143	142	142
144	144	144	144	144	144	144	144	144	144	144
145	145	145	145	145	145	145	145	145	145	145
146	146	146	146	146	146	146	146	146	146	146
147	147	147	147	147	147	147	147	147	147	147
148	148	148	148	148	148	148	148	148	148	148
149	149	149	149	149	149	149	149	149	149	149
150	150	150	150	150	150	150	150	150	150	150
151	151	151	151	151	151	151	151	151	151	151
152	152	152	152	152	152	152	152	152	152	152
153	153	153	153	153	153	153	153	153	153	154
154	154	154	154	154	154	154	154	154	155	155
155	155	155	155	155	155	155	156	156	156	156
156	156	156	156	156	156	156	157	157	157	157
157	157	157	157	157	157	158	158	158	158	158
158	158	158	158	158	159	159	159	159	159	159
159	159	159	159	159	160	160	160	160	160	160
160	160	160	160	160	161	161	161	161	161	161

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

PERCENT of + 3/4 MATERIAL

DD	11	12	13	14	15	16	17	18	19	20
80	72	71	70	69	68	67	66	65	64	63
81	73	72	71	70	69	68	67	66	65	64
82	74	73	72	71	70	69	68	67	66	65
83	75	74	73	72	71	71	70	69	68	67
84	76	75	74	74	73	72	71	70	69	68
85	77	76	76	75	74	73	72	71	70	69
86	78	78	77	76	75	74	73	72	71	70
87	79	79	78	77	76	75	74	74	73	72
88	81	80	79	78	77	77	76	75	74	73
89	82	81	80	79	79	78	77	76	75	74
90	83	82	81	81	80	79	78	77	76	75
91	84	83	82	82	81	80	79	78	78	77
92	85	84	84	83	82	81	80	80	79	78
93	86	85	85	84	83	82	82	81	80	79
94	87	87	86	85	84	84	83	82	81	80
95	88	88	87	86	86	85	84	83	83	82
96	90	89	88	87	87	86	85	85	84	83
97	91	90	89	89	88	87	87	86	85	84
98	92	91	90	90	89	88	88	87	86	85
99	93	92	92	91	90	90	89	88	87	87
100	94	93	93	92	91	91	90	89	89	88
101	95	95	94	93	93	92	91	91	90	89
102	96	96	95	94	94	93	93	92	91	90
103	97	97	96	96	95	94	94	93	92	92
104	99	98	97	97	96	96	95	94	94	93
105	100	99	99	98	97	97	96	96	95	94
106	101	100	100	99	99	98	97	97	96	95
107	102	101	101	100	100	99	99	98	97	97
108	103	103	102	101	101	100	100	99	99	98
109	104	104	103	103	102	102	101	100	100	99
110	105	105	104	104	103	103	102	102	101	100
111	106	106	105	105	104	104	103	103	102	102
112	108	107	107	106	106	105	105	104	103	103
113	109	108	108	107	107	106	106	105	105	104
114	110	109	109	108	108	107	107	106	106	105
115	111	110	110	110	109	109	108	108	107	107
116	112	112	111	111	110	110	109	109	108	108
117	113	113	112	112	111	111	111	110	110	109
118	114	114	113	113	113	112	112	111	111	110
119	115	115	115	114	114	113	113	113	112	112
120	117	116	116	115	115	115	114	114	113	113

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

	← PERCENT of + 3/4 MATERIAL →									
DD	11	12	13	14	15	16	17	18	19	20
121	118	117	117	117	116	116	115	115	115	114
122	119	118	118	118	117	117	117	116	116	115
123	120	120	119	119	119	118	118	117	117	117
124	121	121	120	120	120	119	119	119	118	118
125	122	122	122	121	121	121	120	120	120	119
126	123	123	123	122	122	122	121	121	121	120
127	124	124	124	124	123	123	123	122	122	122
128	125	125	125	125	124	124	124	124	123	123
129	127	126	126	126	126	125	125	125	124	124
130	128	128	127	127	127	127	126	126	126	125
131	129	129	128	128	128	128	127	127	127	127
132	130	130	130	129	129	129	129	128	128	128
133	131	131	131	131	130	130	130	130	129	129
134	132	132	132	132	131	131	131	131	131	130
135	133	133	133	133	133	132	132	132	132	132
136	134	134	134	134	134	134	133	133	133	133
137	136	135	135	135	135	135	135	135	134	134
138	137	137	136	136	136	136	136	136	136	135
139	138	138	138	137	137	137	137	137	137	137
140	139	139	139	139	139	138	138	138	138	138
141	140	140	140	140	140	140	140	139	139	139
142	141	141	141	141	141	141	141	141	141	140
143	142	142	142	142	142	142	142	142	142	142
144	143	143	143	143	143	143	143	143	143	143
145	145	145	145	144	144	144	144	144	144	144
146	146	146	146	146	146	146	146	146	145	145
147	147	147	147	147	147	147	147	147	147	147
148	148	148	148	148	148	148	148	148	148	148
149	149	149	149	149	149	149	149	149	149	149
150	150	150	150	150	150	150	150	150	150	150
151	151	151	151	151	151	152	152	152	152	152
152	152	153	153	153	153	153	153	153	153	153
153	154	154	154	154	154	154	154	154	154	154
154	155	155	155	155	155	155	155	155	155	155
155	156	156	156	156	156	156	156	156	157	157
156	157	157	157	157	157	157	158	158	158	158
157	158	158	158	158	159	159	159	159	159	159
158	159	159	159	160	160	160	160	160	160	160
159	160	160	161	161	161	161	161	161	162	162
160	161	162	162	162	162	162	162	163	163	163

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

	PERCENT of + 3/4 MATERIAL									
DD	21	22	23	24	25	26	27	28	29	30
80	62	61	60	58	57	56	55	53	52	51
81	63	62	61	60	59	57	56	55	54	52
82	64	63	62	61	60	59	57	56	55	54
83	66	65	64	62	61	60	59	58	56	55
84	67	66	65	64	63	61	60	59	58	56
85	68	67	66	65	64	63	62	60	59	58
86	69	68	67	66	65	64	63	62	61	59
87	71	70	69	68	67	65	64	63	62	61
88	72	71	70	69	68	67	66	65	63	62
89	73	72	71	70	69	68	67	66	65	64
90	75	74	73	72	71	70	68	67	66	65
91	76	75	74	73	72	71	70	69	68	66
92	77	76	75	74	73	72	71	70	69	68
93	78	77	76	76	75	74	73	72	70	69
94	80	79	78	77	76	75	74	73	72	71
95	81	80	79	78	77	76	75	74	73	72
96	82	81	80	79	79	78	77	76	75	74
97	83	83	82	81	80	79	78	77	76	75
98	85	84	83	82	81	80	79	78	77	76
99	86	85	84	83	83	82	81	80	79	78
100	87	86	86	85	84	83	82	81	80	79
101	88	88	87	86	85	84	84	83	82	81
102	90	89	88	87	87	86	85	84	83	82
103	91	90	89	89	88	87	86	85	85	84
104	92	92	91	90	89	88	88	87	86	85
105	93	93	92	91	91	90	89	88	87	86
106	95	94	93	93	92	91	90	90	89	88
107	96	95	95	94	93	93	92	91	90	89
108	97	97	96	95	95	94	93	92	92	91
109	99	98	97	97	96	95	94	94	93	92
110	100	99	99	98	97	97	96	95	94	94
111	101	100	100	99	99	98	97	97	96	95
112	102	102	101	101	100	99	99	98	97	96
113	104	103	102	102	101	101	100	99	99	98
114	105	104	104	103	103	102	101	101	100	99
115	106	106	105	104	104	103	103	102	101	101
116	107	107	106	106	105	105	104	103	103	102
117	109	108	108	107	107	106	105	105	104	104
118	110	109	109	108	108	107	107	106	106	105
119	111	111	110	110	109	109	108	108	107	106
120	112	112	112	111	111	110	110	109	108	108

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF **2.7**

← PERCENT of + 3/4 MATERIAL →

DD	21	22	23	24	25	26	27	28	29	30
121	114	113	113	112	112	111	111	110	110	109
122	115	115	114	114	113	113	112	112	111	111
123	116	116	115	115	115	114	114	113	113	112
124	118	117	117	116	116	115	115	115	114	114
125	119	118	118	118	117	117	116	116	115	115
126	120	120	119	119	119	118	118	117	117	116
127	121	121	121	120	120	120	119	119	118	118
128	123	122	122	122	121	121	121	120	120	119
129	124	124	123	123	123	122	122	122	121	121
130	125	125	125	124	124	124	123	123	123	122
131	126	126	126	126	125	125	125	124	124	124
132	128	127	127	127	127	126	126	126	125	125
133	129	129	128	128	128	128	127	127	127	126
134	130	130	130	129	129	129	129	128	128	128
135	131	131	131	131	131	130	130	130	130	129
136	133	133	132	132	132	132	131	131	131	131
137	134	134	134	133	133	133	133	133	132	132
138	135	135	135	135	135	134	134	134	134	134
139	137	136	136	136	136	136	136	135	135	135
140	138	138	138	137	137	137	137	137	137	136
141	139	139	139	139	139	138	138	138	138	138
142	140	140	140	140	140	140	140	140	139	139
143	142	142	141	141	141	141	141	141	141	141
144	143	143	143	143	143	143	142	142	142	142
145	144	144	144	144	144	144	144	144	144	144
146	145	145	145	145	145	145	145	145	145	145
147	147	147	147	147	147	147	147	147	146	146
148	148	148	148	148	148	148	148	148	148	148
149	149	149	149	149	149	149	149	149	149	149
150	150	150	151	151	151	151	151	151	151	151
151	152	152	152	152	152	152	152	152	152	152
152	153	153	153	153	153	153	153	153	154	154
153	154	154	154	154	155	155	155	155	155	155
154	156	156	156	156	156	156	156	156	156	156
155	157	157	157	157	157	157	157	158	158	158
156	158	158	158	158	159	159	159	159	159	159
157	159	159	160	160	160	160	160	160	161	161
158	161	161	161	161	161	161	162	162	162	162
159	162	162	162	162	163	163	163	163	163	164
160	163	163	164	164	164	164	164	165	165	165

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

PERCENT of + 3/4 MATERIAL

DD	31	32	33	34	35	36	37	38	39	40
80	49	48	46	45	43	42	40	38	36	34
81	51	49	48	46	45	43	41	40	38	36
82	52	51	49	48	46	45	43	41	40	38
83	54	52	51	49	48	46	45	43	41	39
84	55	54	52	51	49	48	46	45	43	41
85	57	55	54	52	51	49	48	46	45	43
86	58	57	55	54	52	51	49	48	46	44
87	59	58	57	55	54	53	51	49	48	46
88	61	60	58	57	56	54	53	51	49	48
89	62	61	60	58	57	56	54	53	51	49
90	64	63	61	60	59	57	56	54	53	51
91	65	64	63	62	60	59	57	56	54	53
92	67	66	64	63	62	60	59	58	56	54
93	68	67	66	65	63	62	61	59	58	56
94	70	68	67	66	65	63	62	61	59	58
95	71	70	69	68	66	65	64	62	61	59
96	73	71	70	69	68	67	65	64	63	61
97	74	73	72	71	69	68	67	66	64	63
98	75	74	73	72	71	70	68	67	66	64
99	77	76	75	74	72	71	70	69	68	66
100	78	77	76	75	74	73	72	70	69	68
101	80	79	78	77	76	74	73	72	71	69
102	81	80	79	78	77	76	75	74	72	71
103	83	82	81	80	79	78	76	75	74	73
104	84	83	82	81	80	79	78	77	76	74
105	86	85	84	83	82	81	80	78	77	76
106	87	86	85	84	83	82	81	80	79	78
107	88	88	87	86	85	84	83	82	81	79
108	90	89	88	87	86	85	84	83	82	81
109	91	91	90	89	88	87	86	85	84	83
110	93	92	91	90	89	88	88	87	86	84
111	94	93	93	92	91	90	89	88	87	86
112	96	95	94	93	92	92	91	90	89	88
113	97	96	96	95	94	93	92	91	90	89
114	99	98	97	96	96	95	94	93	92	91
115	100	99	99	98	97	96	95	95	94	93
116	102	101	100	99	99	98	97	96	95	94
117	103	102	102	101	100	99	99	98	97	96
118	104	104	103	102	102	101	100	99	99	98
119	106	105	105	104	103	103	102	101	100	99
120	107	107	106	105	105	104	103	103	102	101

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING

DENSITY OF -3/4 INCH MATERIAL WITH THE +3/4 INCH MATERIAL SPECIFIC GRAVITY OF 2.7

	PERCENT of + 3/4 MATERIAL									
DD	31	32	33	34	35	36	37	38	39	40
121	109	108	108	107	106	106	105	104	104	103
122	110	110	109	108	108	107	107	106	105	104
123	112	111	111	110	109	109	108	108	107	106
124	113	113	112	112	111	110	110	109	108	108
125	115	114	114	113	112	112	111	111	110	109
126	116	116	115	115	114	113	113	112	112	111
127	117	117	117	116	116	115	115	114	113	113
128	119	118	118	118	117	117	116	116	115	114
129	120	120	120	119	119	118	118	117	117	116
130	122	121	121	121	120	120	119	119	118	118
131	123	123	122	122	122	121	121	120	120	119
132	125	124	124	124	123	123	122	122	122	121
133	126	126	125	125	125	124	124	124	123	123
134	128	127	127	127	126	126	126	125	125	124
135	129	129	128	128	128	128	127	127	127	126
136	130	130	130	130	129	129	129	128	128	128
137	132	132	131	131	131	131	130	130	130	129
138	133	133	133	133	132	132	132	132	131	131
139	135	135	134	134	134	134	134	133	133	133
140	136	136	136	136	136	135	135	135	135	134
141	138	138	137	137	137	137	137	137	136	136
142	139	139	139	139	139	138	138	138	138	138
143	141	141	140	140	140	140	140	140	140	139
144	142	142	142	142	142	142	141	141	141	141
145	144	143	143	143	143	143	143	143	143	143
146	145	145	145	145	145	145	145	145	145	144
147	146	146	146	146	146	146	146	146	146	146
148	148	148	148	148	148	148	148	148	148	148
149	149	149	149	149	149	149	149	149	149	149
150	151	151	151	151	151	151	151	151	151	151
151	152	152	152	152	152	153	153	153	153	153
152	154	154	154	154	154	154	154	154	154	154
153	155	155	155	155	156	156	156	156	156	156
154	157	157	157	157	157	157	157	158	158	158
155	158	158	158	158	159	159	159	159	159	159
156	159	160	160	160	160	160	161	161	161	161
157	161	161	161	162	162	162	162	162	163	163
158	162	163	163	163	163	163	164	164	164	164
159	164	164	164	165	165	165	165	166	166	166
160	165	166	166	166	166	167	167	167	168	168

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF THE POINT LOAD STRENGTH INDEX OF ROCK

1. PURPOSE

1.1 To establish a procedure for determining the point load strength index of rock used for estimating the unconfined compressive strength of intact rock core specimens.

2. SCOPE

2.1 Specimens in the form of rock cores, blocks, or irregular lumps that are isotropic and anisotropic can be tested by this test method.

2.2 This test method can be performed in the field or laboratory.

2.3 This is an index test and is intended to be used to classify and characterize rock.

2.4 This test method applies to compressive strength over 2200 psi (15 MPa).

3. REFERENCES

3.1 ASTM D 5731 Standard Test Method for Determination of the Point Load Strength Index of Rock

3.2 ASTM D 5079 Practices for Preserving and Transporting Rock Core Samples

3.3 International Society for Rock Mechanics (ISRM)

3.4 Peabody Group Using the Point Load Test to Determine the Uniaxial Compressive Strength of Coal Measure Rock

4. EQUIPMENT

4.1 A point load tester comprised of a loading frame, conical and flat platens, a load (P) indicator, and a means for measuring the distance (D), between the two platen contact points.

4.2 Measuring Device: A caliper or a steel rule to measure the width (W), with an accuracy of +/- 5% of specimens for all but the diametral test.

4.3 Miscellaneous Items: Diamond saw, chisels, and rock hammer.

5. DEFINITIONS

5.1 Point Load Strength Index – An indicator of strength obtained by subjecting a rock specimen to an increasingly concentrated point load applied through a pair of conical platens until failure occurs.

6. SPECIMEN PREPARATION

6.1 Sampling: When testing core or block specimens, at least ten specimens should be selected. When testing irregular-shaped specimens obtained by other means, at least 20 specimens should be selected. However, if unable to obtain the required minimum number of samples, perform the test annotating the reason and number of samples obtained. A minimum number of three samples are needed to perform the statistical calculation required.

6.2 Dimensions: The specimen's external diameter shall not be less than 1.2 inches (30 mm) and not more than 3.4 inches (85 mm), with the preferred dimension about 2.0 inches (50 mm).

6.3 Anisotropic Rock: When a specimen is shaly, bedded, schistose or otherwise observably anisotropic, it should be tested as close to the direction of design loading as possible. If the bedding plane from the horizontal is equal to or greater then an angle of 45°, testing should be conducted parallel to the bedding plane. If the bedding is less than 45°, testing is conducted normal to the bedding plane. Core trimming may be required to facilitate proper placement of the specimen between platens (Figure 6).

6.4 Size and Shape Requirements: For axial, diametral, block or irregular shape, specimen testing shall conform to the recommendation shown in Figure 6.1.

The specimens shall be free from irregularities that can generate stress concentrations. Anisotropic specimens may require trimming their edges to facilitate loading (Figure 6).

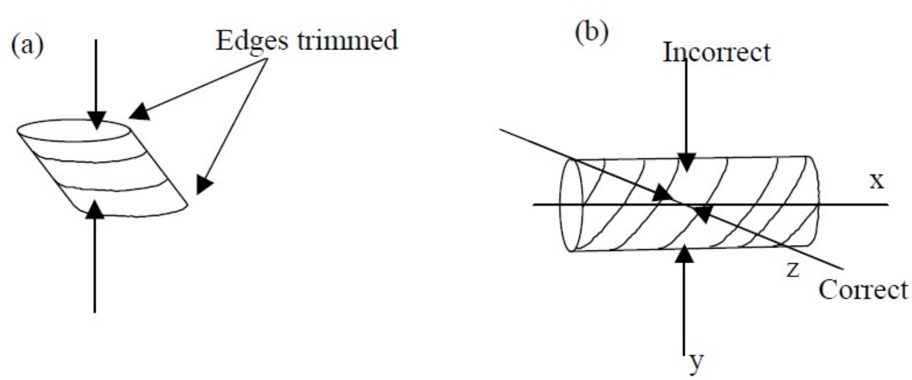


Figure 6: Loading directions for test on anisotropic rock.

6.5 Water Content: Each specimen should be tested at the in-situ water content. Exercise caution when handling, shipping and storing specimen to ensure the original moisture content is preserved.

6.6 Marking and Measuring Specimens: Indicate the desired test orientation of the specimen by marking lines on the specimen. These lines are for centering the specimen in the point load machine to ensure proper orientation during testing.

6.7 Measuring: Measure each dimension of each specimen at three different places. Average each of the three values to obtain the dimension, in each direction, used in the calculations.

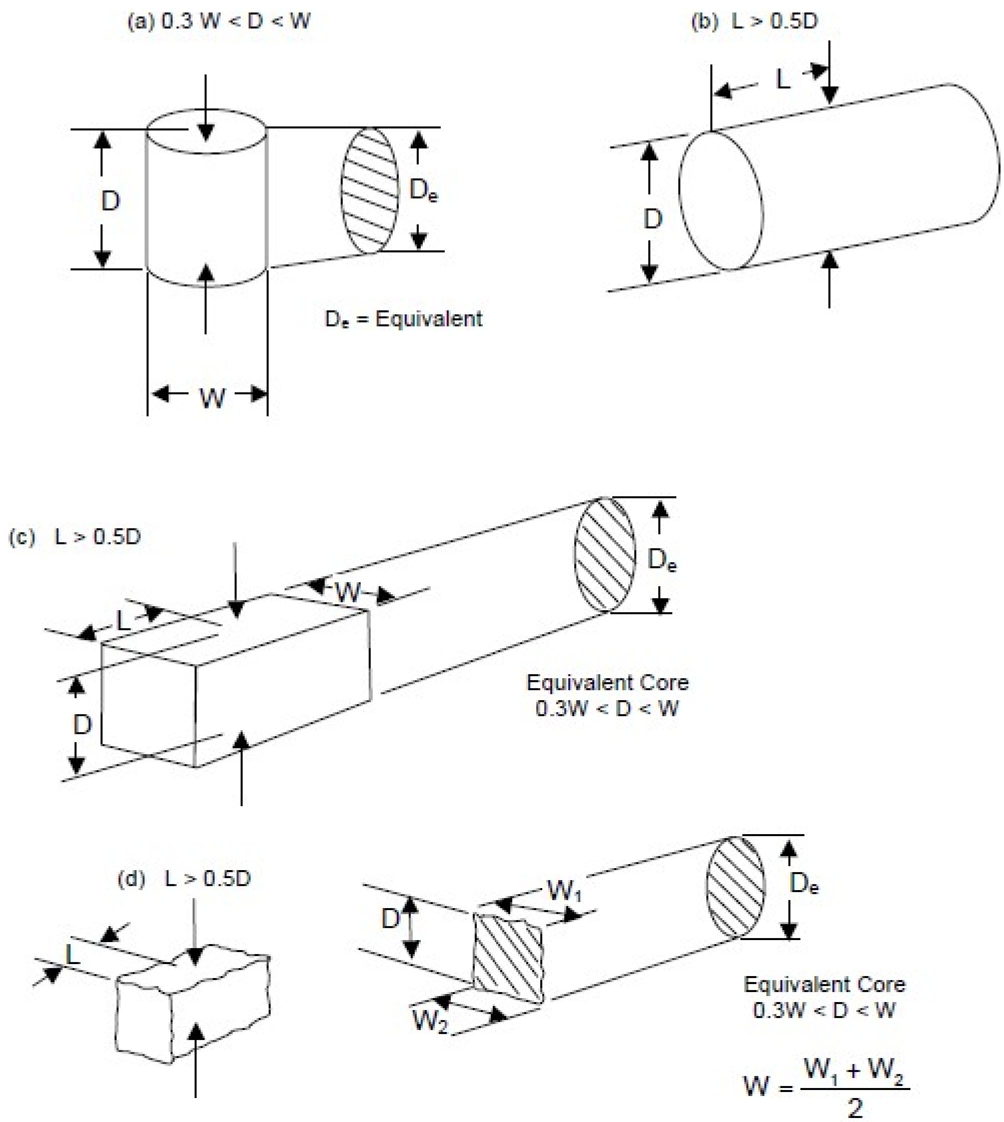


Figure 6.1: Load Configurations and Specimen Shape Requirement for (a) the Diametral Test, (b) the Axial Test, (c) the Block Test, and (d) the Irregular Lump Test.

7. PROCEDURE

7.1 Axial Test

7.1.1 Core specimens with length/diameter ratio of 1/3 to 1.0 are suitable for axial testing (Figure 6.1(b)). A suitable method to prepare specimens is saw- cutting (laboratory) or chisel-splitting (field).

7.1.2 Insert the specimen in the test machine such that when the platens are closed, they make contact along a line perpendicular to the core end faces.

7.1.3 Measure and record the distance D between platen contact points. If significant platen penetration occurs, the dimension D to be used in calculating point load strength should be the value D′, measured at the instant of failure. Record the width (W), normal to the loading direction, with an accuracy of ± 5%.

7.1.4 Increase the load steadily until failure occurs within 10 to 60 seconds, and record the failure load (P). Reject the test if the fracture surface fails to pass through both loading points. (Figure 7(d)).

7.1.5 Repeat Procedures 7.2.2 – 7.2.4 for each specimen.

7.2 Diametral Test

7.2.1 Specimens suitable for diametral testing will have a length to diameter ratio greater than 1.0.

7.2.2 Insert the specimen into the point-load machine and close the platens to make contact along the core diameter. If significant platen penetration occurs, the dimension D is to be used in calculating point load strength should be the value D′ measured at the instant of failure. Ensure that the distance L, between the contact points and the nearest free edge, is at least

7.2.3 0.5 times the core diameter (D) (Figure 6.1(a)).

7.2.4 Determine and record the distance D (Figure 6.1(a)).

7.2.5 Steadily increase the load until failure occurs, and record failure load (P). The load rate is such as to complete the test within 10 to 60 seconds. Reject the test if the fracture surface passes through only one platen loading point (Figure 7(d)).

7.2.6 Repeat procedure 7.1.2 – 7.1.4 for each specimen.

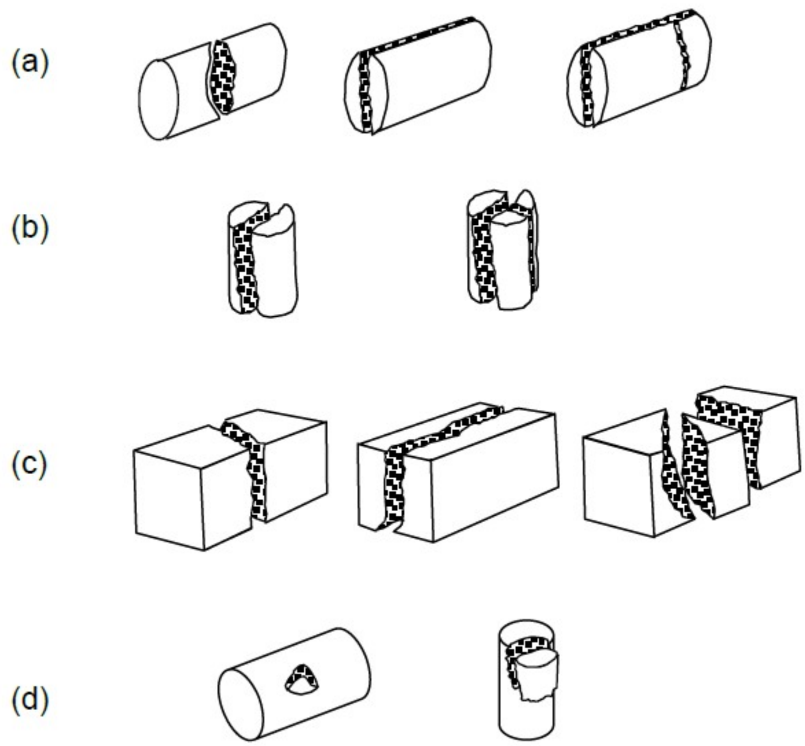


Figure 7: Typical Modes of Failure for Valid and Invalid Tests

7.3 Block and Irregular Lump Test

7.3.1 Rock specimens with a block or lumps of size 1.0 – 3.5 inches and of the shape in Figure 6.1(c) and (d) are suitable for testing. The D/W ratio should be between 1/3 and 1 (preferably close to 1). Distance L should be at least 0.5W.

7.3.2 Insert the specimen in the testing machine and close the platen, making contact with the least lateral dimension (Figure 6.1(c) and (d)).

7.3.3 Record the distance between platen contact points (D). If significant platen penetration occurs, the dimension D to be used in calculating point load strength should be the value D′ measured at the instant of failure. Record the smallest specimen width perpendicular to the loading direction (W), regardless of the actual mode of failure. For nonparallel sides, $W = (W_1 + W_2)/2$ (Figure 6.1(d)).

7.3.4 Increase the load steadily until failure occurs within 10 to 60 seconds; record the failure load (P). Reject the test if the fracture surface fails to pass through both loading points (Figure 6.1(d)).

7.3.5 Repeat Procedures 7.3.2 – 7.3.4 for each specimen.

7.4 Anisotropic Rock

7.4.1 Samples that consist of cores drilled though weakness planes should be tested in a direction that gives the greatest strength value.

7.4.2 When axial testing, specimens edges may need to be trimmed to create a surface that, facilitate loading (Figure 6(a)).

7.4.3 When diametral testing, ensure the load is applied along a single weakness plane (Figure 6(b)).

7.4.4 The ideal situation is when the core axis is perpendicular to the plane of weakness. To obtain the best results the angle between the core axis and the normal to the weakness plane should not exceed 30º (Figures 6.1(a) and (b)).

7.4.5 If the sample consists of core drilled through weakness planes, a diametral test can be conducted first, spaced in such a manner that will yield pieces that can be tested axially, if required.

7.4.6 If the sample consists of blocks or irregular lumps, it should be tested with the load applied perpendicular to planes of weakness.

7.4.7 If the platen penetrates the specimen significantly, dimension D′ measured at the instant of failure is used in calculating point load strength. The error in assuming D to be its initial value is negligible when the specimen is large or strong. The dimension at failure may always be used as an alternative to the initial value and is preferred.

8. CALCULATIONS

8.1 Data and calculations shall be recorded on the attached form. Values shall be reported to the following degree of accuracy:

W	**1**
D	**1**
L	**1.00**
P	**1.00**
$\mathbf{D_e^2}$	**1**
F	**1.00**
$\mathbf{I_s}$	**1.0**
$\mathbf{I_{s50}}$	**1.0**

8.2 Uncorrected Point Load Strength Index—The uncorrected point load strength I_s, expressed in megapascals (MPa), is calculated as:

$$\mathbf{I_s = \frac{P}{D_e^2}} \qquad (1)$$

where:

P = failure load, N,
and for Diametral Testing

D_e = equivalent core diameter = D for diametral tests (see Figure 6.1), and is given by:

$D_e^2 = D^2$ for cores,

and for Axial Testing

$D_e^2 = 4\frac{A}{\pi}$ for axial, block, and lump tests,

where:

A = WD = minimum cross-sectional area of a plane through the platen contact points (see Figure 6)

De2 = DD' for cores = $\frac{4}{\pi}WD'$ shapes (2)

.

Size Correction Factor: Precise rock classification is important, the preferred method of obtaining $I_s(50)$ is to conduct tests at or close to: D = 50 mm. Size correction is then unnecessary. Most point load strength tests are in fact performed using other specimen sizes or shapes.

8.3 Therefore, size correction is necessary and must be applied. Size correction may be accomplished using the formula:

$$I_{s(50)} = F \times I_s \tag{3}$$

The "Size Correction Factor F" can be obtained from the expression: F =

$$(D_e/50)^{0.45} \tag{4}$$

For tests near the standard 50-mm size, only slight error is introduced by using the approximate expression:

$$\mathbf{F = \sqrt{(D_e/50)}} \tag{5}$$

8.4 The relationship between UCS and the point load strength is expressed as:

$$\mathbf{UCS = (K)\ I_{s50} = 21\ I_{s50}} \tag{6}$$

Where:

K = conversion factor = 21 (Peabody 2005)

8.5 Mean Value Calculations

8.5.1 The Mean values of Is(50) is to calculated by deleting the two highest and two lowest values from the ten, or more valid test, and calculating the mean of the remaining values. If significantly fewer specimens are tested, only the highest and lowest values are to be deleted and the mean calculated from those remaining.

8.6 Coefficient of Variance (CV), *Relative Standard Deviation*

8.6.1 Calculate the Coefficient of Variance as follows:

$$\mathbf{CV} = \frac{\mathbf{S}}{\overline{\mathbf{X}}} \mathbf{x\ 100}$$

where:

CV = Coefficient of Variance
S = Standard Deviation
$\overline{X}$ = mean

9. DOCUMENTATION

9.1 The attached form shall include the following information for documentation:

9.1.1 Source of sample including project name, location, and, if known, storage environment. The location may be specified in terms of borehole number and depth of specimen from the collar of the hole.

9.1.2 Physical description of sample including rock type and location and orientation of discontinuities, such as, apparent weakness planes, bedding planes, schistosity, or large inclusions, if any.

9.1.3 Date of sampling and testing,

9.1.4 General indication of the moisture condition of test specimens at the time of testing, such as, saturated, as received, laboratory air dry, or oven dry. In some cases, it may be necessary to report the actual water content as determined in accordance with Test Method D 2216.

9.1.5 Average thickness and average diameter of the test specimen.

9.1.6 The maximum applied load “P”.

9.1.7 The distance “D” or D8, or both, if required.

9.1.8 Direction of loading (parallel to or normal to plane of weakness).

9.1.9 The number of specimens tested.

9.1.10 The calculated uncorrected (*Is*) and corrected *Is(50)* point load strength index values.

9.1.11 The estimated value of uniaxial compressive strength (d*uc*), Method of reporting results is based on the number of test and the coefficient of variance 0.35 (35%).

a. If there are eight or more test results, the highest and lowest test results are ignored and the Mean is reported.

b. If there are less than 8 test results and the COV is equal to, or greater than 0.35, the Mean for all test results is reported.

c. If there are less than 8 test results and the COV is less than 0.35, the Median is reported.

9.1.12 Type and location of failure, including any photographs of the tested specimens before and after the test.

Ronald L. Stanevich, PE, Director
Materials Control, Soils & Testing Division

MP 212.01.20 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE SPECIMENS

1. PURPOSE

1.1 To establish a procedure for testing the unconfined compressive strength of rock core specimens.

2. SCOPE

2.1 This procedure shall apply to nominal 2-inch (51 mm) diameter rock core specimens obtained for the purpose of determining the uniaxial compressive strength of rock.

2.2 This procedure will specify the requirements for the apparatus to be used in the test procedure, specimen preparation, and the actual test procedure.

3. APPARATUS

3.1 Diamond Saw – A manual or automatic rock saw equipped with a circular diamond saw blade, and appropriate cooling and cutting agents.

3.2 Feeler Gage – The feeler gage 3 inch (76 mm) “leaves” must include sizes beginning at 0.0015 inches (.038 mm).

3.3 Testing Machine – The testing machine shall meet the requirements for the testing machine specified in ASTM C 109.

4. SPECIMENS

4.1 Test specimens shall be nominal 2-inch (51 mm) diameter rock cores with a length–to-diameter ratio (L/D) of 2.0 to 2.5 and a diameter of not less than 1.88-inches (47 mm).

4.1.1 The field moisture condition of the test specimen shall be preserved until the time of the test unless otherwise specified.

4.2 The sides of the specimen shall be generally smooth and free of abrupt irregularities that, as determined by the technician performing the test, would adversely affect the compressive strength result.

4.3 Cut the ends of the specimens parallel to each other and at right angles to the longitudinal axis using a diamond saw.

4.4 Determine the diameter of the test specimen to the nearest 0.01 inches (0.25 mm) by averaging two diameters measured at right angles to each other at about mid-height of the specimen. Determine the length of the test specimen to the nearest 0.01 inches (0.25 mm) at the centers of the end faces.

4.5 When the Modified Rock Hardness and Unconfined Compressive Strength (HCSI) of the specimen is 3 or less (average rock – corresponding to an estimated compressive strength of ≤8,000 psi (55 MPa)), the ends of the specimens shall be capped with high-strength gypsum cement paste in accordance with ASTM C 617.

4.6 When the Modified Rock Hardness and Unconfined Compressive Strength (HCSI) of the specimen is 4 or greater (hard rock – corresponding to an estimated compressive strength of >8,000 psi (55 MPa)), the ends of the specimens shall be sawed or ground flat to a tolerance not to exceed 0.002 inches (0.050 mm).

5. PROCEDURE

5.1 Ensure that the spherically seated block of the testing machine rotates freely in its socket before each test. Wipe clean the bearing faces of the upper and lower bearing blocks and place the test specimen in the testing machine on the lower bearing block below the center of the upper bearing block. Bring the spherically seated block into uniform contact with the surface of the specimen.

5.2 Apply the load at a relative rate of movement between the upper and lower platens corresponding to a loading on the specimen within the range of 35 ± 7 psi/s (0.25 ±

0.05 MPa/s). Obtain this designated rate of movement of the platen during the first half of the anticipated maximum load and make no adjustment in the rate of movement of the platen in the latter half of the loading.

5.3 Record the maximum load carried by the specimen. Load readings in pounds (kilonewtons) shall be recorded to the nearest 10 lbs. (0.01 KN).

6. CALCULATION

6.1 Calculate the compressive strength of the specimen as described in section 6.2 and express the result to the nearest 10 psi (0.1 MPa).

6.2 Calculate the compressive strength of the specimen as follows:

$$CS = \frac{ML}{0.25 \cdot \pi \cdot D^2}$$

Where:
CS = Compressive strength of the specimen
ML = Maximum load carried by the specimen during the test
π = Mathematical constant PI
D = Average diameter of the specimen (as determined in section 4.4)

7. REPORT

7.1 The report shall include the following:

7.1.1 Laboratory number;

7.1.2 Project name, project number, and authorization number;

7.1.3 Date of test;

7.1.4 Core boring number and depth of specimen from the top of the hole;

7.1.5 Station and offset of the core boring;

7.1.6 Specimen diameter and length as determined in section 4.4;

7.1.7 Specimen end preparation method (capping, sawing, or grinding);

7.1.8 Maximum load as determined in section 5.3;

7.1.9 Compressive strength as determined in section 6.2;

7.1.10 Physical description of the rock specimen (type, color, and grain size).

7.2 Use Attachment 1 as the format for the report.

Ronald L. Stanevich, PE, Director
Materials Control, Soils & Testing Division

MP 207.06.20 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT

ATTACHMENT 1

<table>
<tr><td colspan="4">WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORES</td></tr>
<tr><td>Laboratory Number:</td><td colspan="3"></td></tr>
<tr><td>Project Name:</td><td colspan="3"></td></tr>
<tr><td>Project Number:</td><td></td><td>Authorization Number:</td><td></td></tr>
<tr><td>Date of Test:</td><td></td><td>Core Boring Number:</td><td></td></tr>
<tr><td>Station:</td><td></td><td>Offset:</td><td></td></tr>
<tr><td colspan="2">Applicable Units (check appropriate box):</td><td colspan="2">English Metric</td></tr>
<tr><td>Depth From Top of Hole (ft / m)</td><td colspan="3"></td></tr>
<tr><td>Diameter (in. / mm)</td><td colspan="3"></td></tr>
<tr><td>Average Diameter (in. / mm)</td><td colspan="3"></td></tr>
<tr><td>Length (in. / mm)</td><td colspan="3"></td></tr>
<tr><td>End Preparation Method</td><td colspan="3"></td></tr>
<tr><td>Maximum Load (lb. / KN)</td><td colspan="3"></td></tr>
<tr><td>Compressive Strength (psi / MPa)</td><td colspan="3"></td></tr>
<tr><td colspan="4">Physical Description of Rock:
Type:
Color:
Grain Size:</td></tr>
<tr><td colspan="4">Remarks:</td></tr>
</table>

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING A REDUCED UNIT PRICE TO BE PAID FOR SELECT MATERIAL FOR BACKFILLING WHICH DOES NOT CONFORM TO GRADING REQUIREMENTS OF GOVERNING SPECIFICATIONS

1. PURPOSE

1.1 To define a range of nonconformance in the grading of aggregates used for Select Material for backfilling which would necessitate its removal from the project, and provide a procedure for reducing the price to be paid for said aggregate. When more than one sample is taken in succession, this procedure is applicable to MP 300.00.51: "Procedural Guidelines for Maintaining Control Charts". In some cases, however, because of the nature of the item, only one sample is taken. In this regard a control chart may not be necessary and conformance will be based on the results of the single sample.

2. SCOPE

2.1 This procedure shall apply only to those aggregates specified for use as Select Material for Backfilling.

3. DEFINITION OF TERMS

3.1 Sublot - The quantity of material represented by a single test value.

3.2 LOT - The quantity of material represented by an average test value.

3.3 In those cases where only one sample is taken to represent the total quantity the sublot and LOT will be considered the same.

4. DESIGNATION OF QUANTITIES FOR EQUITABLE PRICE ADJUSTMENT

4.1 When an average gradation test value, or three individual test values, fall outside the limits of the Specifications, the LOT of material represented thereby is considered to be nonconforming to the extent that the last of its sublots is nonconforming. When a lot of material is nonconforming, then the last sublot contained therein shall have its price adjusted in accordance with Table 1. In no event, however, shall a sublot of material have its price adjusted more than once, and the first adjustment which is determined shall apply.

4.2 When only one sample is taken to represent the total quantity of material used, and any sieve value falls outside the limits of the specification, the material represented thereby is considered to be nonconforming. This material shall have its price adjusted in accordance with Table 1.

5. DEGREE OF NONCONFORMANCE

5.1 When a sublot of material is to have its price adjusted, the percentage point difference between the nonconforming test value and the specification limit shall be determined for each sieve determined to be nonconforming (nonconforming as described in 4.1 above), and this value shall be compared to Table 1. The total measure of the degree of nonconformance is, therefore, the sum of nonconformance on the two sieve sizes of the sublot.

Table 1

Degree of Nonconformance	Designated Action
1.0 to 3.0	Reduced Price 2%
3.1 to 5.0	" " 4%
5.1 to 8.0	" " 7%
8.1 to 12.0	" " 11%

6. DETERMINATION OF EQUITABLE ADJUSTMENT

6.1 When the total degree of nonconformance has been established and it is 12.0 or less, the designated action shall be initiated from Table 1. When the degree of nonconformance for a sublot is greater than 12.0, said sublot will not be incorporated into the project, and in fact, removed from the project as soon as possible.

7. METHOD OF ACCOUNTING AND CHANGE ORDER PREPARATION

7.1 Equitable reductions for nonconformance will be determined, for each lot or sublot. These adjustments may be processed with a single change order when the item is complete by tabulating the data for all nonconforming sublots, and preparing the change order for the total dollar adjustment shown on the tabulation. A copy of the tabulation should accompany and be made a part of the change order.

7.2 Dollar reduction shall be calculated by (A) quantity x (B) % reduction from Table 1 x (C) unit contract price. (A sample tabulation sheet is attached).

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 212.02.20 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT

Equitable Reduction Procedure

TABULATION OF EQUITABLE REDUCTIONS (partial)

Sublot Identity (Note 1)	Quantity	Degree of Nonconformance	% Price Reduction	Unit Contract Price	Dollar Reduction From Contract (A)x(B)x(C)
	800 m^3	7.5	7	3.50	196.00
	200 m^3	2.6	2	3.50	14.00
	500 m^3	5.0	4	3.50	70.00

Subtotal (1) (Note 2) $280.00

	1000 m^3	1.2	2	3.50	70.00
	1000 m^3	11.7	11	3.50	385.00

Subtotal (2) (Note 2) $455.00

Total Reduction (Note 3) $735.00

Note 1: Station numbers may also be used to identify sublots

Note 2: These subtotals should be made at the end of contract pay periods, and the subtotal amounts deducted from contract payments on a current basis.

Note 3: This total reduction should be processed in one change order when the construction of the item is complete.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURAL GUIDELINES FOR MAINTAINING CONTROL CHARTS FOR AGGREGATE GRADATIONS

1. PURPOSE

1.1 To provide a standard method for developing and maintaining control charts to evaluate the grading characteristics of mineral aggregates.

2. SCOPE

2.1 Control charts shall be maintained where specified for sized aggregates, for bases and sub-bases, aggregates for Portland Cement and hot-mix asphalt, etc.

3. INTENT

3.1 It is the intent to have the procedure outlined hereinafter used in instances in which it can be reasonably and logically applied. The applicability of the procedure will normally depend on circumstances such as the number of samples, the continuity of delivery, etc. The moving average may not necessarily be continuous for the entire project. A new moving average series may be started after periods of inactivity, changes in materials or processes, change in job mix formula, resuming operations after correcting deficiencies, etc.

4. GENERAL

4.1 Paper Charts

4.1.1 Control charts should be prepared on 10 x 10 cross section paper approximately 25 inches wide. A chart length of approximately 30 inches should be displayed at all times. When standard cross section sheets are used, the most recent sheet must be displayed and all the previous sheets placed chronologically in a holder.

4.1.2 The item number and/or description of the material should be noted on the top of the chart and visible at all times.

4.1.3 Control charts will be maintained at the project office or at the testing site where applicable.

4.1.4 Scale – The control chart should have a vertical scale of one division equal to one percentage point (or one inch equal to 10 percent), except in the following cases: (a) a vertical scale of two divisions equal to one percentage point (or one inch equals five percent) should be used for any sieve which has a specification tolerance range less than ten percent, and (b) in the case of coarse aggregates used in Portland Cement concrete, a vertical scale of one division equal to 0.1 percentage point (or one inch equal to one percent) should be used for the #200sieve.

4.1.5 On the horizontal scale the test values will be plotted on the heavy, vertical lines (one inch apart), progressing from the left to the right.

4.1.6 General Arrangement – Control charts are to be arranged on the cross section paper in the manner described below; an example of the arrangement is shown on Attachment I. [Note on the attachment the 10 X 10 squares are "stretched" vertically to allow the graph to fit the 8 1/2 by 11paper]

4.1.7 The largest sieve size will be located toward the top of the chart and the smallest sieve size toward the bottom of the chart. The spacing between the lower limit of one sieve and the upper limit of the adjacent sieve should be a minimum of one inch.

4.1.8 The vertical scale for each sieve will be arranged so that the heavy lines will have a value of zero or a value which is a multiple of five. For instance, zero, five, ten, fifteen, etc.

4.1.9 Lines corresponding to the upper and lower limits of the specification will be drawn in red (pen or pencil) across the graph. At the beginning and end of each sheet (or length of the displayed portion) a vertical red line will be drawn between the specification limits of each sieve, an arrow will be placed at the end of each vertical line. The specification limits will be indicated above and below the arrows, and the sieve size and scale will be indicated between the limits on the outside of the displayed portion of the chart.

4.1.10 Inside the solid red lines, that define the specification limits, two green dashed lines will be drawn. (Note exception in Section 4.1.11). These lines will be located parallel to the specification lines and at a distance from each specification line equal to approximately twenty (20) percent of the specification range. The band (area) between the green dashed lines and the specification line will be known as the caution band. This band may be shaded a light yellow or amber to symbolize the caution which the contractor should exercise to prevent the quality of his/her work from going outside the specificationlimits.

4.1.11 For screens specifying only 100 percent passing, plotting of caution band is not applicable. Also when the lower specification limit is zero, plotting of the lower caution band is not necessary.

4.1.12 Plotting of Test Data – Individual test values will be plotted with a blue color pen, or pencil, using the symbol O. [For paper charts the circle should be approximately 1/10 (0.1) inch in diameter]

4.1.13 Averages of consecutive test values will be plotted with a red color pen, or pencil, using the symbol. [For paper charts the square should be approximately 1/10 (0.1) inch on either side]

4.2 Computer Generated Charts

4.2.1 Computer generated charts using any standard variable control charting program may be used that allow hand plotting or computer plotting of the individual data and in a sequence that displays the applicable sieve sizes vertically from largest sieve size at the top of the display to smallest sieve size toward the bottom of the display in the least number of pages as practical when printed. The screen display should show horizontally on any given sieve at least eight potential dataareas.

4.2.2 The item number and/or description of the material should be noted on the top of the chart and visible at alltimes.

4.2.3 Control charts will be maintained at the project office or at the testing site where applicable. These charts must be kept current, printed daily when applicable, and prominently displayed vertically in the specified sieve sequence (from largest sieve to smallest sieve). When printed, the most recent sheet(s) should be displayed and the previous sheets shall be placed chronologically in aholder.

4.2.4 Scale – To the extent possible, the control chart should have a vertical scale which visualizes the differences in tolerances limits between the specifiedsieves.

4.2.5 On the horizontal scale the test values should be plotted on heavy, vertical lines, progressing from the left to the right.

4.2.6 General Arrangement – Control charts are to be arranged on the computer screen (and when printed and displayed) in the manner describedhereinafter.

4.2.7 The largest sieve size will be located toward the top of the chart and the smallest sieve size toward the bottom of the chart. The spacing between the lower limit of one sieve and the upper limit of the bordering sieve should be such that a clear demarcation between sieves isprovided.

4.2.8 The vertical scale for each sieve will be arranged so that the heavy lines will have a value of zero or a value which is a multiple of five. For instance zero, five, ten, fifteen, etc.

4.2.9 General construction of the control chart should be the same as described in Sections 4.1.9 through 4.1.13 as applicable.

---

5. PLOTTING TEST DATA

5.1 Symbols and Color Code

5.1.1 Individual test values will be plotted in a blue color using the symbol described in Section4.1.12.

5.1.2 Averages of consecutive test values will be plotted with a red color using the symbol described in Section 4.1.13.

5.2 Individual Test Values and MovingAverage

5.2.1 Test values will be rounded to the nearest whole percentage point and plotted, except the No. 200 sieve will be rounded to the nearest one tenth (0.1) percentage point then plotted.

5.2.2 The average at the start of the job begins with the second sample result. This average will be plotted on the appropriate line on the control chart. Likewise the average is continued for the third through forth result, averaging all previous results and plotting each of these averages on the appropriate line on the control chart. The moving average will be considered to be the average of five.

consecutive test values and is determined by starting with the fifth test value and averaging it with the four preceding test values. Thereafter only the last consecutive five sample result will be averaged, i.e., second test value through sixth test value, third test value through seventh test value, and so forth. All averages will be plotted on the control chart in the manner described in Section 4.1.13 and rounded in the manner described in Section 5.2.1.

5.2.3 As successive symbols are plotted across the control chart, from left to right, the blue symbol O (individual value) will be connected with a dashed blue line as depicted in Attachment 1, and the red symbols will be connected with a solid red line as depicted in Attachment1.

5.2.4 All additional samples, if taken, will be plotted on successive heavy vertical lines and treated in the same manner as above.

5.2.5 At the bottom of the cross section paper, or below the last (smallest) represented sieve size printed from the computer, and immediately left of the vertical line on which test data is plotted, the following information will bewritten:

1. The laboratory number assigned to thetest.
2. The initials of the person plotting the testdata.
3. The date the sample wastaken.

6. INDIVIDUAL OR MOVING AVERAGE TEST VALUES OUTSIDE THE SPECIFICATIONS

6.1 Individual TestValues

6.1.1 When the individual test value on a sieve is outside the specification limits, or differs markedly from those preceding it, the Project Engineer/Supervisor and the contractor will be promptly advised. The contractor will immediately take any steps that may be necessary to bring the production undercontrol.

6.2 Moving Average

6.2.1 When an average value of consecutive tests falls in the caution zone the contractor will be advised that the material is, or is becoming, borderline, and the following notation will be made in the plant or projectdiary:

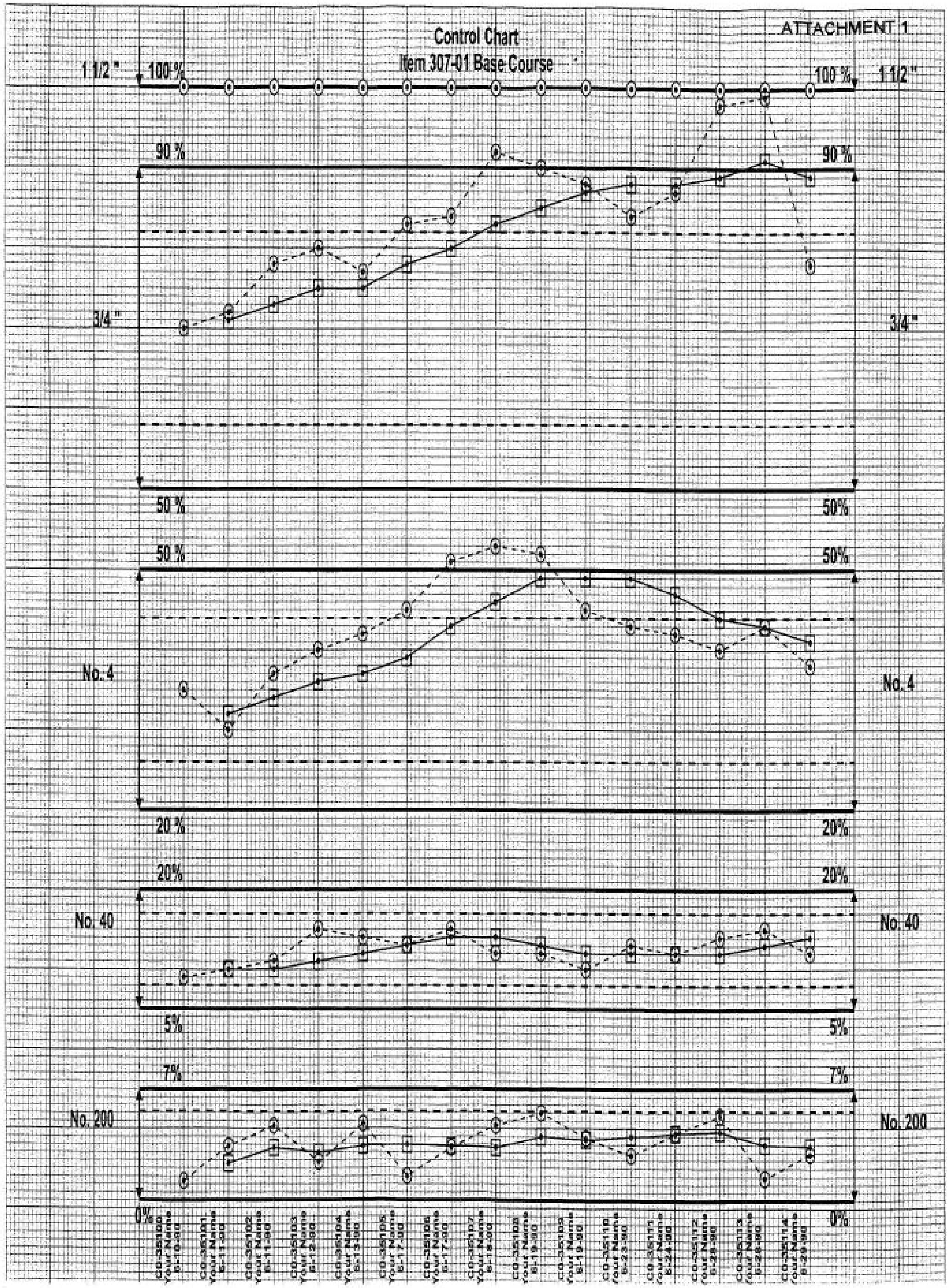
"Contractor advised that ____________ material is borderline". (Write item number for base course or aggregate size and item number for other material in the blank space).

6.3 Material Outside SpecificationLimits

6.3.1 When three consecutive individual test values are outside the specification limits or when an average of consecutive tests falls outside the specification limits the contractor will be promptly advised that the material is non- conforming, and the contractor will immediately take any necessary steps to correct the deficiencies. When an average falls outside of the specification limits and the two immediately following individual test values are also outside the specification limits, operations will be discontinued until the contractor gives reasonable assurance that the deficiency has been corrected. After the contractor has taken significant steps to correct the deficiency the next individual sample that meets the specifications after production is resumed will be used to start a new average.

Ronald L. Stanevich, PE, Director
Materials Control, Soils & Testing Division

MP 300.00.51 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT


ATTACHMENT 1
Control Chart
Item 307-01 Base Course
1 1/2"
100%
100 %
1 1/2"
90 %
90 %
3/4"
3/4"
50 %
50%
50 %
50%
No. 4
No. 4
20 %
20%
20%
20%
No. 40
No. 40
5%
5%
7%
7%
No. 200
No. 200
0%
0%

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CALIBRATION OF THERMOMETERS AND PYROMETERS AT BITUMINOUS CONCRETE MIXING PLANTS

1. PURPOSE

1.1 To provide a test procedure for field calibration of thermometers and pyrometers used at bituminous concrete mix in the truck.

2. SCOPE

2.1 This procedure is applicable to devices used to measure temperature in bituminous material lines, temperature in aggregate dryers, and temperature of the completed mix on the truck.

3. CALIBRATION

3.1 Thermometers and pyrometers shall be calibrated at least once per year.

4. CALIBRATION TEMPERATURE RANGE

4.1 Devices used to measure in the bituminous material lines shall be checked at a minimum of three different temperatures, over a range extending from approximately 25°F below to 25°F above the normal dryer operating temperature.

4.2 Devices used to measure the temperature of the mix in the truck shall be checked at intervals of approximately 25°F through the range of temperature permitted by the specifications for the type of materials to be produced.

5. TEST PROCEDURES

5.1 The following materials will be needed: a sample can or other suitable container of at least two gallon capacity; sufficient oil, asphalt or sand to fill the container; a source of heat, such as a hot plate, propane stove or oven; and a calibrated thermometer. Calibrated thermometers may be obtained from the Materials Control, Soils and Testing Division.

5.2 Fill the container with sand, oil, or asphalt. Sand is preferable, if the test is to be conducted outdoors, since it retains heat longer than oil or asphalt. In order to reduce testing time, hot asphalt from the storage tank, or hot sand from the dryer may be used.

5.3 Heat the material to the first test temperature and remove form the heat source.

5.3.1 If using sand, stir the sand thoroughly, and place the calibrated thermometer and the device being tested in the sand, positioned so that the temperature measuring elements are as close together as possible and are located near the center of the container.

5.3.2 If using oil or asphalt, place both the calibrated thermometer and the device being calibrated in the container, positioned so that the temperature sensing elements are located as close together as possible, and stir the oil or asphalt to equalize the temperature.

5.4 If a pyrometer is being tested, leave the protective shield in place, and be sure that the temperature sensing element is completely immersed in the liquid or sand.

5.5 Wait until the temperature indicated by both devices has stopped rising and either remains constant or begins to drop slightly. Then record the temperature indicated by both devices.

5.5.1 If there is an excessive temperature drop (more than two degrees per minute) it will be difficult to obtain accurate test results, especially if one thermometer responds to a change in temperature faster than the other. In order to decrease the temperature loss, place the container on a hot plate or propane stove and apply sufficient heat to reduce the rate of temperature decrease.

5.5.2 In order to obtain greatest accuracy, the temperature should be recorded as soon as both temperature measuring devices have reached equilibrium. It does not matter if this is not exactly the temperature specified, since the temperatures specified in Section 4 of this MP are approximate.

5.6 Heat, or cool the material to the next test temperature. Repeat the test procedure. When using sand, be especially sure to stir thoroughly in order to equalize the temperature throughout the containers.

5.7 Apply correction factors to the temperatures recorded for the calibrated thermometer. These are obtained from the calibration chart which is furnished with the calibrated thermometer.

5.8 Plot the test data on graph paper. An example is shown in Attachment 1.

6. USE CALIBRATION DATA

6.1 Bituminous Mixture Thermometers

6.1.1 These thermometers are used to determine compliance with temperature specifications, and therefore, it is important that they be accurate. Correction factors, from the calibration graph, should be applied when determining compliance with temperature specifications.

6.2 Bituminous Line Thermometer

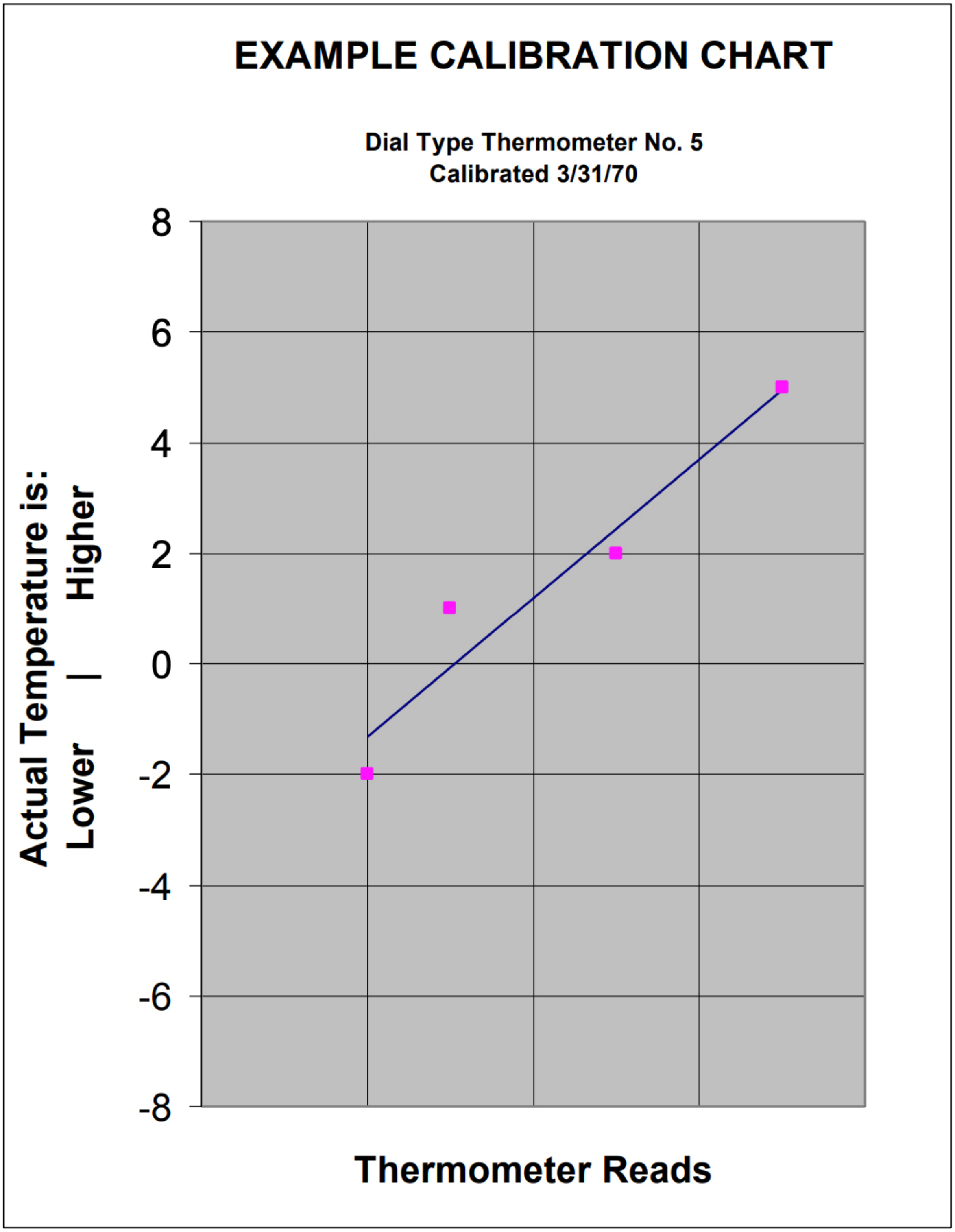
6.2.1 The primary reason for checking this thermometer is to see that it is working properly and is reasonably accurate. If the thermometer does not operate properly, it should be repaired or replaced. If it does not operate properly, but there is a significant error in the temperature, the error should be taken into account when setting the bitumen temperature.

6.3 Dryer Pyrometer -

6.3.1 A properly adjusted pyrometer is probably more accurate than the thermometer used to check it. A slight temperature difference between pyrometer and calibrated, thermometer is considered significant and may be ignored. However, in such cases, the calibration graph should be drawn and kept on file to show that the pyrometer was checked and found to be accurate. If there is a large difference in temperature between pyrometer and calibrated thermometer, it should be assumed that he pyrometer is in error, and this error should either be taken into account when setting the dryer temperature, or the pyrometer should be adjusted.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 401.02.21 Steward – Asphalt Section
RLS:J
ATTACHMENT


EXAMPLE CALIBRATION CHART
Dial Type Thermometer No. 5
Calibrated 3/31/70
8
6
4
2
0
-2
-4
-6
-8
Actual Temperature is:
Lower | Higher
Thermometer Reads

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE TO DESIGNING HOT-MIX ASPHALT USING THE MARSHALL DESIGN METHOD

1. PURPOSE

1.1 To establish an approved Marshall design method, test procedures, and evaluation criteria for hot-mix asphalt (HMA). If reclaimed asphalt pavement (RAP) is used in the design, refer to Materials Procedure (MP) 401.02.24 for additional guidelines.

2. SCOPE

2.1 This procedure is applicable to design tests conducted for the purpose of establishing mixture proportions for HMA using the Marshall mix design method. Marshall designs that have already been approved under the previous version of this MP may still be used as long as the mix design verification and quality control requirements of MP 401.02.27 can be met using Tables 1, 2, and 3 of this MP as the reference design criteria. Note that Table 1 has slightly modified the air void design criteria for Base-I so verification and quality control for older designs will be based on the new value.

2.2 Any approved mix design that exhibits poor field performance may be rejected from further use by the Division.

3. REFERENCED DOCUMENTS

3.1 *AASHTO Standards:*

- R 30, Mixture Conditioning of Hot Mix Asphalt (HMA)
- T 30, Mechanical Analysis of Extracted Aggregate
- T 164, Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)
- T 166, Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)

- T 245, Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- T 308, Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

3.2 *ASTM Standards:*

- D 5581, Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen)

3.3 *Asphalt Institute:*

- MS-2 Manual, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types – This well written Asphalt Institute reference guide explains the entire Marshall Method design process in a logical order. The mix designer must still adhere to WVDOH design property requirements and procedures, and they must use the latest AASHTO and ASTM test methods.

3.4 *Material Procedures:*

- MP 401.02.24, Guide to Designing Hot Mix Asphalt with Reclaimed Asphalt Pavement.
- MP 401.02.27, Guide for Contractor Quality Control of Hot Mix Asphalt
- MP 700.00.06, Aggregate Sampling Procedures
- MP 700.00.54, Procedure for Evaluating Quality Control Sample Test Results with Verification Sample Test Results

4. TESTING REQUIREMENTS

4.1 The laboratory performing the design shall be a Division approved laboratory. To obtain Division approval, a laboratory must demonstrate that they are equipped, staffed and managed, for batching and testing HMA in accordance with this MP. This shall be accomplished by submitting a copy of their latest report of inspection by the AASHTO Materials Reference Laboratory (AMRL) to the District Materials Section. The laboratory must also submit a letter detailing the actions taken to correct any deficiencies noted in the test procedures listed below. The District will forward this information to Materials Control, Soils and Testing Division (MCS&T). It is also required that the laboratory request to be included on AMRL's routine schedule of inspections, which is usually every 18 to 24 months in order to maintain their approval status.

4.1.1 AASHTO Test Procedures

- T 245, Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- T 166, Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
- T 27**,** Sieve Analysis of Fine and Coarse Aggregates**(Note 1)**
- T 11**,** Materials Finer Than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing**(Note 1)**
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T 85, Specific Gravity and Absorption of Coarse Aggregate

Note 1: T 30, Mechanical Analysis of Extracted Aggregate, may be substituted for T 27 and T 11 if the laboratory is using T 308, Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method or T 164, Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA).

4.2 The laboratory is required to have a technician who has attended and successfully completed a Division approved Marshall mix design class. In addition to the class that is offered through the West Virginia University Asphalt Technology Program, hands-on Marshall mix design classes offered by the Asphalt Institute, National Center for Asphalt Technology (NCAT), National Asphalt Pavement Association (NAPA), Chicago Testing Laboratory, and various state DOTs have been approved. Proof of successful completion of all class requirements (including a written examination) must be provided. Approval of an older design class that did not require a written examination will be on a case-by-case basis including a review of the designer's experience. MCS&T will maintain a list of the approved design laboratories and design technicians.

4.3 The required mix design properties are:

4.3.1 Stability and Flow: AASHTO T 245 or ASTM D 5581 as applicable.

4.3.2 Air Voids: AASHTO T 269

4.3.3 Voids in Mineral Aggregate (VMA): Asphalt Institute MS-2 Manual

4.3.4 Voids Filled With Asphalt (VFA): Asphalt Institute MS-2 Manual

4.3.5 Fines to asphalt (FA) ratio: Asphalt Institute MS-2 Manual

4.4 The design PG Binder shall normally be selected in accordance with Section 401.2 of the Standard Specifications. However, the laboratory's mix designer should refer to the contract documents to determine if a nonstandard binder has been specified for the project.

4.5 A series of test specimens shall be prepared for a range of different asphalt contents so that the test data curves show a well-defined "optimum" value. Samples shall be fabricated to include a range of asphalt contents of at least 2 percent at intervals not to exceed 0.5 percent.

4.6 Test specimens shall be fabricated from materials of the same sources and types as proposed in the job mix formula (JMF). The gradation of the combined aggregates used in the test samples shall be the same as that proposed in the plant mix formula and shall meet the requirements of Table 401.4.2A of the Standard Specifications. The percent passing each sieve contained in Table 401.4.2A, from one sieve larger than the nominal maximum size down to the 75 µm (No. 200) sieve, shall be included in all gradation calculations.

4.7 The gradation of each aggregate size from each source used in the mix design shall be determined from an average of at least three individual gradations of each material from the stockpile at the plant or from material supplied by the aggregate producer. The aggregates shall be sampled in accordance with MP 700.00.06.

4.8 If a mix contains reclaimed asphalt pavement (RAP), the asphalt must be removed from the RAP for gradation analysis by the ignition oven method (T 308) or a solvent extraction process (T 164). If the T 164 solvent extraction test method is used, a non-chlorinated solvent may be substituted for the standard specified solvent, and the test method may be modified as per the recommendations of the solvent supplier. The solvent must be a product that has been tested for use in extracting asphalt from HMA. The RAP used for designing a mix must come from the plant stockpile from which it will be produced.

4.9 A minimum of three compacted test specimens for each combination of aggregates and asphalt content are required.

4.10 The maximum specific gravity shall be based on the average of two samples prepared at the estimated optimum asphalt content.

4.11 Immediately after mixing each of the Marshall bulk specific gravity samples and the maximum specific gravity samples, age the samples for 2 hours ± 5 minutes in accordance with AASHTO R30 before further testing.

4.12 Mixtures shall be designed in accordance with the criteria set forth in Table 1, 2, and 3 unless otherwise indicated in a special provision or as a note in the contract documents.

TABLE 1—Marshall Method Mix Design Criteria

Design Criteria	Medium Traffic Design (Note 2 and 3)	Heavy Traffic Design	Base-I Design (Note 4)
Compaction, number of blows each end of specimen	50	75	112
Stability (Newtons) (minimum)	5,300	8,000	13,300
Flow (0.25 mm) (Note 5)	8 to16	8 to 14	12 to 21
Percent Air Voids	4.0	4.0	4.0
Percent Voids Filled With Asphalt (Note 6)	65 to 80	65 to 78	64 to 73
Fines-to-Asphalt Ratio		0.6 to 1.2	

Note 2: If the traffic type is not provided in the contract documents, contact the District to obtain this information before developing the mix designs.

Note 3: All Wearing-III mixes shall be designed as a 50 blow mix regardless of traffic type.

Note 4: All Base-I mixes will be designed and tested using 112 blows with six inch diameter specimens in accordance with ASTM D 5581.

Note 5: When using a recording chart to determine the flow value, the flow is normally read at the point of maximum stability just before it begins to decrease. This approach works fine when the stability plot is a reasonably smooth rounded curve. Some mixes comprised of very angular aggregates may exhibit aggregate interlocking which causes the plot to produce a flat line at the peak stability before it begins to drop. This type of plot is often difficult to interpret, and sometimes the stability will even start increasing again after the initial flat line peak. When such a stability plot occurs, the stability and flow value shall be read at the initial point of peak stability.

Note 6: A Wearing-I heavy traffic design shall have a VFA range of 73–78 percent. A Wearing-III mix shall have a VFA range of 75–81 percent.

1.1 TABLE 2—Percent Voids in Mineral Aggregate (Note 7)

Mix Type	Nominal Size Sieve	Percent Voids in Mineral Aggregate (VMA) (minimum)
Wearing-III & Scratch-III	4.75 mm (No. 4)	17.0
Wearing-I & Scratch-I	9.5 mm (⅜ in.)	15.0
Base-II, P&L & Wearing-IV	19 mm (¾ in.)	13.0
Base-I	37.5 mm (1 ½ in.)	11.0

Note 7: Mixtures designed with the VMA exceeding the minimum value by more than two percent may be susceptible to flushing and rutting problems, especially when used on pavements subjected to slow moving traffic conditions. They may also be difficult to compact as they often have a tendency to shove under the roller.

TABLE 3—Design Aggregate Gradation Requirements for Marshall Mixtures (Note 8)

TYPE OF MIX	**Base-I**	**Base-II (Patch & Level)**	**Wearing-IV** (Note 9)	**Wearing-I (Scratch-I)**	**Wearing-III (Scratch-III)**
SIEVE SIZE	**Nominal Maximum Size**				
	1 ½ in (37.5 mm)	**¾ in** (19 mm)	**¾ in** (19 mm)	**3/8 in** (9.5 mm)	**No. 4** (4.75 mm)
2 in (50 mm)	100				
1 ½ in (37.5mm)	90 - 100				
1 in (25 mm)	90 max	100	100		
¾ in (19 mm)	-	90 – 100	90 – 100		
½ in (12.5 mm)	-	90 max	90 max	100	
3/8 in (9.5 mm)	-	-	-	85 - 100	100
No. 4 (4.75 mm)	-	-	47 min	80 max	90 - 100
No. 8 (2.36 mm)	15 – 36	20 – 50	20 – 50	30 – 55	90 max
No. 16 (1.18 mm)	-	-	-	-	40 - 65
No. 30 (600 µm)	-	-	-	-	-
No. 50 (300 µm)	-	-	-	-	-
No. 200 (75 µm)	1.0 – 6.0	2.0 – 8.0	2.0 – 8.0	2.0 – 9.0	3.0 – 11.0

Note 8: For quality control of the mixture the allowable tolerances for each JMF shall be the specified design control points shown in Table-3 with the exception that a Wearing-III mix shall have a tolerance limit of the JMF ± 5% on the 1.18 mm (No. 16) sieve, and all other mix types shall have a tolerance limit of the JMF ± 6% on the 2.36 mm (No.8) sieve. These tolerances shall also be applied to the mix design and shall be documented on the T-400 Form. The tolerances shall not fall outside of the specified control points of Table-3.

Note 9: In addition, a Wearing-IV mix shall have a tolerance limit of the JMF ± 5% on the 4.75 mm (No. 4) sieve, but not below the minimum requirement.

5. DETERMINING THE OPTIMUM ASPHALT CONTENT

5.1 Prepare a graphical plot of the following relationships:

- Asphalt Content vs. Percent Air Voids

- Asphalt Content vs. Stability
- Asphalt Content vs. Flow
- Asphalt Content vs. VMA
- Asphalt Content vs. VFA

5.2 From the plot of asphalt content vs. percent air voids, pick the asphalt content that corresponds to the 4.0 percent air voids.

5.3 If the corresponding stability, flow, VMA, and VFA values are within the specified design criteria at the asphalt content determined in Section 5.2, then this asphalt content shall be considered the optimum asphalt content for the mix.

5.4 If the design property values determined as per Section 5.3 do not meet the specified criteria at the percent asphalt content determined in Section 5.2, then new mix proportions must be determined and new test data developed.

5.5 Full mix design testing will not be required when a mix design is developed using the sources, exact aggregate types, and compaction level as a prior Division approved design, along with a different neat binder grade. The designer may instead select to make a set of bulk specific gravity test specimens and a maximum specific gravity test specimen with the approved aggregate structure and the new binder grade at the optimum asphalt content of the approved design. Since these samples are laboratory produced design specimens, they must be oven aged for 2 hours ± 5 minutes before testing in accordance with R 30. Mix and compaction temperature will be based on the requirements of the new binder grade. The percent air voids must be 4.0 ± 0.3 percent. The voids-in-mineral aggregate must be within ± 0.5 percent of the original approved job mix formula design target (but not outside of the design limits of this MP). All other mix design criteria must be within the design limits specified in this MP (including stability and flow). If the mix design meets all of these requirements then this test data may be submitted along with a new T400 form for approval as a new mix design. A copy of the approved T400 on which this new design is based should also be included. If the mix design fails to meet all of the requirements then a new mix design must be developed.

6. REPORT

6.1 The T-400 JMF form shall include the design property information required in Section 401.4 of the Standard Specifications. The JMF package shall include the following:

6.1.1 A summary sheet (Marshall Mix Design Package Attachment #1, Optimum Asphalt Content Determination) showing the proposed asphalt content determination plus the design properties compared to the design criteria of Table 1. This attachment shall be signed and dated by the mix design technician.

6.1.2 The chart showing the plots described in Section 5.1 used to determine the optimum asphalt content (Attachment #2).

6.1.3 A Summary of Marshall Mix Design Data worksheet (Attachment #3).

6.1.4 Worksheet for calculating the effective gravity of the blended aggregates (Attachment #4 or #4A).

6.1.5 Worksheets showing calculations for maximum specific gravities of the mix at different asphalt contents (Attachment #5). For any mix design that contains any single coarse aggregate component with the water absorption of 1.5 percent or greater, follow the supplemental procedure of T 209 to determine if a dry-back is necessary. Because the dry-back procedure is addressing an aggregate coating issue, this same supplemental procedure shall be used on quality control and verification samples of mixes containing these high absorptive aggregates to determine if the dry-back procedure is necessary.

6.1.6 Worksheet for calculating the bulk and apparent specific gravities of the total aggregate, and the percent VMA in the compacted mixture (Attachment #6 or #6A).

6.1.7 Worksheet for determining the maximum specific gravity of the mixture, including the dry-back procedure when required (Attachment #7).

6.1.8 Worksheets showing calculation for bulk and apparent specific gravities and absorption of the coarse and fine aggregates used in the mix design (Attachments #8 and #8A).

6.1.9 The 0.45 power gradation chart (Attachment #9) developed for each mix design. This chart shall include the maximum density line, aggregate control points, and a gradation plot showing each screen used in the design.

6.1.10 A worksheet showing the calculations for the combined aggregate of the mix design (Attachment #10).

6.1.11 Worksheets showing the washed sieve analysis results for each aggregate used in the mix design (Attachment #11).

6.1.12 The temperature-viscosity chart for the asphalt used in the mix design. An asphalt supplier issued chart or document containing the mix and compaction temperature recommended for the specific grade of asphalt will be acceptable.

6.2 The entire printed JMF package shall be submitted to the local District Materials Section in which the HMA plant is located. After reviewing, the District shall attach a memo to the JMF package requesting approval of the design and submit it to the MCS&T Asphalt Section.

6.2.1 The JMF package can also be submitted electronically by scanning it into an Adobe Acrobat Reader file and e-mailing the file to the appropriate District Materials Section and the MCS&T Asphalt Section. After reviewing the JMF package, the District will send an e-mail to the MCS&T Asphalt Section verifying that the JMF package has been reviewed. The District will also note any problems that they find with the JMF. The MCS&T Asphalt Section will conduct a final review on the design package and assign a laboratory number to each approved mix design. MCS&T will contact the mix designer if there are any problems or concerns with the JMF package that will delay final approval. An electronic copy of the approved T400 form shall be e-mailed to the District and Producer for distribution.

6.3 All applicable mix design worksheets can be found on the MCS&T's Webpage[1] under the "Toolbox."

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 401.02.22 Steward – Asphalt Section
RLS:J

[1] http://www.transportation.wv.gov/highways/mcst

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE TO DESIGNING HOT-MIX ASPHALT WITH RECYCLED ASPHALT PAVEMENT

1. PURPOSE

1.1 To establish criteria for designing hot-mix asphalt (HMA) which contains recycled asphalt pavement (RAP) and Performance Graded (PG) Binders.

2. SCOPE

2.1 This procedure is applicable to all hot-mix asphalt designs which contain both RAP and PG Binders.

3. GENERAL

3.1 This MP does not alter the design specification requirements of the 401 Specification or MP 401.02.22. It is to be used only as a supplement to the specifications when designing RAP mixes. It does not affect RAP mixes which were designed through previously approved methods prior to issuance of this MP.

4. APPLICABLE DOCUMENTS

4.1 MP 401.02.22

5. GUIDELINES

5.1 The following guidelines shall apply to all new mix designs which incorporate RAP with PG Binders.

5.2 For design purposes, the specific gravity of the virgin PG Binder shall be used as the specific gravity of the asphalt binder in the RAP. Also, the effective specific gravity of the aggregate in the RAP shall be determined and used as the bulk specific gravity of the RAP aggregate for calculation purposes.

5.3 If the amount of RAP in the mix is equal to or less than 15 percent, then the selected PG Binder to be used as the virgin asphalt shall be the same as the specified PG Binder for the region where the mix will be used. For example, if the specified PG Binder for the region is a PG 64-22 then the PG Binder used in the RAP design shall be a PG 64-22.

5.4 If the amount of RAP in the mix is 16 to 25 percent, then the selected PG Binder to be used as the virgin asphalt shall be one grade below both the high and low temperature grade of the specified PG Binder for the region where the mix will be used. For example, if the specified PG Binder for the region is a PG 64-22 then the PG Binder used in the RAP design shall be a PG 58-28.

5.5 If the amount of RAP in the mix is more than 25 percent, then the blending chart described in Section 6.0 of this MP shall be used to select the high temperature grade of the virgin asphalt. The low temperature grade shall be at least one grade lower than the binder grade specified for the area where the mix will be used. The binder test data and the blending chart must be submitted along with the mix design package.

6. EXAMPLE USE OF BLENDING CHART

6.1 The dynamic shear rheometer can be used to look at permanent deformation (rutting factor) of the binder, which is governed by limiting G*/sin d at the test temperature. The maximum allowable value of the rutting factor shall be 2.0 kPa. A blending chart, similar to the viscosity blending charts used with viscosity graded asphalts, has been developed which plots G*/sin d on a log-log scale on the y-axis as a replacement test for viscosity. Both the recovered asphalt and the virgin asphalt are tested at the high temperature of the specified binder to be used in the design. The test value G*/sin d for each asphalt is plotted on the chart (the recovered asphalt result on the left and the virgin asphalt on the right) and connected with a straight line. The point on the chart where the plot of G*/sin d intersects the y-axis (G*/sin d, kPa, at test temperature) at 2.0 kPa is represented on the x-axis (% virgin binder) as the minimum percentage of virgin binder to be used in the RAP design.

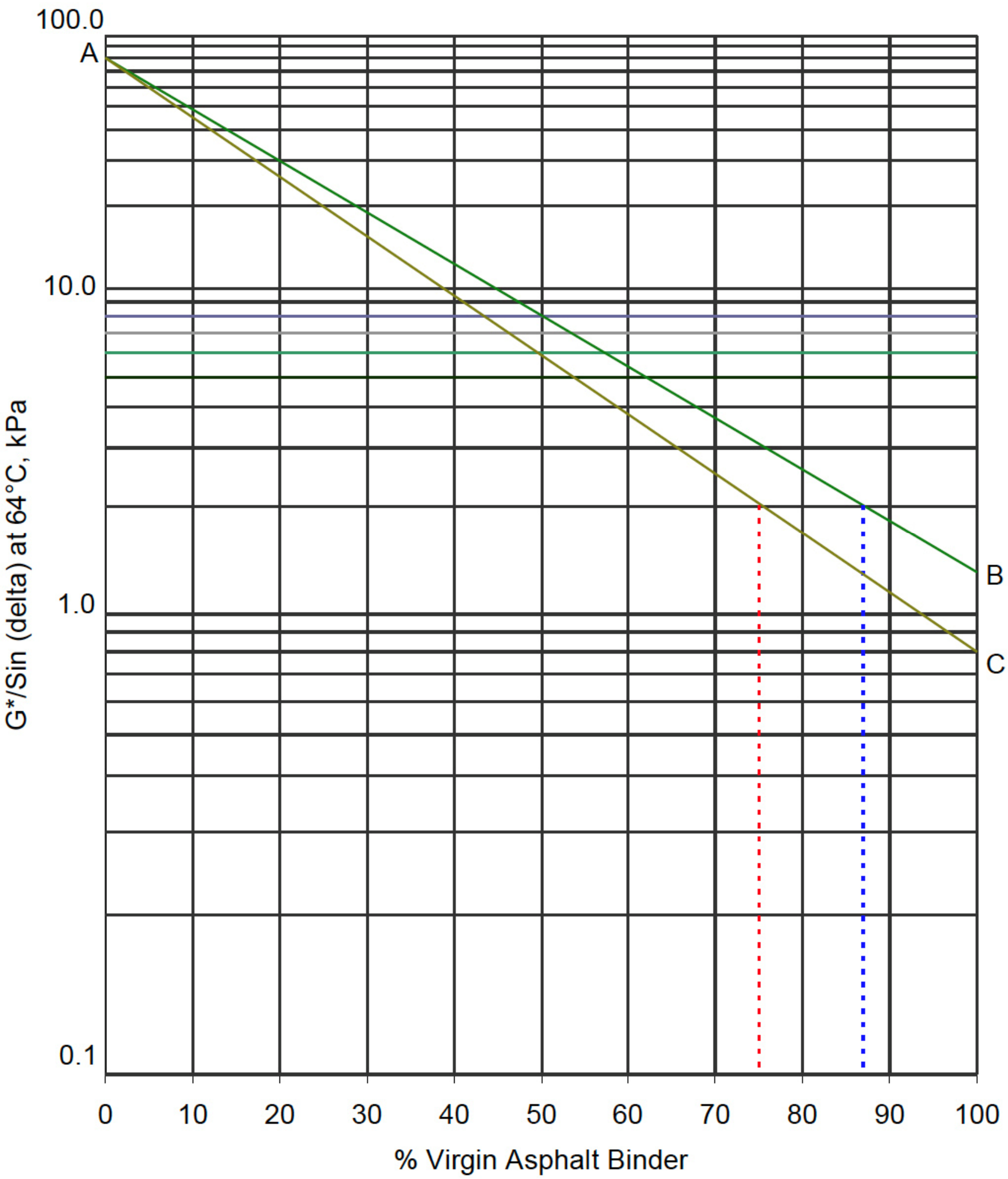
6.2 The attached example illustrates how the blending chart shall be used. The standard binder for the design in this example is a PG 64-22. Test measurements for both the recovered asphalt and the virgin binder are taken at 64 °C. Point A on the chart represents the G*/sin d value for the recovered asphalt. Point B represents the G*/sin d test value for the PG 64-22 binder which has a minimum requirement of 1.0 kPa. The line connecting points A and B intersects the 2.0 kPa rutting factor value at approximately 87% on the x-axis. This means that the minimum amount of virgin asphalt (PG 64-22) that must be used in the RAP design will be 87%. MP 401.02.24 ORIGINAL ISSUANCE: JANUARY, 1998

6.3 Now look at point C on the example chart. This point represents G*/sin d for a PG 58-28 Binder which has been tested at 64 °C. A PG 58-28 Binder would normally be tested at 58 °C and would have a minimum G*/sin d value of 1.0 kPa. However, because we are using this material where the required binder is a PG 64-22, the virgin binder must be tested at 64 °C. The higher test temperature results in a test value of less than 1.0 kPa, as illustrated on the chart attachment. The line connecting points A and C intersects the 2.0 kPa rutting factor value at approximately 75% on the x-axis. This means that the minimum amount of virgin asphalt (PG 58-28) that must be used in the RAP design will be 75%.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 401.02.24 Steward – Asphalt Section
RLS:J
ATTACHMENT

PG Binder/RAP Blending Chart



WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE TO DESIGNING HOT-MIX ASPHALT USING THE SUPERPAVE VOLUMETRIC DESIGN METHOD

1. PURPOSE

1.1 To establish an approved Superpave volumetric design method, test procedures, and evaluation criteria for hot-mix asphalt (HMA). If reclaimed asphalt pavement (RAP) is used in the design, refer to Materials Procedure (MP) 401.02.24 for additional guidelines.

2. SCOPE

2.1 This procedure is applicable to design tests conducted for the purpose of establishing mixture proportions for HMA using the Superpave mix design method. Superpave designs previously approved under the March 2000 version of this MP may continue to be used only if they were designed and approved within the volumetric and gradation parameters of Table 1, Table 2, and Table 3, and the quality control requirements of MP 401.02.29 can continue to be maintained.

2.2 Any approved mix design that exhibits poor field performance may be rejected from further use by the Division.

3. REFERENCED DOCUMENTS

3.1 *AASHTO Standards:*

- M 323, Superpave Volumetric Mix Design
- R 30, Mixture Conditioning of Hot Mix Asphalt (HMA)
- R 35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)
- T 11, Materials Finer Than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
- T 27, Sieve Analysis of Fine and Coarse Aggregates
- T 30, Mechanical Analysis of Extracted Aggregate
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T85, Specific Gravity and Absorption of Coarse Aggregate

- T 166, Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
- T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- T 283, Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture Induced Damage
- T 304, Uncompacted Void Content of Fine Aggregate
- T 308, Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method (Test Method A)
- T 312, Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

3.2 *ASTM Standards*

- D 4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

3.3 *Material Procedures*

- MP 401.02.24, Guide To Designing Hot-Mix Asphalt with Reclaimed Asphalt Pavement
- MP 401.02.29, Guide for Quality Control and Acceptance Requirements for Superpave Hot-Mix Asphalt

---

4. TESTING REQUIREMENTS

4.1 The laboratory performing the design shall be a Division approved laboratory. To obtain Division approval, a laboratory must demonstrate that they are equipped, staffed and managed, for batching and testing HMA in accordance with this MP. This shall be accomplished by submitting a copy of their latest report of inspection by the AASHTO Materials Reference Laboratory (AMRL) to the District Materials Section. The laboratory must also submit a letter detailing the actions taken to correct any deficiencies noted in the test procedures listed below. The District will forward this information to Materials Control, Soils and Testing Division (MCS&T). It is also required that the design laboratory request to be included on AMRL's routine schedule of inspections, which is usually every 18 to 24 months in order to maintain their approval status.

4.1.1 AASHTO Test Procedures

- T 30, Mechanical Analysis of Extracted Aggregate
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T85, Specific Gravity and Absorption of Coarse Aggregate
- T 166, Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
- T 283, Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture Induced Damage (specimens prepared using T 312)
- T 308, Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method (Test Method A)
- T 312, Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

4.2 The laboratory is required to have a technician who has attended and successfully completed a Division approved Superpave mix design class. In addition to the class that is offered through the West Virginia University Asphalt Technology Program, hands-on Superpave mix design classes offered by the Asphalt Institute, National Center for Asphalt Technology (NCAT), National Asphalt Pavement Association (NAPA), Chicago Testing Laboratory, and various state DOTs have been approved. Also, Superpave design classes offered by all of the state DOTs that border West Virginia are approved. Classes offered by other state DOTs may be evaluated for approval as needed. Proof of successful completion of all class requirements (including a written examination) must be provided. Approval of an older design class that did not require a written examination will be on a case-by-case basis including a review of the designer's experience. MCS&T will maintain a list of the approved design laboratories and design technicians.

4.3 The mix design properties shall meet the requirements of Table 1, and shall consist of the following:

4.3.1 Percent Air Voids: T 269

4.3.2 Percent Voids in Mineral Aggregate (VMA): R 35

4.3.3 Percent Voids Filled With Asphalt (VFA): R 35

4.3.4 Fines to effective asphalt (FA) ratio: R 35

4.3.5 Tensile Strength: T 283

TABLE 1—SUPERPAVE METHOD VOLUMETRIC MIX DESIGN CRITERIA

Design air void content, percent	4.0
Fines-to-effective asphalt (FA) ratio (Note 1)	0.6 – 1.2
Tensile strength ratio, percent (T 283) (Note 2)	80 (minimum)

	Nominal Maximum Size, mm (in.)					
	37.5 (1½)	25 (1)	19 (¾)	12.5 (½)	9.5 (⅜)	4.75 (No.4)
Percent Voids in Mineral Aggregate (VMA) (Note 3)	11.5	12.5	13.5	14.5	15.5	16.5
Percent Voids Filled with Asphalt (VFA)	65 – 75	68 – 76	70 – 78	72 – 79	74 – 80	75 – 81

Note 1: When the design aggregate gradation falls within the coarse graded requirement of Table 4, the FA ratio criteria shall be 0.8 – 1.6. For all 4.75 mm (No. 4) mixes, the FA ratio shall be 0.9 - 2.0.

Note 2: Test specimens shall be compacted using a gyratory compactor in accordance with T 312. If the 80 percent minimum tensile strength ratio is not met, a new design will be required. A Division approved antistripping additive, such as hydrated lime conforming to the requirements of M 303 or a liquid antistripping additive, may be added to the mixture if needed. The additive must be identified on the T400SP Form. T 283 shall be waived when a new mix design is developed using all of the aggregate sizes and sources of a previously approved mix design that has met the required tensile strength ratio of at least 85 percent. This waiver information should be noted on the submitted design package along with the previously approved design T400SP number to inform the MCS&T why T 283 test data has not been included. If the approved design contained an antistripping additive, then the new design must also contain this additive. MCS&T may request the tensile strength ratio be checked at any time on any design that is shown to exhibit signs of stripping.

Note 3: Mixtures designed with the VMA exceeding the minimum value by more than two percent may be susceptible to flushing and rutting, especially when used on pavements subjected to slow moving traffic conditions. They may also be difficult to compact as they often have a tendency to shove under the roller.

4.4 The mix design shall be developed using the volumetric design guidelines provided in M 323 and R 35 with the exception of any variations or additions that are noted in this MP. All laboratory prepared design test specimens shall be conditioned in an oven for 2 hours ± 5 minutes in accordance with R 30. The gyratory compaction criteria shall be in accordance with Table 2 based on the projected 20-year design traffic ESAL value supplied in the contract documents. If the traffic ESAL value is not supplied in the contract documents, contact the District to obtain this information. The design PG Binder shall normally be selected in accordance with Section 401.2 of the Standard Specifications. However, the laboratory's mix designer should refer to the contract documents to see if a nonstandard binder grade has been specified for the project.

TABLE 2 - GYRATORY COMPACTION CRITERIA (NOTE 4)

20-Year Projected design ESALs (millions)	Compaction Parameters	
	Gyration Level-1	Gyration Level-2
	N_{design} for Binder < PG 76-XX	N_{design} for Binders $\geq$ PG 76-XX or Mixes Placed Below Top Two Lifts (Note 5)
< 0.3	50	50
0.3 to < 3	65	65
3 to < 30	80	65
≥ 30	100	80

Note 4: Unless otherwise specified in the contract documents, a PG 64-22 binder shall be used in mixtures located below the top two pavement lifts. The use of a different binder grade must be approved by the Engineer.

Note 5: The Gyration Level-2 criteria for mixes placed below the top two lifts applies only to mainline paving. Multi-lift base failure and other pavement repairs shall fall under the criteria of Gyration Level-1 unless otherwise specified in the contract documents.

4.5 The design gradation shall meet the requirements of Table 3 for the specified mix type. Table 4 shall be used to distinguish between the gradation criteria for each mix type. The percent passing each sieve listed in Table 3, from one sieve larger than the nominal maximum size down to the 75 µm (No. 200), shall be included in all gradation calculations.

TABLE 3– DESIGN AGGREGATE GRADATION REQUIREMENTS FOR SUPERPAVE MIXTURES (NOTE 7)

Type of Mix	**37.5**	**25**	**19** (Patch & Level)	**12.5**	**9.5** (Scratch)	**4.75** (Scratch)
Standard Sieve Size	**Nominal Maximum Size**					
	37.5 mm (1 ½ inch)	**25 mm** (1 inch)	**19 mm** (3/4 inch)	**12.5 mm** (1/2 inch)	**9.5 mm** (3/8 inch)	**4.75 mm** (No. 4)
50 mm (2")	100					
37.5 mm (1½")	90 – 100	100				
25 mm (1")	90 max	90 – 100	100			
19 mm (3/4")		90 max	90 – 100	100		
12.5 mm (1/2")			90 max	90 – 100	100	100
9.5 mm (3/8")				90 max	90 – 100	95 – 100
4.75 mm (No.4)			**(Note 6)**		90 max	90 – 100
2.36 mm (No.8)	15 – 41	19 – 45	23 – 49	28 - 58	32 - 67	
1.18 mm (No.16)						30 – 60
600 µm (No.30)						
300 µm (No. 50)						
75 µm (No.200)	0.0 – 6.0	1.0 - 7.0	2.0 – 8.0	2.0 - 10.0	2.0 - 10.0	6.0 – 12.0

Note-6: When a 19 mm mix is specified for use as a heavy duty surface mix, it shall be designed as a fine graded mix with the additional requirement of a minimum of 47% passing the 4.75 mm (No.4) screen. The allowable tolerance limit shall be the JMF ± 5% on the 4.75 mm (No.4) sieve, but not below the minimum requirement.

Note 7: For quality control of the mixture the allowable tolerances for each JMF shall be the specified design control points shown in Table-3 with the exception that a 4.75 mm mix shall have a tolerance limit of the JMF ± 5% on the 1.18 mm (No. 16) sieve and all other mix types shall have a tolerance limit of the JMF ± 6% on the 2.36 mm (No.8) sieve. These tolerances shall also be applied to the mix design and shall be documented on the T-400SP Form. The tolerances shall not fall outside of the specified control points of Table-3.

TABLE 4–COARSE AND FINE GRADED HMA CRITERIA

Mixture Nominal Maximum Size	Coarse Graded % Passing / Sieve Size	Fine Graded % Passing / Sieve Size
37.5 (1½)	< 47% / 9.5 mm	≥ 47% / 9.5 mm
25 (1)	< 40% / 4.75 mm	≥ 40% / 4.75 mm
19 (¾)	< 47% / 4.75 mm	≥ 47% / 4.75 mm
12.5 (½)	< 39% / 2.36 mm	≥ 39% / 2.36 mm
9.5 (3/8)	< 47% / 2.36 mm	≥ 47% / 2.36 mm
4.75 (No. 4)	No distinction between coarse and fine grading	

4.6 The aggregate used in the mix design shall meet the requirements of Sections 702.3, 702.4, 703.1, 703.2, and 703.3 of the Standard Specifications with exceptions and additions as noted in Table 5. If a mix contains reclaimed asphalt pavement (RAP), the asphalt must be removed from the RAP for gradation analysis by the ignition oven method (T 308) or a solvent extraction process (T 164). If the T 164 solvent extraction test method is used, a non-chlorinated solvent may be substituted for the standard specified solvent, and the test method may be modified as per the recommendations of the solvent supplier. The solvent must be a product that has been tested for use in extracting asphalt from HMA. The RAP aggregate shall be proportionally blended into the samples submitted to MCS&T as described in Section 4.8. The RAP used for designing a mix must come from the plant stockpile from which it will be produced.

4.7 Test results for fine aggregate angularity, recorded on Design Attachment Number 13, shall be submitted along with the mix design package. Testing shall be conducted in accordance with T 304 (Method A) on a sample blended in accordance with the methods described in Section 4.8.1 and 4.8.2. This testing may be performed by a WVDOH certified asphalt technician or aggregate inspector. The name of the testing laboratory and the technician conducting the test shall be indicated on the worksheets.

4.8 Other than the exception noted in Section 4.9, to obtain final approval of the mix design, coarse and fine aggregate samples must be submitted to the MCS&T through the District Materials Section. These samples will be tested and used as part of the overall approval process for the mix design, therefore, they should be submitted well in advance of the earliest anticipated use of the mix. The aggregate property requirements of Table 5 shall be applied to the blend of coarse and fine aggregates within the mixture.

4.8.1 For each mix design, a minimum 30,000 gram sample (40,000 gram sample for a 37.5 mm mix) of the coarse and fine aggregates shall be blended to the mix design proportions. The blended sample shall then be separated into plus 4.75 mm (No. 4) and minus 4.75 mm (No. 4) portions. The fine aggregate sample shall then be further prepared in accordance with Section 4.8.2. Mixtures shall be designed in accordance with the criteria set forth in Table 1, 2 and 3 unless otherwise indicated in a special provision or as a note in the contract documents.

4.8.2 Fine Aggregate Sampling Procedure: The minus 4.75 mm (No. 4) portion of the blended aggregate sample shall be split into two separate samples. One of these split samples shall be bagged and labeled as the unwashed portion of the fine aggregate blended sample. The other split sample shall be washed, oven dried, and graded to remove all plus 2.36 mm (No. 8) and minus 150 µm (No. 100) material. This washed sample shall then be split and placed into two sample bags. One bag shall be labeled as washed fine aggregate specific gravity sample and the other shall be labeled as washed fine aggregate angularity sample.

4.9 If a new mix design uses the exact aggregate design structure and sources as a previously approved mix design, the aggregate evaluation used to accept the previous mix design will apply to the new mix design. A note of the testing waiver along with the T400SP lab number from the previous design shall be included in the remarks of the T400SP worksheet submitted along with the documentation of the new mix design.

TABLE 5 – AGGREGATE CONSENSUS PROPERTY REQUIREMENTS

20 Year Projected Design ESALs (millions)	Coarse Agg. Angularity (% Minimum) ASTM D5821 (Note 8)		Fine Agg. Angularity (% Minimum) AASHTO T304, Method A (Note 10)		Fine Agg. Sand Equivalent AASHTO T176	Coarse Agg. Flat and Elongated ASTM D4791
	Top Two Pavement Lifts (Note 9)	Below Top Two Pavement Lifts	Top Two Pavement Lifts	Below Top Two Pavement Lifts	% Minimum	% Maximum (Note 13)
< 0.3 (Note 11)	55 / -	- / -	-	-	40	-
0.3 to < 3 (Note 11)	75 / -	50 / -	40	40	40	10
3 to < 10	85 / 80	60 / -	45	40	45	10
10 to < 20 (Note 12)	90 / 85	80 / 75	45	40	45	10
20 to < 30	95 / 90	80 / 75	45	40	45	10
≥ 30	100/100	100/100	45	45	50	10

Note 8: "85/80" denotes that a minimum of 85 percent of the coarse aggregate has one fractured face and a minimum of 80 percent has two fractured faces.

Note 9: The referenced "top two pavement lifts" does not include a scratch course or patching-and-leveling course that may be placed between these lifts. When a scratch or patching-and-leveling course is placed between the top two lifts, the aggregate requirements for the mix shall fall under the "top two pavement lifts" criteria.

Note 10: For design traffic levels of 3 million ESALs or greater, any mix composed of a 100 percent crushed aggregate blend that will be used in the top two lifts of the pavement structure will be acceptable with an FAA value of 43 percent or greater. The 43 percent FAA criteria shall also apply to the 30 million or grater traffic level for mixtures below the top two lifts. It shall also apply to 100 percent crushed aggregate blends that contain no more than 15 percent RAP.

Note 11: The minimum requirement for coarse aggregate angularity for any Section 402 skid resistant mix design with a projected ESAL value of 0.3 to less than 3 million shall be 85/80. For skid resistant mix design with a projected ESAL value of less than 0.3 million it shall be 75/-.

Note 12: The 10 to less than 20 million design ESAL aggregate criteria only applies to Section 402 skid resistant mix designs.

Note 13: Flat and elongated particles in coarse aggregates shall be tested in accordance with D 4791 with the exception that the material passing the 9.5 mm (⅜ in.) sieve and retained on the 4.75 mm (No. 4) sieve shall be included. The aggregate shall be measured using the ratio of 5:1, comparing the length (longest dimension) to the thickness (smallest dimension) of the aggregate particles.

4.10 At the beginning of each paving season in subsequent years the aggregate consensus properties of Table 5 shall be tested on blended aggregate samples prepared in accordance with Section 4.8. These tests may be conducted by a WVDOH certified asphalt technician or aggregate inspector. These test results shall be submitted to the District Materials Section for the purpose of maintaining approval of the mix design. The name of the testing laboratory, date tested, and signature of the technician conducting the tests shall be indicated on the worksheets. These test results must be submitted before the mix is used on any Division project each year.

4.10.1 During the time that the annual aggregate consensus testing is being performed, the Division may periodically request that a duplicate set of blended aggregate samples be prepared for submittal to MCS&T for testing. The Division will identify the mix design in advance so that sufficient material is obtained for preparation of duplicate samples. Nonconforming test results on these samples will require further investigation by the Division. No corrective action will be required by the Contractor unless the investigation concludes that it is necessary. If corrective action is required, the contractor will be notified, and further use of the mix design shall be discontinued until the Division has determined that the problem has been properly addressed.

4.11 If the aggregate consensus property test results submitted to the Districts meet specification requirements, the District shall forward the results to MCS&T for the purpose of maintaining approval of the mix design. If any of the required aggregate tests fail to meet specification requirements, retesting by the contractor will be permitted, and the District shall submit a sample of the blended aggregate to MCS&T to verify the consensus property test that failed.

4.12 If the mix is comprised of 100 percent crushed blended aggregates that contain no more than 15 percent RAP, and it met both the coarse and fine aggregate angularity requirements, the flat-and-elongated requirement, and the sand equivalent requirement during the initial design approval, and any annual follow-up testing, then retesting each year by MCS&T will not be required. However, fine aggregate samples of mixes containing rounded natural sand and/or greater than 15 percent RAP must be prepared by a certified asphalt technician in accordance with Section 4.8 and 4.8.1, and a sample of sufficient size required for testing the fine aggregate angularity shall be submitted to MCS&T on an annual basis.

4.13 Full mix design testing will not be required when a mix design is developed using the exact aggregate structure, sources, and compaction level as a prior Division approved design, along with a different neat binder grade. The designer may instead select to make a set of bulk specific gravity test specimens and a maximum specific gravity test specimen with the approved aggregate structure and the new binder grade at the optimum asphalt content of the approved design. Since these samples are laboratory produced design specimens, they must be oven aged for 2 hours ± 5 minutes before testing in accordance with R 30 (Mix Conditioning of HMA) as specified in R 35 (Superpave Volumetric Design for HMA). Mix and compaction temperature will be based on the requirements of the new binder grade. The percent air voids must be 4.0 ± 0.3 percent. The voids-in-mineral aggregate must be within ± 0.5 percent of the original approved job mix formula design target (but not outside of the limits of this MP). All other mix design criteria must be within the limits specified in this MP. If the mix design meets all of these requirements then this test data may be submitted along with a new T400SP form for approval as a new mix design. A copy of the approved T400SP on which this new design is based should also be included. If the mix design fails to meet all of the requirements then a new mix design must be developed.

5. REPORT

5.1 The T-400SP JMF form shall include the design property information required in Section 401.4 of the Standard Specification. JMF submittals shall include all Superpave mix design software printouts from the specimen compaction and analysis covering the required mix properties. In addition, if not automatically generated through the mix design software, the following information must be included.

5.1.1 A summary sheet (Superpave Package Attachment #1) showing the optimum asphalt content determination plus the design properties compared to the design criteria of Table 1. This attachment shall be signed and dated by the mix design technician.

5.1.2 Worksheet for calculating the effective gravity of the blended aggregates (Attachment #4 or #4A).

5.1.3 Worksheets showing calculations for maximum specific gravities of the mix at the different asphalt contents (Attachment #5). For any mix that contains any single coarse aggregate component with the water absorption of 1.5 percent or greater, follow the supplemental procedure of T 209 to determine if a dry-back is necessary. Because the dry-back procedure is addressing an aggregate coating issue, this same supplemental procedure shall be used on quality control and verification samples of mixes containing these high absorptive aggregates to determine if the dry back procedure is necessary.

5.1.4 Worksheet for calculating the bulk and apparent specific gravities of the total aggregate, and the percent VMA in the compacted mixture (Attachment #6 or #6A).

5.1.5 Worksheet for determining the maximum specific gravity of the mixture, including the dry-back procedure when required (Attachment #7). Note that AASHTO R-35 specifies that the maximum specific gravity shall be based on the average of at least two tests.

5.1.6 Worksheets showing calculation for bulk and apparent specific gravities and absorption of the coarse and fine aggregates used in the mix design (Attachments #8 or #8A).

5.1.7 The 0.45 power gradation chart (Attachment #9) developed for each mix design. This chart shall include the maximum density line, aggregate control points, and a gradation plot showing each screen used in the design.

5.1.8 A worksheet showing the calculations for the combined aggregate of the mix design (Attachment #10).

5.1.9 Worksheets showing the washed sieve analysis results for each aggregate used in the mix design (Attachment #11).

5.1.10 A worksheet showing the calculations for the fine aggregate angularity test (Attachment #13).

5.1.11 A worksheet showing the calculations for absorbed asphalt and effective asphalt content (Attachment #14).

5.1.12 The temperature-viscosity chart for the asphalt used in the mix design. A supplier issued chart or document containing the mix and compaction temperature recommended for the specific grade of asphalt will be acceptable.

5.2 The entire printed JMF package shall be submitted to the local District Materials Section in which the HMA plant is located. After reviewing, the District shall attach a memo to the JMF package requesting approval of the design and submit it to the MCS&T Asphalt Section.

5.2.1 The JMF package can also be submitted electronically by scanning it into an Adobe Acrobat Reader file and e-mailing the file to the appropriate District Materials Section and the MCS&T Asphalt Section. After reviewing the JMF package, the District will send an e-mail to the MCS&T Asphalt Section verifying that the JMF package has been reviewed. The District will also note any problems that they find with the JMF. The MCS&T Asphalt Section will conduct a final review on the design package and assign a laboratory number to each approved mix design. MCS&T will contact the mix designer if there are any problems or concerns with the JMF package that will delay final approval. An electronic copy of the approved T400SP form shall be e-mailed to the District and Producer for distribution.

5.3 All applicable mix design worksheets can be found on the MCS&T's Webpage[1] under the "Toolbox."

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 401.02.28 Steward – Asphalt Section
RLS:J

[1] http://www.transportation.wv.gov/highways/mcst

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR QUALITY CONTROL AND ACCEPTANCE REQUIREMENTS FOR SUPERPAVE HOT-MIX ASPHALT

1. PURPOSE

1.1 To provide a method for daily monitoring and quality assurance of Superpave hot- mix asphalt (HMA).

1.2 To provide guidelines for adequate acceptance plans.

1.3 To provide plant personnel with criteria upon which to base decisions of continuing or ceasing plant production.

1.4 To provide field personnel with criteria upon which to base decisions of accepting or rejecting material.

1.5 To provide an equitable and uniform method for determining price adjustments in those instances where adequate production control has not been maintained and non-specification material has found its way into the completed work.

2. SCOPE

2.1 This acceptance procedure shall be applicable to all Superpave hot-mix asphalt types relative to compliance with job mix formula (JMF) acceptance limits as specified in the governing specifications.

3. DEFINITIONS

3.1 Job Mix Formula – The specification for a single mix produced at a single plant. This mix may be used on a single project or on multiple projects if the basic design criteria (design compaction level and PG Binder grade) are the same.

3.2 Lot - The quantity of material represented by the average of four (4) consecutive test values.

3.3 Sublot – The quantity of material represented by an individual test value within the Lot.

3.4 Field Design Verification Samples and Tests - Those samples taken and tests conducted by the contractor to verify that a mix design can be produced within the limits of the criteria set forth by this Materials Procedure. These samples are taken during the initial use of each mix design or whenever circumstances described in this MP require a new field design reverification. These samples should not be confused with the Division verification samples that are used to determine specification compliance.

3.5 Quality Control Samples and Tests - Those samples taken and tests conducted by the Producer/Contractor to monitor and control the production of this product.

3.6 Verification Samples and Tests - Those samples taken and tests conducted by the Division to determine specification compliance.

4. DOCUMENTATION

4.1 The Contractor shall maintain adequate records of all testing and records of any production changes required to control their product. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, and the nature of corrective action taken. The Contractor's documentation procedures will be subject to the review and approval of the Division at any time during the progress of the work being performed.

4.2 Forms and Distribution: All test data shall be documented on forms provided by the Division. The original copy of the form shall be delivered to the District Materials Supervisor. One copy of each completed form is to be retained by the contractor until the project is completed. Testing shall be conducted using only the approved test methods listed in Section 401.5.1 of the Specification unless specified otherwise in contract documents. Asphalt content and gradation test results shall be recorded on form T417. Mix design property test results shall be recorded on form T419. To be an effective quality control program, tests must be completed in a regular and timely manner.

4.3 The Contractor shall take prompt action to correct conditions that have resulted, or could result, in the submission to the Division of materials and products that do not conform to the requirements of the Contract documents. The Contractor shall establish a detailed plan of action regarding the disposition of non-specification material. In the event that non-specification material is incorporated into the project, the Division shall be notified immediately.

4.4 All HMA component materials shipped to the plant must have proper documentation which identifies the type and source of each material. This information shall be made accessible to the Division for review at any time.

5. JOB MIX FORMULA FIELD DESIGN VERIFICATION

5.1 For each JMF, a field design verification shall be conducted during the first days of plant production for the purpose of demonstrating that the mix can be produced within the specified tolerances set forth in this MP.

5.2 This field design verification shall consist of a randomly selected HMA sample taken in accordance with AASHTO T168 for each three hours of production, with no more than three samples in one day. A minimum of three samples are required for verification, however, three additional samples are required if none of the first three samples are completely within the specification limits. Samples used for gradation analysis during the verification process shall be obtained from the asphalt ignition oven samples (AASHTO T308, formerly TP53). If there is a problem with major aggregate breakdown affecting the gradation test results when using the ignition oven, gradation samples may be obtained from hot bins, cold feeds, or extracted HMA samples.

5.3 Field design verification testing shall not be conducted if less than 200 tons (180 Mg) of material is to be produced in a single day. In such cases daily quality control testing shall be conducted in accordance with Section 6.0 and the sample shall meet the gradation requirements set forth in Table 401.02.29B. The sample shall also meet the design asphalt content within ± 0.4%, a minimum VMA of 0.5% below the design criteria, and the VFA design criteria specified in MP

5.4 401.02.28. The percent air voids shall be within the range of 2.8 – 5.2 percent.

5.5 The field design verification mix property requirements are listed in Table 401.02.29A. Field design verification test results shall be documented on Form T419.

TABLE 401.02.29A
Mix Property Field Design Verification Requirements

Property	**Field Verification Tolerances**
Asphalt Content (%)	JMF ± 0.4 %
Air Voids (%)	3.0 – 5.0 %
Voids in Mineral Aggregate (VMA) %	Min. of 0.5% Below Design Criteria
Voids Filled With Asphalt (VFA) %	Limits of Design Criteria

5.6 Gradation requirements for the field design verification samples shall be as indicated in Table 401.02.29B. The gradation results shall fall within the limits of each listed control point with the exceptions as noted on the 2.36 mm (No. 8) sieve. The gradation must also pass beneath the restricted zone as described in Table 401.02.29B. Gradation results for all sieves listed in this table for each mix type shall be documented on Form T421.

5.7 After each of the field design verification samples is tested, the results shall be evaluated to determine conformance to the requirements of Tables 401.02.29A and 401.02.29B. If any test results fall outside the allowable tolerance limits then steps must be taken to make any necessary production adjustments to bring the mix back to within specification limits. If, after three samples the design criteria and gradation requirements of at least one of the samples is within all of the allowable tolerance limits then verification of the design is complete. If this criteria is not met, then three additional samples shall be tested. If, after six samples, the Division determines that the mix cannot be produced within specification limits, then a new mix design will be required. If the mix design is rejected the average percent asphalt and the average percent air voids of the six verification samples shall be determined. If either or both average values are outside the allowable tolerance limits of Table 401.02.29C then the material represented by these samples shall have its price reduced in accordance with the schedule set forth in Section 7.0.

TABLE 401.02.29B
Design Aggregate Gradation
Requirements (Note 1)

Nominal Max. Size	**37.5 mm (1 ½ inch)**	**25 mm (1 inch)**	**19 mm (3/4 inch)**	**12.5 mm (1/2 inch)**	**9.5 mm (3/8 inch)**	**Gradation Tolerances Shall Be The Design Control Points With Exception As Noted Below**
Standard Sieve Size	**Base-I**		**Base-II (P&L) Wearing-IV**		**Wearing-I (Scratch)**	
50 mm (2")	100.0					-
37.5 mm (1½")	90.0 – 100.0	100				-
25 mm (1")	90.0 max	90.0 – 100.0	100.0			-
19 mm (3/4")		90.0 max	90.0 – 100.0	100.0		-
12.5 mm (1/2")			90.0 max	90.0 – 100.0	100.0	-
9.5 mm (3/8")				90.0 max	90.0 – 100.0	-
4.75 mm (No.4)					90.0 max	-
2.36 mm (No.8)	15.0 – 41.0	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0	JMF ± 6
1.18 mm (No.16)						-
600 µm (No.30)						-
300 µm (No. 50)						-
75 µm (No.200)	0.0 - 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	-

Sieve Size	**Restricted Zone**					
	37.5 mm (1 ½ inch)	**25 mm (1 inch)**	**19 mm (3/4 inch)**	**12.5 mm (1/2 inch)**	**9.5 mm (3/8 inch)**	
4.75 mm (No.4)	34.7	39.5				Mix gradation 45 power plot must fall below the restricted zone
2.36 mm (No.8)	23.3 - 27.3	26.8 – 30.8	34.6	39.1	47.2	
1.18 mm (No.16)	15.5 - 21.5	18.1 – 24.1	22.3 - 28.3	25.6 – 31.6	31.6 - 37.6	
600 µm (No.30)	11.7 - 15.7	13.6 - 17.6	16.7 - 20.7	19.1 – 23.1	23.5 - 27.5	
300 µm (No. 50)	10.0	11.4	13.7	15.5	18.7	

Note 1: Allowable tolerances for each JMF shall be the specified design control points shown in Table 401.02.29A with the exception as indicated on the 2.36 mm (No.8) sieve. These tolerances shall be applied to both the field verification testing of the JMF and the daily contractor quality control testing. The gradation of the mix shall also continue to pass beneath the restricted zone.

5.8 Volumetric production targets shall be established at the end of the field design verification process. The production target asphalt content shall be selected at a value within ± 0.2 % of the approved design asphalt content using the results of the field verification testing to determine the appropriate value. The VMA production target shall be determined from the field verification test data at a value which also provided an air void content that was at or near the JMF target air void content. This VMA value may be adjusted to optimize the ± 1.0 % tolerance of Table 401.02.29C if the result is near the minimum allowable requirement. The production target for VFA shall be the limits of the design criteria. The production target for air voids shall remain at 4.0 %.

5.9 When new plant production targets are established from the field verification process, a new target maximum density shall also be determined for compaction control by averaging the maximum density results of all of the samples used for verification of the mix. The District will forward the verification test data to the Division.

5.10 An approved mix design may be used on other projects during the year without reverification if all of the mix design criteria are the same.

5.11 The maximum allowable blend change for a mix design shall be ten percent on any single aggregate component. If an aggregate blend change of more than five percent on any single aggregate component is required, the Contractor shall evaluate the mix to determine whether or not the volumetric properties, FA ratio, and aggregate properties (coarse and fine aggregate angularity, clay content, and flat and elongated particles) are adversely affected by the change in blended aggregates. The Contractor shall also determine whether or not the aggregate gradation still passes between the control points and beneath the restricted zone. The calculations used in this evaluation shall be provided to the District. The District will review and verify the results of this evaluation. If the District determines that any of the above mentioned properties are adversely affected by the blend adjustment then they may revoke the change in the JMF. If the JMF volumetric properties can not be maintained without these changes, then the contractor will be required to provide a new mix design.

5.12 After the field design verification has been successfully completed and quality control testing (as described in Section 6.0) has begun, the Contractor shall monitor the maximum specific gravity of the mix for any consistent change. If, over a five sample period, there is an average change in the maximum specific gravity of ± 0.02 or greater from the verified value of the mix then a field design reverification may be required. A reverification shall not be conducted if the averages of the % asphalt, % air voids, %VMA, and % VFA of the five quality control samples do not meet the requirements of Table 401.02.27C. The District will review the Contractor's test data, compare it to their verification sample test data, and determine if a reverification is necessary. If the District determines that a reverification of the mix is needed, a new blended aggregate bulk specific gravity shall also be determined for the mix before the field reverification begins. The District will forward the reverification and bulk aggregate specific gravity test results to the Division.

5.13 All approved mix designs shall be reverified on the first project on which they are used in any subsequent years as long as there are no changes to the design specifications that would require a new mix design. In addition, the blended aggregate bulk specific gravity shall be determined before reverification begins.

6. QUALITY CONTROL REQUIREMENTS

6.1 After the field design verification has been successfully completed, quality control sampling and testing shall begin. If production is to continue for four hours or more after the last field design verification sample was taken then the first randomly selected quality control sample shall be taken within that remaining time period. If production continues for less than four hours after the last field design verification sample was taken, then the first randomly selected quality control sample will not be required until the next production day.

6.2 The material produced shall conform to the verified plant production target values established and controlled within the tolerances of Table 401.02.29C. The aggregate gradation shall conform to the requirements of Table 401.02.29B.

6.3 Adjustments to the accepted JMF aggregate proportions shall be made only for the purpose of maintaining the gradation requirements of Table 401.02.29B and/or the design properties of Table 401.02.29C. The maximum allowable adjustment shall be as indicated in Section 5.10. The minimum sample requirements of the approved quality control plan will be sufficient when the allowable adjustments are made as a result of deficient or borderline test properties of the previous test sample.

TABLE 401.02.29C
Quality Control Mix Property Tolerances

Property	Production Tolerances
Asphalt Content (%)	Verified JMF ± 0.4 %
Air Voids (%)	4.0 ± 1.2 %
Voids in Mineral Aggregate (VMA) %	Verified JMF ± 1.0 % with a minimum of 0.5% below the minimum design criteria
Voids Filled With Asphalt (VFA) %	Design Criteria ± 2 %

6.4 If the previous test sample meets all specification requirements, but the Contractor later determines that the gradation of the material entering the plant has changed, then an aggregate proportion adjustment up to two percent will be allowed without requiring an additional test sample. However, if more than one such change is made during the production day, then an additional test sample beyond that specified in the approved quality control plan will be required for each adjustment.

6.5 Minimum Sampling and Testing Frequency: During each day of plant production a minimum of one sample shall be taken for production periods of six hours or less. When the production period exceeds six hours, a minimum of one sample for each half of the production period shall be taken. If the production period exceeds twelve hours, a third sample shall be taken. The Contractor's sampling frequency shall be in accordance with their approved Quality Control Plan.

6.6 For the purpose of administration, the quantity of material represented by an individual test shall be determined as follows: the first sample taken after the field design verification has been approved shall represent the quantity produced from the beginning of production after field design verification until the time the sample was taken. The second sample shall represent the material produced between the time that the first and second samples were taken and so on. The last sample taken prior to a halt in production under a given JMF shall represent that quantity of material produced from the time that the next to last sample was taken until production was stopped.

6.7 Sampling and testing for evaluation of compliance with the verified JMF shall be as follows: Obtain a sample large enough for determining the percent asphalt, percent air voids, percent VMA, percent VFA, and gradation of the mix in accordance with the specified test methods listed in Section 401.5.1 of the Specifications. If excessive aggregate breakdown in the ignition oven prevents proper gradation analysis, aggregate samples may be obtained from hot bins, cold feeds, or extracted HMA samples.

6.8 A four sample average shall be used for the purpose of determining whether or not the material meets specification requirements. The test results of the first four samples shall be averaged. After the fifth sample is taken a four sample moving average shall begin. This first moving average shall consist of the average of the second through fifth test samples. Each time a new sample is taken a new moving average shall be calculated by averaging the new sample with the previous three samples. The moving average shall continue through a single paving season (one calendar year).

6.9 In cases where production is limited and less than four samples of the specified mix design are taken, then the average shall consist of the total number of samples taken during the paving season in accordance with the Quality Control Plan. A new four sample average shall be established at the first startup of a new paving season after the field design verification has been completed.

6.10 The Contractor shall maintain control charts for percent asphalt, percent air voids, percent VMA, and percent VFA. These control charts shall be prepared in accordance with the guidelines of MP 300.00.51. As an alternative method, the control charts may be prepared with a personal computer using software that can generate such charts and provide a distinct graphic representation of all data points. Data points required on the control charts are the daily individual Contractor quality control tests, district verification sample tests, and the moving average of every four Contractor quality control tests. VFA data points shall be calculated to the nearest one percent and all other data points shall be calculated to the nearest 0.1 percent.

6.11 For hand drawn charts, the quality control test data points shall be represented by a small blue circle symbol "∉" and connected by a dashed line. The four sample moving average data points shall be represented by a small red square symbol "0" and connected by a solid line. District verification sample test data points shall be represented by a small red circle symbol "∉", but shall not be connected. The upper and lower tolerance limits of the test properties which were established through the field design verification described in Section 6.0 shall be represented by solid horizontal lines.

6.12 If the computer generated control chart can not be produced using the symbols and lines described above, then a graph legend shall be included which shall indicate the graphic symbols used to represent the required data points and lines.

6.13 The quality control charts shall be kept up to date and placed in a location that is easily accessible to the Division for review at any time.

7. DEGREE OF NONCONFORMANCE

7.1 Should the four sample average of test values for percent asphalt, percent air voids, percent VMA, or percent VFA fall outside the verified JMF tolerances by more than the allowable deviation of Table 401.02.29C then production shall be halted until the Contractor takes necessary steps to bring production under control. Production shall also be halted if three consecutive aggregate gradation tests fall outside the tolerance limits of Table 401.02.29B. Actions taken by the Contractor to bring production back in control shall be documented in the plant diary.

7.2 When the four sample average of the Contractor's quality control tests for percent asphalt and/or percent air voids falls outside the JMF tolerances of Table 401.02.29C, the Sublot of material represented by the last individual test value in the moving average shall have its price reduced in accordance with the schedule set forth in Section 7.3. In the case where the average is nonconforming and the last tested Sublot is conforming, then there would be no price adjustment.

7.3 The degree of nonconformance shall be determined using the following relationship:

When the moving average is greater than the upper control limit Q_U

$= X_n - UL$

When the moving average is less than the lower control limit

$Q_L = LL - X_n$

Where Q_U = Percent of non-conformance at Upper Limit
Q_L = Percent of non-conformance at Lower Limit
UL = Upper Limit
LL = Lower Limit
X_n = Average of four consecutive test values (less than four when production is limited)

If it is decided by the Division that the material is to be allowed to remain in place, then the Sublot shall have its price reduced in accordance with Tables 401.02.29D and/or 401.02.29E as applicable.

TABLE 401.02.29D
ADJUSTMENT OF CONTRACT PRICE FOR MIX NOT WITHIN TOLERANCE LIMITS OF PERCENT ASPHALT

QU or QL	Percent of Contract Price to be Paid
0.0	100
0.1	98
0.2	96
0.3	92
Greater Than 0.3	*

* The Division will make a special evaluation of the material and determinethe appropriate action.

TABLE 401.02.29E
ADJUSTMENT OF CONTRACT PRICE FOR MIX NOT WITHIN TOLERANCE LIMITS OF PERCENT AIRVOIDS

QU or QL	Percent of Contract Price to be Paid
0.0	100
0.1	98
0.2	96
0.3	92
Greater Than 0.3	*

* The Division will make a special evaluation of the material and determinethe appropriate action.

7.4 Should the moving average of both the test properties for the same Sublot fall outside of the JMF tolerance, thus resulting in a reduced price for each, then the following procedure shall be used. The quantity of material represented by the last Sublot in the moving average will have an adjusted unit price which is the product of the original price times the percent as a result of non-conformance of the first test property times the percentage unit price as a result of non-conformance of the second test expressed in the following formula.

AUP = OUP x PUPAC x PUPAV *

Where: AUP = Adjusted Unit Price
OUP = Original Unit Price
PUPAC = Percent Unit Price as a result of Asphalt Content Analysis expressed as a decimal
PUPAV = Percent Unit Price as a result of Air Void

Analysis expressed as a decimal

* PUPAC and PUPAV are used in the formula as needed as a single non-conforming item or together for both non-conforming items as shown.

7.5 A new moving average shall start with the fourth sample that is taken after production is resumed (less than four when production is limited). If, at any time, the Division determines that a mix can not be consistently produced within the tolerance limits of the verified design properties, approval of the mix may be revoked and the contractor will be required to provide a new mix design.

8. SMALL QUANTITY TESTING

8.1 In the event that project activities are such that not more than 75 tons (70 Mg) of a specific mix design are being produced per day during the period of an entire calendar week, then the following small quantity testing requirements shall apply.

8.2 If the plant source rating is A-1, as determined per MP 700.00.52, Guide To Source Rating System Relative To Maintenance Contracts, then the minimum quality control sample requirements shall be one sample per week. The sample shall be taken on the first day of use during the week. If the plant source rating is A-2, as determined per MP 700.00.52, then the normal testing requirements of this MP shall apply.

9. DIVISION VERIFICATION SAMPLING AND TESTING

9.1 Verification testing of HMA is the responsibility of the Division. Quality control tests conducted by the Contractor may be used as a part of the verification process. Verification activities may be accomplished in any of three ways: 1) By conducting sampling and testing completely independent of the quality control activities, 2) by witnessing or reviewing tests performed by the Contractor, or 3) by a combination of both the above. In all cases, those samples and tests taken by the Division completely independent of the Contractor will be taken at a frequency approximately equal to 10% of the frequency required in the Contractor's approved Quality Control Plan for the applicable item.

9.2 The verification samples taken by the Division will be statistically evaluated for similarity to the Contractors quality control tests in accordance with the guidelines of MP 700.00.54. If the evaluation indicates that the Division's test results are similar to the Contractor's test results, then the material represented by this evaluation will be considered acceptable. Those properties to be evaluated, as referenced in MP 700.00.54, will consist of percent asphalt, percent air voids, and gradations. In addition, the VMA and VFA test results will be evaluated using the guidelines of MP 700.00.54.

9.3 If a dissimilarity is detected, an immediate investigation will be conducted to determine the cause. The intent of the investigation is to define and correct any testing deficiencies that may cause a misrepresentation of the tested material.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 401.02.29 Steward – Asphalt Section
RLS:J

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

COMPACTION TESTING OF HOT-MIX ASPHALT PAVEMENTS

1. PURPOSE

1.1 The purpose of this procedure is to establish the test methods for quality control testing by the Contractor and verification testing by the Division.

2. SCOPE

2.1 This procedure is applicable for all items of hot-mix asphalt pavements requiring compaction testing.

3. DEFINITIONS

3.1 Quality Control Testing – Testing conducted by the Contractor to monitor and control the production of their product.

3.2 Verification Testing – Testing conducted by the Division to determine specification compliance.

4. APPLICABLE DOCUMENTS \

4.1 *AASHTO R11*

4.2 *MP 712.21.26*

5. EQUIPMENT

5.1 Nuclear density gauges of the backscatter type.

5.2 One measuring tape of approximately 50 feet (20 meters).

5.3 Lime or other suitable material to mark test sites.

5.4 Dry mortar sand.

5.5 Supply of T401 or T407 data sheets.

6. ROUNDING OF DATA

6.1 Test data must be rounded according to AASHTO R11.

6.2 Test data and calculations are rounded to the following nearest significant digit.

Station Number	1 ft (0.1 m)
Offset	1 ft (0.1 m)
Wet Density	0.1 lb/ft^3 (1 kg/m^3)
Target Density	0.1 lb/ft^3 (1 kg/m^3)
Lift Thickness Compacted	0.25 inch (1
mm) Relative Density	1 %
Average Relative Density	1 %
Average Wet Density	0.1 lb/ft^3 (1 kg/m^3)

7. STANDARDIZATION OF NUCLEAR GAUGE

7.1 Warm up the gauge in accordance with the manufacturer’s recommendations.

7.2 Standardization must be performed away from metal and other objects.

7.3 Clean the top of the standard block and the bottom of the gauge with a cloth.

7.4 Make sure the gauge is turned the correct way on the block.

7.5 After making the necessary adjustments on the gauge for standardization, take a four minute count for density.

7.6 Compare the standard count to the manufacturer's standard count. The standard count must be within ± 2% from the manufacturer's standard.

7.7 If the gauge is not within the specified tolerance, repeat the standardization. If the gauge will not standardize after four attempts, there is probably something wrong with the gauge. There may be electronics problems, the gauge needs calibrated, or a stability check needs to be performed. Do not use a gauge for testing if it will not standardize.

7.8 A gauge must be standardized before testing and at least every four hours during testing.

8. COMPARISON OF GAUGES

8.1 The gauge used for the Contractor’s quality control testing should be compared with the gauge used for the Division’s verification testing.

8.2 Standardize both gauges according to 7.1 through 7.8.

8.3 Place the aluminum plate provided by the Division on the standard block used for verification testing. Place the standard block on material weighing a minimum of 110 lb/ft^3 (1762 kg/m^3). The block must not be near metal or other objects during testing and must not be moved. Keep the gauges separated a minimum of 30 feet (9.1 meters) during testing.

8.4 Take 5 one minute wet density readings with each gauge in the backscatter position. The gauges are to be oriented on the block the same as for standardization.

8.5 Record the wet density readings exactly as shown on the gauge. The range of the five readings shall not exceed 1.5 lb/ft^3 (24 kg/m^3). If the readings exceed this range, perform a new set of five readings. A gauge should not be used if the repeatability of the gauge is not within this range.

8.6 Average the five readings for each gauge. The gauges are considered similar if the averages of the readings are within 3 lb/ft^3 (48 kg/m^3).

8.7 The density readings for verification testing will not be adjusted to compensate for any differences in readings between gauges.

9. QUALITY CONTROL TESTING

9.1 Record the test data on a T401 form.

9.2 Divide the LOT into five equal sublots.

9.3 Randomly locate a test site within each sublot according to MP 712.21.26.

9.4 Check each test site to determine if there are surface voids. Fill the voids with dry mortar sand. Avoid a build-up of fines on the surface to no more than 0.1 inch (3 mm).

9.5 Take a one minute wet density reading on each test site.

9.6 Perform the calculations on the Division approved form.

9.7 Compare the relative densities to the specification requirements.

9.8 The results of the quality control tests should be used by the Contractor to judge if the LOT will meet specifications when verification tests are performed by the Division. Corrective measures are to be taken to bring the LOT into specifications if the quality control tests indicate that a nonconformance situation exists.

10. LOT-BY-LOT DIVISION VERIFICATION TESTING

10.1 Once the Contractor offers a LOT of material to the Division for testing, verification testing will be performed to determine compliance to the specifications.

10.2 Randomly locate a test site within the LOT according to MP 712.21.26.

10.3 Check each test site to determine if there are surface voids. Fill the voids with dry mortar sand. Avoid a build-up of fines on the surface to no more than 0.1 inch (3 mm).

10.4 Take a one minute wet density reading in the backscatter position.

10.5 Perform the calculations on the T401 form.

10.6 Compare the percent relative density to the specification range. If the value is within the range, the LOT is accepted for density.

10.7 When the percent relative density is outside the specification range, divide the LOT into five equal sublots and randomly locate a test site in each sublot according to MP 712.21.26.

10.8 Take a wet density reading at each test site.

10.9 Average the five wet densities.

10.10 Calculate the percent relative density.

10.11 The LOT would be acceptable if the average relative density falls within the specification range. A nonconformance situation exists if the value is outside the range.

11. ROLLERPASS COMPACTION PROCEDURE

11.1 When the total new pavement thickness is limited, the specifications may require that compaction testing will be performed in accordance with the following rollerpass procedure.

11.2 At the beginning of the work, a test section shall be constructed with a length of 100 feet (30 meters) and the width of the paving operation except in restricted areas. If the 100 feet (30 meters) length cannot be obtained, then the test section shall be the maximum obtainable length.

11.3 If there is a concern that the existing pavement conditions may cause difficulty in obtaining the specified density requirement then the Division will either monitor or conduct density testing of the existing pavement before the test section is constructed. Five randomly located wet density tests will be conducted within the test section area and the results will be recorded on a T401 form. Additional testing may also be conducted on other sections of the existing pavement if it is considered necessary for later evaluation.

11.4 To determine the number of roller passes for lift thicknesses of less than 1.5 inches (38 mm), immediately after placement start the rolling operation on the test section and continue this process until the mat temperature reaches 175 °F (80

11.5 °C). If the mat begins to show signs of distress (such as excessive surface aggregate breakage or mat cracking) before reaching 175 °F (80 °C), then discontinue rolling and record the number of roller passes completed before the stress signs occurred. The mat temperature may be lowered to 165 °F (74 °C) if the contractor can demonstrate through the test section that additional densification can be achieved at this lower temperature without causing any pavement distress.

11.6 If the lift thickness is 1.5 inches (38 mm) or greater, the rolling operation may be stopped at 200 °F (93 °C) to conduct density testing as per Section 11.7. If additional rolling is needed then continue as per Section 11.4. If the air temperature is below 60 °F (16 °C), the rolling operation should not be halted until the mat temperature reaches 175 °F (80 °C) unless the distress signs described in Section 11.4 occur. Project conditions may require the Engineer to determine the proper rolling application for lift thicknesses of 1.5 inches (38 mm) or greater.

11.7 The Division will either conduct or closely monitor all density testing on the test section.

11.8 Divide the test section into two equal sublots and randomly locate a test site within each according to MP 712.21.26. Take a wet density reading on each sublot using the procedure described in Section 10.3 and 10.4. Determine the average wet density obtained from the two sublots and use this average to calculate the relative density of the test section. Record all rollerpass density test data on a T407 form.

11.9 If the relative density of the test section is within 92 – 96 % of the maximum density of the approved mix design, or the maximum density established by the most recent plant mix formula verification, then density has been achieved and the number of roller passes has been established for the remainder of the project.

11.10 If the relative density of the test section is above 96 % the Division will make a visual evaluation of the mat and the mixture to look for any appearance of excessive asphalt or an extremely fine mix which may result in over compaction. A review of any density test results obtained from the existing pavement will be made to determine if the existing pavement density was significantly higher than the target density of the mix. The Division will determine whether additional test sections are needed or that the pavement is compacted to the satisfaction of the Engineer with the established number of roller passes. If it is later determined, through the Contractor's daily quality control testing, that the mix had an air void content below 2.5% then proper adjustments shall be made to the mix to bring the air voids back into the allowable tolerance limits. The Division may require the Contractor to establish a new test section if such mix adjustments are required.

11.11 If the relative density of the test section is below 92 %, then a new test section shall be established and the Contractor shall make adjustments to his rolling operation in an attempt to achieve a higher density level before the mat temperature reaches 175 °F (80 °C).

11.12 If the density requirement is not met after two consecutive test sections are completed, the Division will determine whether additional test sections are needed or that the pavement is compacted to the satisfaction of the Engineer with the established number of roller passes. To help with this decision, an evaluation will be made of the existing pavement condition and any density test results obtained prior to construction of the test section will be reviewed. If it is later determined, through the Contractor's daily quality control testing, that the mix had an air void content above 5.5% then proper adjustments shall be made to the mix to bring the air voids back into the allowable tolerance limits. The Division may require the Contractor to establish a new test section if such mix adjustments are required.

11.13 The established number of roller passes shall continue for the remainder of the project unless the Division determines that weather conditions or changes in the condition of the existing roadway are affecting the rolling operation. Under such circumstances, the Division may request that a new roller pattern be established through a new test section.

11.14 The designated number of roller passes shall continue to be completed before the mat temperature falls below 175 °F (80 °C) unless the conditions of Section 11.4 have been established.

11.15 The Contractor shall designate a person to monitor and document the number of roller passes and the mat temperature through the duration of the project.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 401.05.20 Steward – Asphalt Section
RLS:J

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

RAPID DETERMINATION OF THE POLISH SUSCEPTIBLE CARBONATE PARTICLE CONTENT IN AGGREGATES

1. PURPOSE

1.1 To establish a rapid testing procedure for determining the approximate percentage, by weight, of polish susceptible carbonate particles in aggregate.

2. SCOPE

2.1 This procedure is designed to be used in conjunction with the testing of heterogeneous aggregate such as river gravel.

3. 3.0 APPLICABLE DOCUMENTS ASTM E-11

3.1 *ASTM C-702 or AASHTO T-248*

3.2 *MP 700.00.06*

4. APPARATUS

4.1 A #4 U. S. Standard 203 mm diameter sieve, conforming to ASTM E-11 Specifications.

4.2 Balance or scale, having a capacity of at least 300 grams and a sensitivity of at least 0.1 grams.

4.3 Oven capable of being maintained at 110 $\pm$ 5°C.

4.4 Containers: an acid resistant 225 X 175 X 51 mm pyrex dish.

4.5 Receiving beaker: 400 or 600 ml pyrex beaker.

4.6 Tongs: acid resistant

4.7 Hydrochloric Acid: 6N solution

4.8 Safety Apparatus (rubber gloves, aprons, respirators, ventilation hood, etc.)

4.9 A source of magnification, preferable a microscope of sufficient power, to discern grain sizes as small as 2 mm.

5. SAMPLE PREPARATION

5.1 Samples shall be representative of the sources from which they are obtained and shall be reduced to an appropriate size by use of a sample splitter or by quartering in accordance with ASTM C-702 or AASHTO T-248.

5.2 Samples shall be sieved and thoroughly washed over a 4.75 mm and dried in an oven to constant weight at $110 \pm 5^{\circ}$C.

5.3 An oven dry sample, weighing a minimum of 350 grams, shall be used for the test and shall be weighed to the nearest 0.1 gram.

5.3.1 The selection of samples of an exact predetermined weight shall not be attempted.

6. PROCEDURE

6.1 Under a ventilation hood, pour a quantity of 6N hydrochloric acid to cover the largest piece of aggregate in the sample.

6.2 Place a small number of aggregate particles from the sample into the acid and observe signs ofeffervescence.

6.3 Immediately remove all pieces of aggregate exhibiting strong signs of effervescence and place in a beaker containing water to stop the acid- carbonate reaction.

6.4 Repeat this process until all particles exhibiting effervescence have been removed from the sample.

6.5 Thoroughly wash and oven dry all pieces which exhibited effervescence and discard the remainder of the sample.

6.6 Each individual piece of aggregate should be carefully examined under a microscope by a person qualified by education and experience to employ petrographic techniques for the recognition of characteristic properties of rocks and minerals.

6.6.1 It is the intent of this test to determine those carbonate particles which would be considered to be polish susceptible and detract from the overall anti-skid properties of the aggregate. Those carbonate particles which exhibit frictional properties by virtue of a coarse grained texture (> 2 mm) should not be counted as polish susceptible. Calcareous sandstone, for example. would not be considered as a carbonate particle because only the matrix would be made up of carbonate material.

6.7 After this final separation has been made, weigh the carbonate particles to the nearest 0.1 gram.

7. CALCULATIONS

7.1 Calculate the percentage of carbonate particles as follows:

$$C = \underline{W_1}\ x$$
$$100\ W_2$$

Where:

C = Percentage of carbonate particles

W_1 = Total weight of carbonate particles

W2 = Total weight of test sample coarser than a 4.75 mm.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 402.02.20 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING A REDUCED UNIT PRICE TO BE PAID FOR PENETRATION MACADAM WHICH DOES NOT CONFORM TO THE GRADING REQUIREMENTS OF THE GOVERNING SPECIFICATIONS

1. PURPOSE

1.1 This procedure will define a range of non-conformance into the grading of penetration macadam aggregates that may not affect its performance to an extent which would necessitate its removal from the project and will provide a method for reducing the price to be paid for said non-conforming aggregate. Grading characteristics of Penetration Macadam aggregates shall be evaluated in accordance with MP 300.00.51, exceptions noted below.

2. SCOPE

2.1 This procedure shall apply only to those aggregates specified for use as Penetration Macadam.

3. DEFINITION OF TERMS

3.1 SUBLOT - The quantity of material represented by a single test value.

3.2 LOT - The quantity of material represented by an average test value (not to exceed five (5) SUBLOTs). Generally, at the beginning of the project, the average shall be started on the second sample (sublet) in accordance with MP 300.00.51.

4. DESIGNATION OF QUALITIES FOR EQUITABLE PRICE ADJUSTMENT

4.1 In lieu of Section 6.3.1 of MP 300.00.51, the condition of non-compliance shall be defined as that condition which exists when the moving average, or the average of four (4) individual samples (see Section 4.3.2 below), falls outside the specification limit.

4.2 When the moving average falls outside the specification tolerance and material from the LOT represented thereby has been incorporated into the work, then the price for that quantity of material represented by the last SUBLOT in the LOT shall be reduced in accordance with Section 5.0. When the evaluation is based on the average of four (4) samples as described in Section 4.3.2, the quantity of material comprising the LOT represented by the four (4) individual samples shall have its price reduced in accordance with Section 5.0.

4.3 Sampling Frequency and Number of SUBLOTs in the Moving Average

4.3.1 Sampling and testing frequency shall be as prescribed by the Construction Manual except as set forth in 4.3.2.

4.3.2 The number of SUBLOTs included in the moving average will generally be five (5) as described in Section 3.2. However, for limited production when it appears that normal sampling frequency will yield less than five (5) samples total, the sampling frequency shall be adjusted so as to yield four (4) random samples to represent the material. The average of the four (4) samples shall be used in this event to judgecompliance.

5. DEGREE OF NON-CONFORMANCE

5.1 When a sublot of material is to have its price adjusted, the percentage point difference between the non-conforming average value and the specification limit will be determined for each sieve size which has its average outside the limits of the specification for that SUBLOT. The total measure of non- conformance is the sum of all non-conformances on the various sieves for the sublot. This value shall be compared to Table1.

5.2 When the quantity of material represented by an average of four (4) SUBLOTs is to have its price adjusted, the percentage point difference between the non-conforming average value and the specification limit will be determined for each sieve size which has its average outside the limits of the specification. The total measure of non-conformance is the sum of all non- conformances on the various sieves for the SUBLOT. This value shall be compared to Table 1.

Table 1

Degree of Non-conformance	Designated Action
1.0 to 3.0	1.5%
3.1 to 5.0	3%
5.1 to 8.0	5%
8.1 to 12.0	8%

5.3 When the total measure of non-conformance has been established and it is

12.30 or less, the designated action will be initiated from Table 1. When the total measure of non-conformance is greater than 12.0, each non-conforming situation will be resolved on an individual basis, requiring a special investigation by the Engineer to determine the appropriate course of action to be followed.

6. METHOD OF EQUITABLE REDUCTION

6.1 Dollar reduction shall be calculated by (A) quantity of non-conforming sublot x (B) % reduction from Table 1 x (C) unit contract price.

7. METHOD OF ACCOUNTING AND CHANGE ORDER PREPARATION

7.1 Equitable reductions for non-conformance will be determined, for each LOT or SUBLOT, during each contract pay period and the subtotal deducted from the current voucher estimate. These adjustments may be processed with a single change order or when the item is completed by tabulating the data for all non-conforming SUBLOTs and preparing the change order for the total dollar adjustment shown on the tabulation. A copy of the tabulation should accompany and be made a part of the change order.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 403.01.50 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CHEMICAL DETERMINATION OF CEMENT CONTENT IN HARDENED CONCRETE

1. PURPOSE

1.1 To set forth a procedure for determining the cement content of hardened concrete by a chemical method.

2. APPLICABLE DOCUMENTS

2.1 Highway Research Record, Number 370, 1971.

2.2 American Society for Testing and Materials, C-127.

3. PROCEDURE

3.1 Bulk Specific Gravity (ASTM Method C-127 with adaption for concrete saturated surface dried basis).

3.1.1 A sample of the concrete approximately three times the size of the largest aggregate used in the concrete mix is dried to constant weight at 105º C $\pm$2º

C. After soaking for 24 hours, the sample is surface dried and weighed in air, then weighed in water.

3.2 Free Water Loss

3.2.1 The sample from 3.1.1 is dried in an oven for 24 hours at 105º C $\pm$ 2º C. The sample is cooled in a desiccator and weighed.

3.3 Combined Water Loss

3.3.1 The sample from 3.2.1 is crushed and pulverized to 850 µm. The sample is split to approximately 100 grams.

3.3.2 Approximately 50 grams of sample are accurately weighed on an analytical balance. The sample is placed into a weighed dish and dried at 600º C $\pm$10º C for four (4) hours. The sample is then cooled in a desiccator and weighed.

3.4 Extractable Matter

3.4.1 Approximately 10 grams of sample are accurately weighed on an analytical balance. To the sample is added 400 milliliters of 20% maleic acid (dissolved in anhydrous methanol). The sample is stirred for ten (10) minutes. The sample is decanted through a previously weighed set of filter papers in a Buchner funnel, one paper should be fast filtering, the other slow filtering. To the residue in the beaker is added an additional 200 milliliters of the maleic acid solution. The sample is stirred for ten (10) minutes, then washed into the filtering funnel. The funnel is carefully washed with methanol to remove the maleic acid from the paper. The residue is dried for ten (10) minutes at 105º C ± 2º C, cooled in a desiccator, and weighed.

4. CALCULATIONS

4.1 Bulk Specific Gravity (ssd)

$$Sp.\ Gr. = \frac{A}{A-B}$$

Where A = weight in grams of saturated surface dried sample in air.
B = weight in grams of saturated sample in water.

4.2 Free Water Loss (percent)

$$Lf = \frac{A-C}{A} \times 100$$

Where C = weight in grams of sample after 24 hours at 105ºC (ssd).

4.3 Combined Water Loss (percent)

Where D = Weight in grams of sample
E = Weight in grams after heating at 600ºC.

$$Lc = \frac{D-E}{D} \times 100$$

4.4 Extractable Matter (percent)

$$M_E = \frac{F-G}{F} \times 100$$

Where: F = Sample weight in grams
G = Weight of residue in grams

4.5 Residue

$$R = 100 - M_E$$

4.6 Cement Percentage

$$Cp = (100\text{-}R\text{-}L_C)\left(1\text{-}\frac{Lf}{100}\right)$$

4.7 Cement Content in bags/m^3

$$M_E = \frac{F\text{-}G}{F} \times 100$$

Where K = 997.05

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.03.20 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF Ā OF THE TOTAL SOLIDS IN PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish a procedure for determining the Ā of the total solids contained in portland cement concrete.

1.2 To establish a uniform definition of Ā.

2. SCOPE

2.1 This procedure shall apply in all cases where the specification requires the determination of Ā of the total solids in portland cement concrete.

3. DEFINITIONS

3.1 Ā (A-Bar) – A factor that characterizes the gradation of an aggregate. The size of the factor is very highly correlated with the aggregate surface area. The Ā factor is used as a control in concrete mix designs.

4. PROCEDURE

4.1 Since the solids contained in a portland cement concrete mix consist of coarse aggregate, fine aggregate, and portland cement, this procedure will address the determination of Ā of these solids in combination.

4.1.1 The mass of the solid materials used in the mix proportions shall be used to determine the percent of each constituent material in the total solids.

4.1.1.1 Determine the total mass of solids: $M_{ca} + M_{fa} + M_c = M_t$

Where:

M_{ca} = mass of coarse aggregate (SSD) used in one cubic yard (meter) of concrete.
M_{fa} = mass of fine aggregate (SSD) used in one cubic yard (meter) of concrete.
M_c = mass of cement used in one cubic yard (meter) of concrete.

M_t = total mass of solids in one cubic yard (meter) of concrete.

Determine the fractional part of each solid (solid fraction):

$\frac{M_{ca}}{M_t}$ = fractional part of coarse aggregate in the mix

$\frac{M_{fa}}{M_t}$ = fractional part of fine aggregate in the mix

$\frac{M_c}{M_t}$ = fractional part of cement in the mix

4.1.2 Determine the gradation of each of the individual materials using standard procedures with the following modifications.

4.1.2.1 When determining the fine aggregate gradation, include Standard Sieve sizes 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm).

4.1.2.2 When determining the coarse aggregate gradation, all material passing the smallest specification sieve shall be sieved through either eight or twelve inch sieves. Only a minor amount of material will be retained on any sieves above the No. 200. This amount of material is considered to be insignificant and is added to the amount retained on the No. 200 sieve.

4.1.3 Determine the Solid Ā's. The Solid Ā of each constituent shall be determined by adding the cumulative percentages by mass of material passing each of Standard Sieve sizes 1 1/2 inch (37.5 mm), 3/4 inch (19 mm), 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm) and dividing by 100.

4.1.4 Determine the Ā of each of the solids using the fractional parts (solid fractions) from 4.1.1.2 and the Solid Ā of each constituent from 4.1.3.

$\bar{A}_{ca}$ = fractional part of coarse aggregate x Solid Ā of coarse aggregate

$\bar{A}_{fa}$ = fractional part of fine aggregate x Solid Ā of fine aggregate

$\bar{A}_{c}$ = fractional part of cement x Solid Ā of cement

Where:

$\bar{A}_{ca}$ = Ā of coarse aggregate
$\bar{A}_{fa}$ = Ā of fine aggregate
$\bar{A}_{c}$ = Ā of cement

4.1.5 Determine the Ā of the Total Solids:

$\bar{A}$ Total Solids = $\bar{A}_{ca} + \bar{A}_{fa} + \bar{A}_{c}$

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.03.51 Steward – Cement and Concrete Section
RLS:T
ATTACHMENT

EXAMPLE OF CALCULATIONS
Ā TOTAL SOLIDS

1. Total mass of solids in one cubic yard (meter) of concrete:

M_{ca} = Mass of SSD Coarse Aggregate = 1800 lb. (816 kg) M_{fa} =

Mass of SSD Fine Aggregate = 1100 lb. (499 kg) M_c = Mass of

cement = 600 lb. (272 kg)

M_t = Total mass of Solids

$M_t = M_{ca} + M_{fa} + M_c$

M_t = 1800 lb. (816 kg) + 1100 lb. (499 kg) + 600 lb. (272 kg) = 3500 lb. (1587 kg)

2. Fractional part of each solid:

$$\frac{M_{ca}}{M_t} = \frac{1800 \text{ lb.} \quad (816 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.514$$

$$\frac{M_{fa}}{M_t} = \frac{1100 \text{ lb.} \quad (499 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.314$$

$$\frac{M_c}{M_t} = \frac{600 \text{ lb.} \quad (272 \text{ kg})}{3500 \text{ lb.} \quad (1587 \text{ kg})} = 0.171$$

3. Determination of the Solid $\bar{A}$ of each constituent:

PERCENT PASSING

Sieve Size		Coarse Aggregate	Fine Aggregate	Cement
1 1/2 in.	(37.5 mm)	100	100	100
3/4 in.	(19.0 mm)	84	100	100
3/8 in.	(9.5 mm)	21	100	100
No. 4	(4.75 mm)	2	98	100
No. 8	(2.36 mm)	1	83	100
No. 16	(1.18 mm)	0	65	100
No. 30	(600 μm)	0	48	100
No. 50	(300 μm)	0	13	100
No. 100	(150 μm)	0	3	100
No. 200	(75 μm)	0.5	1.5	100
Totals		208.5	611.5	1000
Solid Ā's		2.08	6.12	10

4. Determine the $\bar{A}$ of each of the solids:

$$\bar{A}_{ca} = 0.514 \times 2.08 = 1.07$$
$$\bar{A}_{fa} = 0.314 \times 6.12 = 1.92$$
$$\bar{A}_{c} = 0.171 \times 10 = 1.71$$

5. Determine the $\bar{A}$ of the Total Solids:

$$\bar{A} \text{ Total Solids} = 1.07 + 1.92 + 1.71 = 4.70$$

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURAL GUIDELINES FOR MAINTAINING CONTROL CHARTS FOR PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish guidelines for developing and maintaining control charts to evaluate consistency, percent entrained air, strength characteristics, and the total solids A of portland cement concrete.

2. SCOPE

2.1 These procedures shall be applicable in all instances in which they can be reasonably and logically applied. For consistency, air, and strength, the applicability will normally depend on the quantity of material used, the continuity of delivery, etc. Control charts for total solids A shall be maintained for all concrete designs used on state work by a concrete producer.

3. GENERAL PROCEDURE

3.1 Control charts will be maintained at locations where the test samples are taken.

3.2 Control charts will be prepared on a 10 x 10 cross section paper with a width of approximately 560 mm for the sheet presenting the charts for consistency, percent entrained air, and strength characteristics. A separate sheet of sufficient width shall be used to accommodate the control charts for the total solids A for concrete mix designs. A chart length of approximately 760 mm should be displayed at all times. When standard cross section sheets are used, the most recent sheet will be displayed and the previous sheets will be placed chronologically in a holder.

3.3 Charts for consistency, air, and strength shall have the item number and/or description of the material noted on the top of the chart and will be visible at all times. charts will have the design number and class of concrete visible at all times.

4. CHART PREPARATION

4.1 At the beginning and end of each sheet (or the length of the displayed portion), vertical red lines will be drawn between the limits of the specification or tolerance; an arrow will be placed at the end of the vertical lines; the specification limits will be written above and below the arrows and the name of the property being graphed and the scale will be indicated between the limits on the left edge of the chart. See Appendix 1 and 2 for typical arrangements.

4.2 Scale

4.2.1 Consistency - One division of vertical scale will represent 5.0 mm of slump, or

4.2.2 5.0 mm of ball penetration (25 mm - 50 mm).

4.2.3 Air Content - One division of vertical scale will represent one-tenth of a percentage point of entrained air (25 mm - 1%).

4.2.4 Strength - One division of vertical scale will represent 1 MPa (25 mm = 10 MPa) compressive or 69 KPa (25 mm = 1 MPa) flexural strength.

4.2.5 Total solids A - One division of vertical scale will represent .01 (25 mm = 0.1) when the coarse aggregate size is 57, 7, 78, or 8 and .02 (25 mm = 0.2) when the coarse aggregate size is Number 3.

4.3 Plotting Test Data

4.3.1 Symbols and Color Code - Individual test values will be plotted in blue using the symbol "O", with the circle being approximately 2.5 mm in diameter. Average test values for consistency, percent air, and strength as well as the averages of consecutive five test values for total

4.3.2 Solids A shall be plotted in red using the symbol, "□" with the square being approximately 2.5 mm on each side. Independent Assurance test values developed by the Division, including record samples, will be plotted in green using the symbol "△" with the sides of the triangle being approximately 2.5 mm.

4.3.3 Arrangement of Data - All data developed on a production day will be plotted on one heavy, vertical line, however, when two or more individual test values developed on the same production day have the same magnitude, the symbols may be plotted side-by-side on the same horizontal division line. All test data for a characteristic developed on a production day, exclusive of any independent testing conducted by the Division, will be averaged, and the average value plotted on the same vertical line as the individual test values. When an average value and an individual test value have the same magnitude, the plotted symbols may be superimposed.

4.3.4 When individual test values fall outside the specification limits, an arrow will be placed on the plotted symbol pointing in the direction of the specification limit.

4.3.5 As test data are developed on following production days, it will be plotted on successive heavy vertical lines, 25 mm apart, progressing from left to right across the control chart. As successive averages for consistency, percent air, and strength characteristic are plotted, the symbol "□" will be connected with a heavy red solid line. For total solids A control chart the moving average is the average of five consecutive test values and is determined by starting with the fifth test value and averaging it with the four preceding test values. The moving average of five symbol "□" will be connected with a heavy red solid line. Individual test values will have the symbol "O" connected with a dashed blue line.

4.3.6 At the bottom of the cross section paper and immediately to the left of the heavy vertical line on which the test data are plotted, the date of sampling and initials of the individual plotting the test data will be recorded.

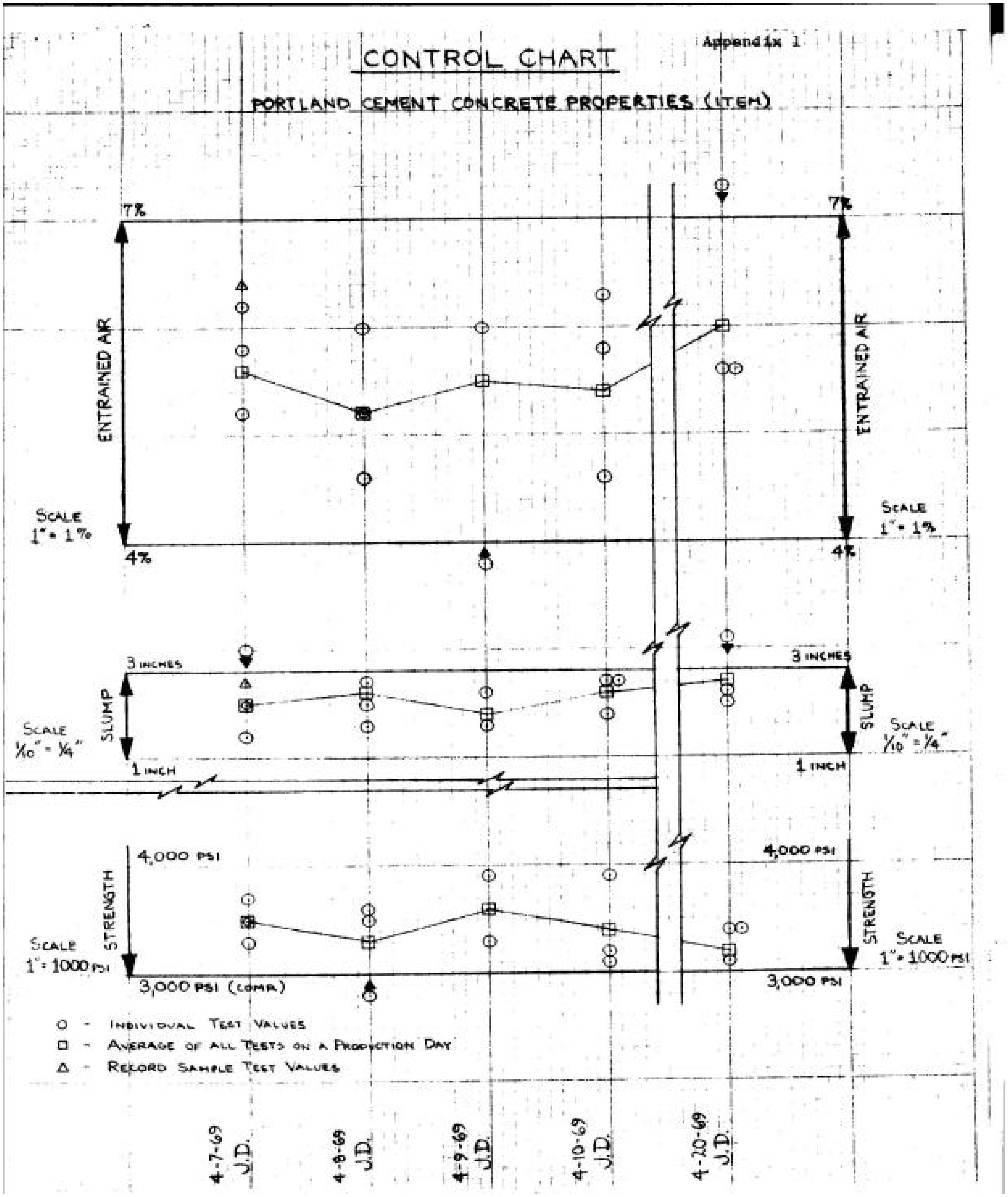
5. FAILING TESTS

5.1 When individual test values fall outside the specification limits, this information will immediately be made available to the supervisory personnel of both the Contractor and the Division.

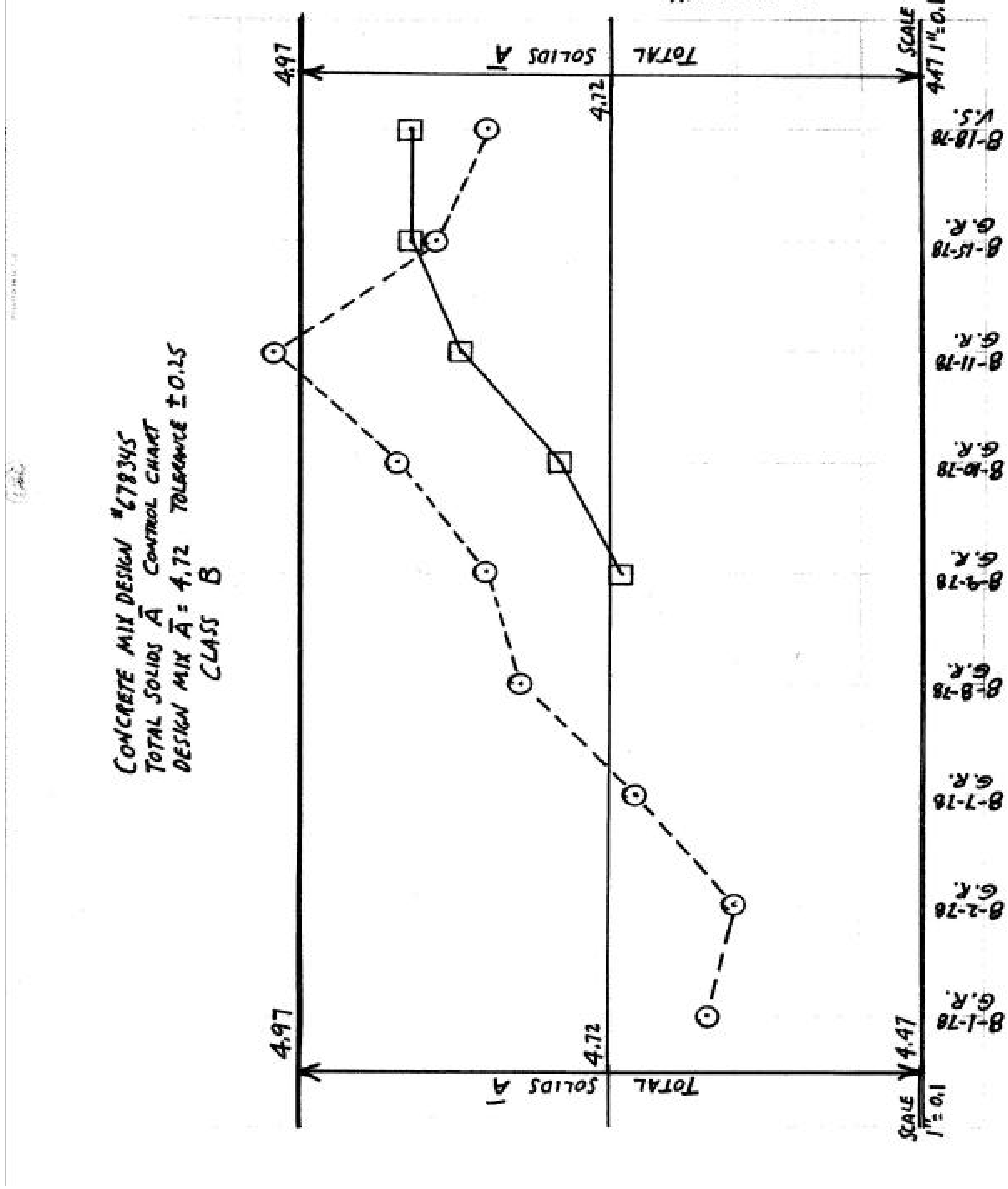
5.2 Should the moving average of five fall outside the design mix A tolerance, action required by the Specification will be taken. When appropriate action has been taken to bring the A back within tolerance the first individual production sample that is within tolerance shall be used to start a new moving average.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.03.52 Steward – Cement and Concrete Section
RLS:T
ATTACHMENT


Appendix 1
CONTROL CHART
PORTLAND CEMENT CONCRETE PROPERTIES (ITEM)
7%
7%
ENTRAINED AIR
ENTRAINED AIR
SCALE
1" = 1%
SCALE
1" = 1%
4%
4%
3 INCHES
3 INCHES
SLUMP
SLUMP
SCALE
1/10" = 1/4"
SCALE
1/10" = 1/4"
1 INCH
1 INCH
4,000 PSI
4,000 PSI
STRENGTH
STRENGTH
SCALE
1" = 1000 PSI
SCALE
1" = 1000 PSI
3,000 PSI (COMP.)
3,000 PSI
○ - INDIVIDUAL TEST VALUES
□ - AVERAGE OF ALL TESTS ON A PRODUCTION DAY
△ - RECORD SAMPLE TEST VALUES
4-7-69
J.D.
4-8-69
J.D.
4-9-69
J.D.
4-10-69
J.D.
4-20-69
J.D.

APPENDIX 2


CONCRETE MIX DESIGN #678345
TOTAL SOLIDS Ā CONTROL CHART
DESIGN MIX Ā = 4.72 TOLERANCE ±0.25
CLASS B
4.97
4.72
4.47
TOTAL SOLIDS Ā
SCALE 1" = 0.1
8-1-78 G.R.
8-2-78 G.R.
8-7-78 G.R.
8-8-78 G.R.
8-9-78 G.R.
8-10-78 G.R.
8-11-78 G.R.
8-15-78 G.R.
8-18-78 V.S.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CURING CONCRETE TEST SPECIMENS IN THE FIELD

1. PURPOSE

1.1 The purpose of this procedure is to modify the curing requirements for cylindrical and prismatic specimens that have been made in the field.

2. BACKGROUND

2.1 The Division's Standard Specifications (501.4 and 601.4) require that the making and curing of concrete test specimens in the field be done in accordance with AASHTO Designation T 23.

2.2 Section 9 of AASHTO Designation T 23 covers curing of the test specimens until time of test.

3. APPLICABLE DOCUMENT

3.1 *AASHTO Designation T 23*

4. PROCEDURE

4.1 Curing of cylindrical and prismatic specimens made in the field shall be in accordance with Section 9 of AASHTO Designation T 23 with modifications as follows.

4.1.1 Delete the section that covers initial curing (10.1.2 in T23-04) and substitute the following:

10.1.2 Initial Curing - Immediately after molding and finishing, the specimens shall be stored for a period of 24 $\pm$ 8 hours in a temperature range from 60 to 80˚F (16 to 27˚C), and in an environment preventing moisture loss from the specimens. For concrete mixtures with a specified strength of 6000 psi (40 MPa) or greater, the initial curing temperature shall be between 68 and 78˚F (20 and 26˚C). Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (Note 6). Shield all specimens from direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by the use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. If cardboard molds are used, protect the outside surface of the molds from contact with wet burlap or other sources of water.

4.2 Delete the section that covers transportation of specimens to the laboratory (11.1 in T23-04) and substitute the following:

11.1 Prior to transporting, cure and protect specimens as required in Section 9. When standard curing is used, specimens shall be transported within 24 $\pm$ 8 hours after molding. When field curing is used, specimens shall not be transported to the laboratory until just prior to testing. During transporting, protect the specimens with suitable cushioning material to prevent damage from jarring. During cold weather, protect the specimens from freezing with suitable insulation material. Prevent moisture loss during transportation by wrapping the specimens in plastic, wet burlap, by surrounding them with wet sand or tight-fitting plastic caps on plastic molds. Transportation time shall not exceed 4 hours.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.04.20 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

FIELD CALIBRATION AND OPERATION OF ROLLING 3m STRAIGHT EDGE ON BRIDGE DECKS

1. PURPOSE

1.1 To establish a field calibration procedure for the 3 m rolling straight edge.

1.2 To establish a procedure for documenting out of tolerance bridge deck sections.

2. FIELD CALIBRATION

2.1 The marking of high and low sections on the deck is best accomplished by the use of red and green clothes dye. One small package should be mixed with 1.89 L of water. It is suggested the dye be mixed in gallon jugs and poured into the appropriate tank on the machine. Drain the tanks and flush when it is anticipated the machine will not be used for a week or more.

2.1.1 Before using, ensure the tank valves on the bottom of the tank are open. Use the red dye solution for high areas and green dye solution for low areas. Do not leave fluid in tanks in freezing weather.

2.2 Under each set of wheels place a piece of steel or other suitable solid material, with dimensions approximately 76 mm x 305 mm x 13 mm. Stretch a piece of string between the front and rear wheels, across the top of each of the pieces, and adjust the center riding wheel so that it just touches the string.

2.3 When straight edging a deck with a vertical curve, the riding wheel should be adjusted as above and then a final adjustment up or down should be made according to the vertical differences of the curve in a 3 m length.

2.4 When the center wheel is in proper alignment, the dial on the straight edge should read zero. This adjustment may be made by removing the top from the control box and loosening the Allen-bolt on the straight gear ram. Move the ram up or down to get the zero adjusted, then tighten the Allen-bolt.

2.5 The adjustment for the high and low valves to open on 3 mm, 6.3 mm or any other designated tolerance is accomplished in the following manner.

2.5.1 Fill the tanks with premixed red dye and green dye.

2.5.2 Set the dial to read the designated high tolerance.

2.5.3 Loosen the two Allen-bolts at the lower front face of the dial marker high side.

2.5.4 Turn on the electric switch at the side of the control box (on is up), and raise or lower the slide held by the Allen-bolts until the solenoid valve opens. Then secure by tightening the Allen-bolts.

2.5.5 Repeat the above procedures for the low side.

3. OPERATION

3.1 Preparation

3.1.1 Obtain a bridge deck floor plan from the project plans and place this plan sheet on a hard surface. Cover the deck floor plan with graph paper. Align the graph paper so that the lines are parallel to the centerline of the deck. Draw a centerline and parallel lines, set to scale at 0.6 m intervals, the length of the deck.

3.1.2 As an alternate method, the bridge floor plan may be printed on graph paper with one set of lines parallel to the centerline or a sketch may be drawn on graph paper.

3.1.3 If the bridge includes a horizontal curve, mark locations on the scale drawing that are 7.6 m to 15.2 m, apart along the centerline. Lay off lines at these locations, perpendicular to the centerline. Mark locations that represent 0.6 m intervals along these lines. Connect these locations to produce lines parallel to the centerline.

3.2 Procedure

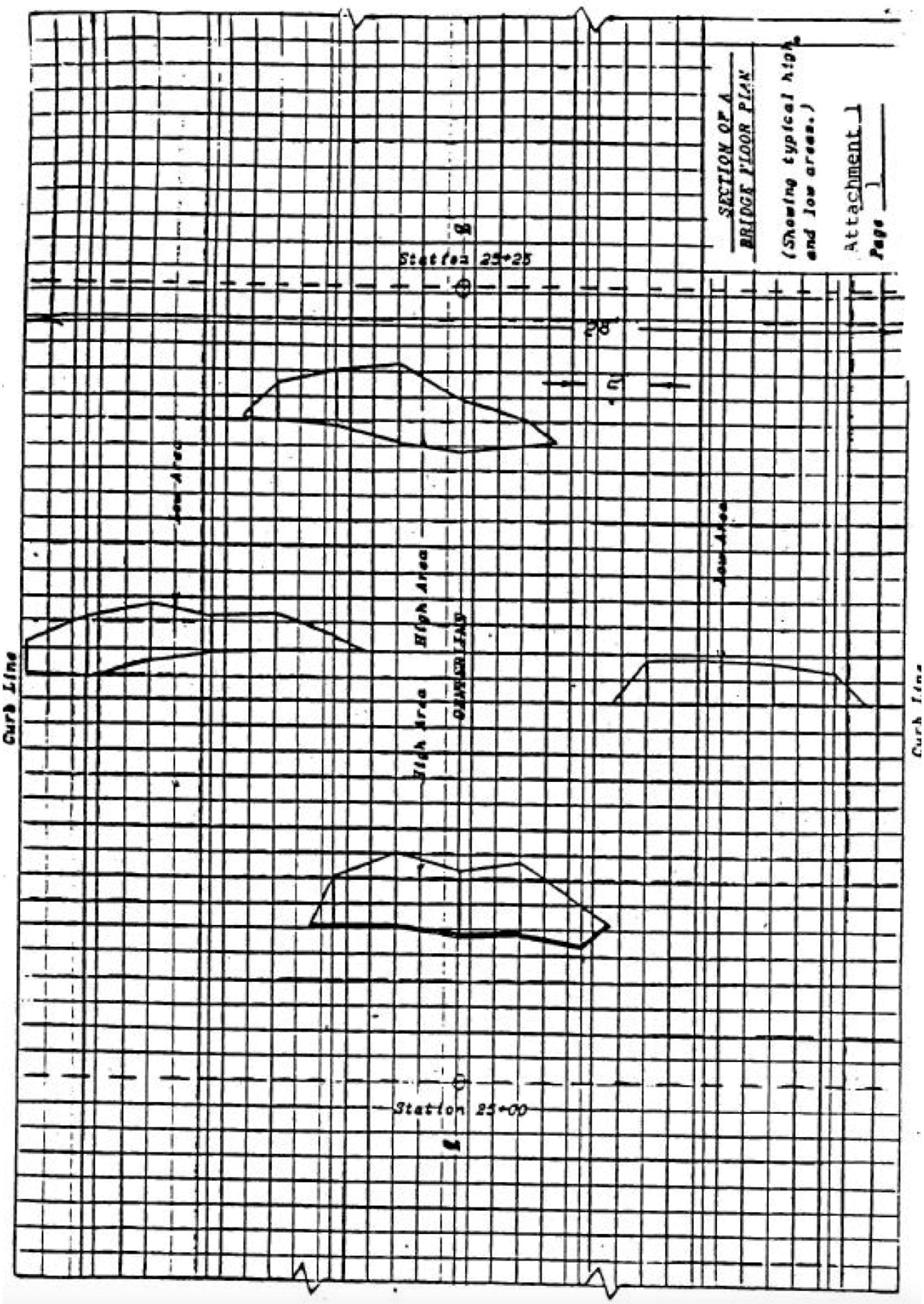
3.2.1 Mark the centerline of the bridge with a suitable chalk. If stations are available on the bridge, draw a transverse perpendicular line every 7.6 m t o 15.2 m. Continue to mark off longitudinal lines parallel to the centerline at 0.6 m centers. Transfer the location of the transverse perpendicular lines to the bridge deck plans or overlay.

3.2.2 Pull the rolling straight edge down the bridge centerline with the center wheel running over the chalk line. When the pass is completed, move the straight edge to the next 0.6 m line and push it back across the bridge. Repeat this operation until all lines have been straight edged. The direction the straight edge is oriented should not be changed.

3.2.3 Transfer the location of any dye markings (measure to the nearest 30 mm) from the deck to the overlay paper or other graph paper. Mark red and green (red for high, green for low) lines and tie them together as per the attachment. The lines should be extended and joined approximately 0.3 m into the next two segments of the bridge deck area. The areas may then be computed by use of a planimeter.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.11.20 Steward – Pavement Analysis and Evaluation Section
RLS:A
ATTACHMENT


SECTION OF A
BRIDGE FLOOR PLAN
(Showing typical high and low areas.)
Attachment 1
Page 1
Station 25+25
Station 25+00
Low Area
High Area
High Area
Low Area
Curb Line
Curb Line

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

TEST METHOD FOR THE DETERMINATION OF BOND STRENGTH BETWEEN PRESTRESSING STEEL STRAND AND SELF-CONSOLIDATING CONCRETE (SCC)

---

1. PURPOSE

1.1 To establish a test method for the determination of the bond strength between prestressing steel strand and self-consolidating concrete (SCC).

---

2. SCOPE

2.1 The test method set forth in this MP shall be used as part of the mix design qualification and approval process for SCC mixes used in the fabrication of prestressed concrete bridge members fabricated for the WVDOH.

---

3. PETERMAN BEAM TEST

3.1 The Peterman Beam Test shall be used to determine the bond capacity of AASHTO M203 Grade 270 0.520-inch (½-inch "oversize") diameter 7-wire steel strand (area of steel = 0.167 in^2) and AASHTO M203 Grade 270 0.600-inch diameter 7-wire steel strand (area of steel = 0.217 in^2) when used in conjunction with SCC. Each size of strand which will be used during the fabrication of prestressed concrete bridge members for the WVDOH must be tested.

3.2 An 8-inch wide x 6-inch tall x 11-ft 6-inch long concrete test beam, containing a single prestressing strand of the size being qualified, shall be constructed as shown in Figures 1, 2, & 3. The SCC mix being qualified and the Fabricator's standard batching, placement, curing, and de-tensioning methods shall be used to fabricate this test beam. The single prestressing strand shall be embedded along the centerline of the beam at a depth of 4.5-inch from the top.

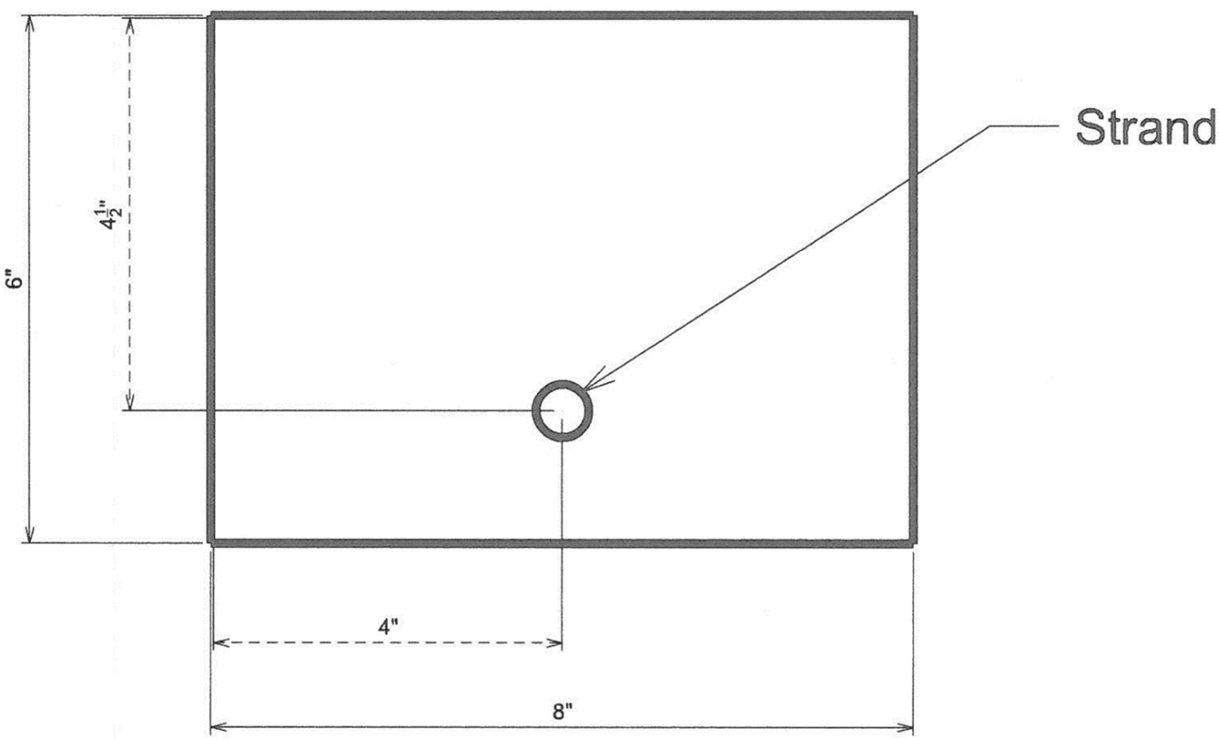


Figure 1. This drawing shows a cross section of the quality assurance test beam. (1 in = 25.4 mm) Dimensional tolerance: +/- 1/8 inch

3.3 After de-tensioning, the ends of the strand shall be ground flush with the concrete at the ends of the test beam. Figure 1 shows the cross section at the end of beam.

3.4 Gradually load the test beam to $P_{85\%}$, which is the load necessary to produce 85% of the calculated nominal moment capacity of the section as shown in Figure 2. This can be accomplished by slowly lowering concrete dead-weight blocks using a forklift or other lifting device. The use of nylon slings to suspend the blocks facilitates the gradual loading process, as the nylon stretches during the loading process. Alternatively, several smaller weights may be sequentially loaded onto the beam.

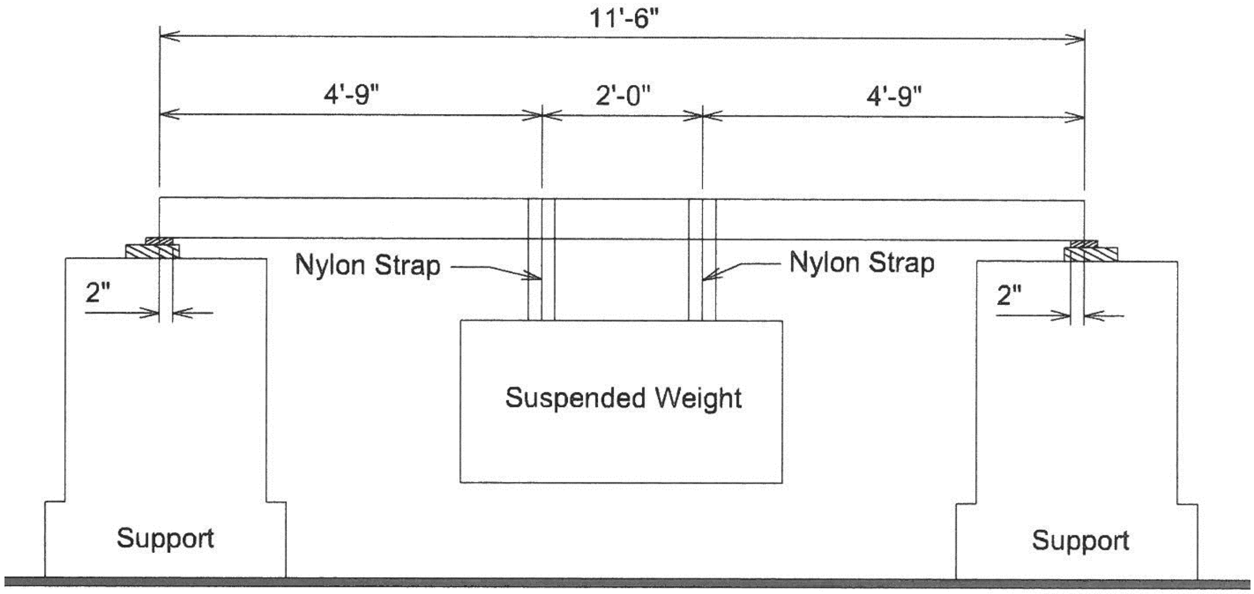


Figure 2. Test Setup

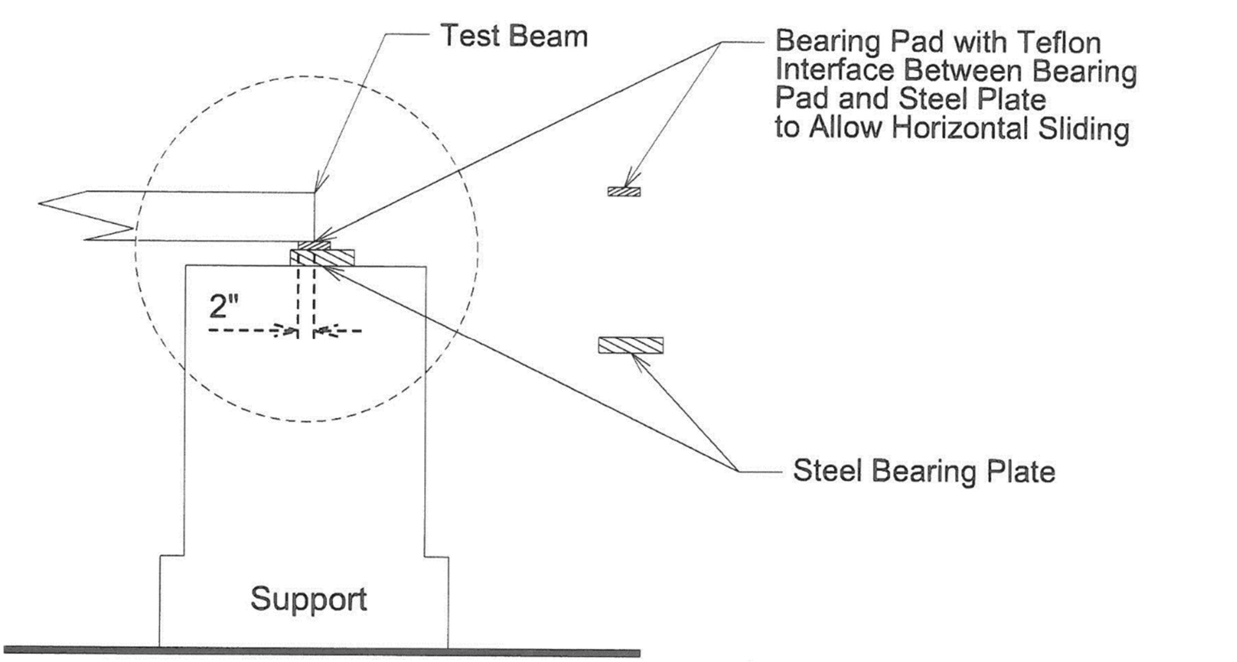


Figure 3. The test setup can be with neoprene bearing pads and bearing plates at each end, or one end of the test setup can have a slide bearing or roller (3 inch diameter minimum), while the other end has a standard neoprene bearing pad. The bearing pad (1 inch thickness minimum) has a Teflon interface on top of a stainless steel bearing plate (1/2 inch thickness minimum). Note: When this test is carried out at an actual facility, a protective fence and other safety measures should be used. (1 in = 25.4 mm. 1 ft = 0.305m). Dimensional Tolerance: +/- ¼ inch

3.5 Inspect the beam and document cracks and strand end-slip if present. With the ends of the strand ground initially flush with the end of the beam end, additional strand slip can be visually detected by noting any draw-in at the ends.

3.6 Sustain the load a minimum of 24 hours to see if there are increasing signs of distress, such as increased strand slippage at the ends, increased cracking, concrete crushing, and the like.

3.7 Load the beam with the additional 15% of the load ($P_{15\%}$) which will give the total load ($P_{100\%}$) required to give a full nominal moment (M_n) of the section and hold that load for at least 10 minutes. If the beam has not collapsed, it has successfully passed the test, and the SCC mix being qualified shall be considered to have acceptable bonding characteristics to the size of strand being tested.

3.8 Tables 1 and 2 are the prescribed loads for specified compressive strengths of concrete for Areas of Steel Reinforcement of 0.167 inch^2 and 0.217 inch^2 respectively. Note the specified minimum compressive strength of concrete at the time of initial prestress is 4000 psi.

Table 1. Prescribed Loadings for Specified Compressive Strength of Concrete for when the Area of Reinforcement is 0.167 inch^2.

$f_c`$ (psi)	$P_{85\%}$ (lbs)	$P_{15\%}$ (lbs)	$P_{100\%}$ (lbs)
5000	4440	840	5280
6000	4560	860	5420
7000	4650	880	5530
8000	4720	890	5570
9000	4770	900	5670
10000	4820	910	5730

Table 2. Prescribed Loadings for Specified Compressive Strength of Concrete for when the Area of Reinforcement is 0.217 inch^2.

$f_{c`}$ (psi)	$P_{85\%}$ (lbs)	$P_{15\%}$ (lbs)	$P_{100\%}$ (lbs)
5000	5580	990	6570
6000	5780	1020	6800
7000	5920	1040	6960
8000	6020	1060	7080
9000	6100	1080	7180
10000	6170	1090	7260

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 603.06.20 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

QUALITATIVE DETERMINATION OF COATING MATERIALS ON METAL

1. PURPOSE

1.1 To set forth test methods for the chemical analysis of coating materials on various types of metal.

2. SCOPE

2.1 These procedures shall be used to determine whether the coating material is aluminum, zinc, or cadmium.

3. DETERMINATION OF ALUMINUM COATING

3.1 Aluminum metal is amphoteric (reacts with acids or bases); zinc and cadmium do not react with bases. Aluminum can, therefore, be identified from the other by its property of reacting in a base.

3.2 The sample is placed in a beaker with enough sodium hydroxide (200 g per liter) to cover the sample. If the coating is aluminum, gas bubbles will form on the coating and then rise to the top of the beaker.

4. DETERMINATION OF ZINC OR CADMIUM COATING

4.1 Procedure

4.1.1 The sample is placed in a small beaker with sufficient dilute (1:1) hydrochloric acid to cover the sample.

4.1.2 The coating is allowed to react. The acid solution is diluted with water to 100 milliliters in a volumetric flask.

4.1.3 The atomic absorption spectrophotometer is standardized using ten (10) and twenty (20) parts per million standards of zinc and cadmium. The sample is aspirated and the predominate concentration of zinc or cadmium is considered to be the type coating.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

QUALITY CONTROL OF STEEL FENCE POST STUDDED TEE TYPE

1. PURPOSE

1.1 To provide acceptance procedures for certified and non-certified sources of studded tee type steel line fence posts for use with farm field fence.

2. SCOPE

2.1 This procedure is applicable to studded tee type steel fence posts.

3. GENERAL

3.1 To become certified (a Division approved source - Section 4.4), it is the manufacturer's responsibility to maintain a Quality Control System assuring only material meeting the governing specification is supplied.

3.2 When fence posts are obtained from a supplier rather than the producer, the responsibility for maintaining the Quality Control System is notrelieved.

4. MANUFACTURER'S CERTIFICATION

4.1 A manufacturer that has demonstrated, via test data developed by the Division, the ability to supply specification fence posts on a regular basis will be considered for certification.MP 608.02.50

4.2 When a manufacturer has met the above criteria, personnel from the Division (or their representative) will visit and inspect the complete manufacturing process. At that time, the manufacturer will randomly sample and test at least one galvanized post. This sample will be taken and tested in the presence of the Division's representative. Additional samples may also be taken and tested by the Division as deemed necessary.

4.3 Tests to be conducted: AASHTO M 281 and M 111.

4.4 When the manufacturer's Quality Control Program is approved, a laboratory number will be issued for that manufacturer and placed on an approved source list.

4.4.1 After certification (approval), the Division may request the manufacturer to submit randomly selected test data representing material shipped.

4.4.2 Division representatives will visit the manufacturer at least once a year, at which time a sample will be chosen at random for a test. At the discretion of the Division this sample may be tested at the manufacturing site and observed by the Division, or the sample may be tested at the Division's facilities.

4.4.3 Any deviation of test results from the specifications will require additional sampling and testing and may be considered cause to remove the manufacturer from the certified status.

4.5 After certification, the manufacturer submits with each shipment to a project or supplier, a document identifying the manufacturer, the approved source laboratory number, length of posts, quantities, and project number. When a supplier receives fence posts from an approved source, the supplier must identify the manufacturer and the approved source laboratory number shipping documents to the project.

4.6 Upon receipt at the project, the project will record the following on Form HL- 440:

- Material - Studded Tee Posts with Accessories Quantity - For each length
- Name - Of certified source
- Approved Source Laboratory Number - In effect when the material was received.

5. NON-CERTIFIED MANUFACTURERS

5.1 Non-certified manufacturers or other suppliers may supply studded tee posts to the Division from approved LOTs only. Each shipment must be sampled, tested, and identified in accordance with MP 700.00.01. A sample for each shipment will be randomly selected by the Division or their representative. In the event of failure, two samples will be selected and tested. Should one of these samples fail, the LOT will be rejected. Documentation for acceptable posts will be in accordance with MP 700.00.01.

6. DIVISION DOCUMENTATION

6.1 Project personnel will review all shipping documents to assure quantities are correct and all information is included. The posts must be inspected for damage. Damage Material will be rejected.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 608.02.50 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

MAINTAINING, RECORDING, AND TRANSMITTING AN APPROVED LIST OF WELDING ELECTRODES AND FLUXES

1. PURPOSE

1.1 To establish a procedure to qualify manufacturers of welding electrodes and fluxes for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

1.3 To establish a procedure for transmitting such information to the Districts and Contractors of WVDOH projects.

2. SCOPE

2.1 This procedure shall apply to all manufacturers of welding electrodes and fluxes for WVDOH projects.

2.2 The word electrode in this document refers to an electrode or an electrode/flux combination.

3. REFERENCED DOCUMENTS

3.1 American National Standard Specifications/American Welding Society, ANSI/AWS:

- A5.l Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
- A5.5 Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding
- A5.17 Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
- A5.18 Specification for Carbon Steel Electrodes for Gas Shielded Arc Welding
- A5.20 Specification for Carbon Steel Electrode for Flux Cored Arc Welding
- A5.23 Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
- A5.28 Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding
- A5.29 Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding

4. APPROVAL CRITERIA

4.1 For a manufacturer of an electrode to be included on the Approved Products List of Electrodes and Fluxes, the manufacturer shall submit a certification document acceptable to the WVDOH certifying that the electrode is currently being manufactured, and is manufactured to current AWS specifications.

4.2 After the certification document has been received, a review and evaluation to determine the compliance with ANSI/AWS Specification will be conducted.

4.3 After a review indicating specification compliance, a laboratory approval number shall be issued to the electrode, thereby indicating approval status.

4.4 An electrode may be retained on the Approved Products Lists of Electrodes and Fluxes for one year provided no unsatisfactory reporting is received concerning the electrode.

4.5 In January of each year, a new list of Approved Products List of Electrodes and Fluxes shall be generated indicating the manufacturer, electrode trade name, ANSI/AWS class, ANSI/AWS specification, and laboratory approval number.

5. RETENTION OF APPROVED STATUS

5.1 All approved electrodes may be subject to periodic inspection and review to determine if the approved electrode is maintaining the same characteristics and quality as originally approved.

5.2 The criteria for re-approval is as follows:

5.2.1 The manufacturer will receive an email that their electrode(s) on the Approved Products List of Electrodes and Fluxes will expire the first of the year. The email will also provide the current Approved Products List of Electrodes and Fluxes for the manufacturer to review and confirm that the electrodes listed are still currently being manufactured, and complies with current ANSI/AWS specifications.

5.2.2 Retention of the electrode will continue if a newer version of an ANSI/AWS Specification is issued from the time of the original specification.

5.2.3 After an electrode has been re-approved for another year, the Approved Products List of Electrodes and Fluxes shall retain the previous laboratory approval number and shall be used thereafter for as long as the material is re-approved.

5.2.4 Once the electrode has met all criteria for re-approval, an update shall be made in the WVDOH mainframe indicating the date the material was re-approved.

6. DOCUMENTATION REPORT

6.1 The Approved Products List of Electrodes and Fluxes shall be updated at least once a year, but can be updated at any time with the addition of a new electrode or removal of an electrode.

6.2 A current Approved Products List of Electrodes and Fluxes can be found on the Materials Control, Soils and Testing Division's web page under the "Division Approved Source/Product Listing" heading at the following link:

https://transportation.wv.gov/highways/mcst/Pages/APL_By_Number.aspx

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 615.05.10 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

QUALITY ASSURANCE OF STEEL BEARING PILES - ITEM 616, STEEL SHEET PILING, WELDED AND SEAMLESS STEEL PIPE PILES (CAISSON PIPE)

1. PURPOSE

1.1 To set forth procedure for Quality Assurance and Acceptance of steel bearing piles, sheet piling, and caisson pipe.

2. SCOPE

2.1 This procedure shall be used by personnel of project level, District Storekeeper, and Materials Control, Soils and Testing Division.

3. NOTIFICATION OF SOURCE OF MATERIAL

3.1 Submission of Form HL-454

3.1.1 The Contractor will show on Form HL-454 the source of piling covered by this procedure.

3.1.2 For piling orders placed by District Engineers or District Storekeepers under purchase orders, the HL-454 is not required. The source of supply will be obtained when purchase order is awarded.

4. INSPECTION AT SOURCE OF SUPPLY

4.1 Materials Control, Soils and Testing Division will maintain identification of the source of piling, as shown on HL-454 or purchase order, in the applicable project file, but will not authorize inspection of the materials at the producing mill or intermediate supplier. Piling received at project site or by the District Storeroom will not have been pretested, inspected, or stamped by inspection agencies previously performing this assignment.

5. INSPECTION AND DOCUMENTATION PROCEDURE

5.1 Upon receipt of material at project site or District storage area, the following procedure will be initiated.

5.1.1 Visual Inspection by District Personnel

5.1.1.1 This visual inspection must encompass an inspection of piling for damage to flanges and/or webs. Verification that material received agrees with purchase order or contract plans regarding size of piling required, the recording of quantity, size, and length by heat number.

5.1.2 A log should be maintained to assure that sufficient acceptable piling is received to meet the quantity shown on the contract plans or purchase order. Format for this form is attached as Exhibits 1 or 2. All information required on Exhibit 1 or 2, except "Accepted Under Laboratory Number", shall be completed by project or District personnel. The laboratory number will be entered by Materials Division personnel.

5.2 Test Reports

5.2.1 Test reports must be from the material producer in order to determine specification compliance. These test reports may accompany the shipment of piling or may be obtained through the Contractor.

5.2.1.1 Test reports must be reviewed for compliance to the latest applicable specification or to the specification in effect at the time Contract is awarded.

5.2.2 Submission of Test Reports

5.2.2.1 One copy of test report obtained from the producer shall be submitted to Materials Control, Soils and Testing Division.

5.2.2.2 A carbon copy of form referenced in Section 5.1.2 shall accompany the submission of test reports.

5.2.2.3 A properly executed Exhibits 1 or 2 shall be submitted for each shipment of piling received.

5.3 Procedure at Division Level

5.3.1 Review and Distribution of Test Reports

5.3.1.1 Test reports submitted by project or District Storekeeper personnel will be reviewed by personnel of Materials Control, Soils and Testing Division for compliance to the applicable specification.

5.3.1.2 Test reports meeting the requirements of the governing specification will be accepted by Materials Control, Soils and Testing Division. Test reports will be stamped "Checked and Accepted", signed and dated by personnel reviewing test report.

5.3.1.3 Test reports will be assigned a laboratory control number for identification purposes.

5.3.1.4 Test reports and Exhibit 1 or 2 will be distributed as outlined below.

5.3.1.5 Distribution of test reports submitted by project personnel will be: 1 copy to applicable District

1 copy Materials Division Central File
1 copy to Design Division (when applicable)

5.3.1.6 Distribution of test reports submitted by District Storekeeper will be: 3 copies of Maintenance Division

1 copy to Materials Division Central File
1 copy to Design Division (when applicable)

6. ACCEPTANCE OR REJECTION OF PILING

6.1 Piling failing to meet the requirements of the visual inspection or the requirements of the governing specification shall be rejected. At the discretion of the project or District Engineer, rejected piling shall be replaced.

6.2 Based upon acceptable results of Section 5.1.1 and Section 5.1.3, the Project Engineer or District Engineer has the authority to accept piling.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 616.14.50 Steward – Metals Section
RLS:H

EXHIBIT 1

Purchase Order No.	District	Supplier (Mill)	Bridge Number (if applicable)

REQUIRED			RECEIVED		
Piling Size & Total Length	Quantity	Heat Number	Length	Total Length Rec'd to date	Accepted Under Laboratory No.

I certify that the above listed material has been visually inspected by me and found to meet specification requirements.

____
District Storekeeper or Authorized Representative

____
Title

EXHIBIT 2

PROJECT NUMBER	BRIDGE NUMBER	COUNTY	SUPPLIER (MILL)

REQUIRED		RECEIVED				
PILING SIZE & TOTAL LENGTH	QUANTITY	HEAT NUMBER	LENGTH	REC'D	TOTAL LENGTH TO DATE	LABORATORY NO.

I certify that the above listed material has been visually inspected by me and found to meet specification requirements.

____
Project Personnel

____
Title

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SAMPLING PROCEDURES FOR QUALITY DETERMINATION

1. PURPOSE

1.1 The purpose of this procedure is to establish practices for the Contractor's Quality Control System for surface waters. This procedure is intended to be used in designing an adequate Quality Control Plan for the sampling, testing, and evaluation of surface water quality during construction.

1.2 This procedure includes requirements for methods to be used in collecting samples and conducting testing. Also, procedures are established that outline actions to be taken if the water quality is not maintained.

2. APPLICABLE DOCUMENTS

2.1 MP 642.40.20

2.2 West Virginia Administrative Regulations, State Water Resources Board, Chapter 20-5 and 20-5A, Series I

2.3 Environmental Water: Quality Check

3. REQUIREMENTS AND GUIDELINES

3.1 General Requirements: The Contractor will design a Quality Control Plan to include tests, methods, and frequency of sampling. The plan will be submitted to the Engineer at the Pre-Construct ion Conference and a plan must be approved by the District Materials Section before construction may begin. The Contractor's Quality Control results of surface water testing, both field and laboratory, will be documented and copies will be provided to the Engineer throughout the life of the contract.

3.1.1 The Quality Control Plans shall be updated as needed during the life of the contract. The updating will be done by the Contractor as directed by the project Engineer/Supervisor. The updating shall be approved by the District Construction Division.

3.1.2 The Contractor will assign a qualified technician to each project to perform and document the sampling and testing.

3.1.2.1 A qualified technician is defined as a person who is knowledgeable and trained in the sampling and testing of surface waters for those tests as stated in Section 4.3 of this procedure. A resume' of the technician's experience in water quality sampling and testing must accompany the Quality Control Plan. If found inadequate, the technician will be replaced by the Contractor or be given additional training so that sampling and testing is adequately performed.

3.2 Quality Control Plan: The plans will clearly describe the methods by which the Quality Control Program will be conducted. As a minimum, an acceptable plan will include the following:

3.2.1 Name of company official for the specific project who is responsible for the Quality Control and liaison with the Division project personnel. Also, the name of person(s) actually conducting sampling and testing. Sampling and testing will be conducted by a qualified technician and such duties are to be this person's primary assignment.

3.2.2 The tests and type of equipment to be used in sampling and testing will be listed along with accepted methods.

3.2.3 The number and locations of sampling points shall be identified. This may need to be updated frequently during the course of the project.

4. QUALITY CONTROL BY THE CONTRACTOR

4.1 Quality Control testing of surface waters will be performed by the Contractor. Sampling and testing will be conducted on those surface waters within the Division of Highways project areas and in adjacent surface waters that may be affected by construction on these projects.

4.1.1 The Contractor will ensure that a precipitation gauge is located on the project. A daily record will be kept of precipitation. This record will be submitted to the project with any test results that cover the same time period.

4.2 Points of Sampling

4.2.1 Water quality will be determined in flowing streams and/or other surface waters to be affected by construction.

4.2.1.1 The Contractor will monitor the quality of the water upstream and downstream from the limits of construction.

4.2.1.2 In cases of major highway construction, streams will be sampled above and below structures, such as bridges, large sediment control devices, or a series of smaller devices.

4.2.1.3 Streams outside the construction limits that receive flow from construction affected streams are to be sampled. This sampling will be conducted on the receiving stream above and below the mouth of the stream affected by construction. Sampling on the receiving stream will not have to be conducted when the distance of the affected stream from the construction limits to the receiving stream is greater than one-half mile, unless it is observed that pollution is carried a greater distance to enter the receiving stream.

4.2.2 Samples will be taken approximately 15 m above and 30 m below construction limits, structures, sediment control devices and the confluence of streams.

4.2.2.1 When mixing has not created visible homogeneous conditions within approximately 30 m below a confluence, sampling will be conducted at the nearest point where visible homogeneity exists throughout the cross section. This location is to be recorded. When homogeneity does not exist within approximately 304 m below the confluence, a minimum of three samples are to be taken along the cross section at this point. Additional samples may be necessary if determined by the Engineer.

4.2.3 Samples should not be taken from areas of heavy aeration, agitation, or stagnation, unless for specific circumstances and tests.

4.2.4 Under some conditions, points of sampling may have to be located at a specific spot to determine influx of concentrated substances or isolated sources of pollution.

4.2.5 Grab samples will be appropriate in most cases. Depth of sample will be from just below the surface to 9 m below depending on the depth of the stream.

4.2.5.1 Containers for grab samples may be either soap and water cleaned glass or plastic, fitted with plastic screw caps. Containers will be able to hold at least 500 ml.

4.3 Testing

4.3.1 The following tests will be conducted using MP 642.40.20:

pH Turbidity

Testing for pH and turbidity will be conducted within thirty (30) minutes after the samples have been collected. The Engineer will be notified immediately after testing when limits have been exceeded.

4.3.1.1 For other tests that may be specified in the contract document, the Contractor will utilize MP 642.40.20.

4.3.2 The Contractor's attention is directed to the "Limits as per W.Va. Administrative Regulations" attachment. Under the turbidity limit it is noted that this control factor may not apply if the sediment control plans are submitted to the appropriate cooperative. This may result in a waiver approval by the cooperative with concurrence of the chief for streams other than trout streams. The cooperative, as mentioned above, is the Soil Conservation District that has control in the area of construction. The chief, as mentioned above, is the head of the Water Resources Division of the Division of Natural Resources.

4.3.2.1 The waiver approval may contain limits for turbidity. If the waiver does not contain limits for turbidity, then the following limits shall apply. Turbidity shall not exceed 20 Nephelometric Turbidity Units (NTU) over background (l) turbidity when the background is 50 NTU or less, or have more than a 20 percent increase in turbidity (plus 20 NTU minimum) when the background turbidity is more than 50 NTU.

4.3.2.2 The continuation of the waiver, for the duration of the project construction period, will be based on the adherence of the Contractor to the control plan submitted.

4.3.2.3 The Engineer shall be monitoring the water quality data to determine compliance with the specifications and sediment control plan to determine if the methods of control need revision, maintenance, or adjustment.

4.4 Frequency and Duration of Sampling

4.4.1 In normal weather conditions, water quality sampling and testing will be conducted daily at each site. When testing indicates that pollution problems exist, sampling and testing will be conducted once per work shift.

(1) Background water quality is the quality of water entering the project area or the quality of the receiving body of water upstream from the discharge point of project affected water.

4.4.1.1 During periods of no precipitation (greater than one week), when it is evident by the Contractor's is testing that pollution is not being created beyond standard limits at a site, and with the concurrence of the Engineer, water quality sampling and testing may be limited to a weekly frequency at these sites. Visual observations are to be made daily to determine that conditions have not significantly changed. If a change is noted visually, testing is to be conducted and the frequency revised as needed.

4.4.1.2 During in-stream construction, when visual inspection indicates possible pollution, water quality sampling and testing will be conducted at least once per work shift.

4.4.1.3 During periods of project shutdown sampling will be conducted at least once per week.

4.5 Documentation of Results

4.5.1 Water quality results will be maintained on the Division's form entitled "Environmental Water: Quality Check" or on a Contractor's form containing the same information as the Division's form. The completed forms will be provided to the Project Engineer on a daily basis.

5. ACCEPTANCE PROCEDURE

5.1 Acceptance shall be the responsibility of the Division. Acceptance may be accomplished by testing a sample obtained by and tested by the Contractor, by observation of Contractor's sampling and testing, or by sampling and testing independent of the Contractor's.

5.1.1 Testing or observation frequency should be equal to approximately 10% of the frequency of the Contractor's sampling and testing listed in the Quality Control Plan. Normally, some sampling and testing shall be independent of the Contractor's testing.

5.1.2 When discrepancies exist between the Contractor's data and the Division's findings, the Division and Contractor shall individually test a sample in an attempt to locate and correct the problem. These samples shall be taken at the same times and locations. The investigation of the problem is to be mutually cooperative.

5.1.3 Water quality which is affected by actions of the Contractor resulting in violations will require action to be taken. The water quality requirements are contained in the West Virginia Administrative Regulations, State Water Resources Board, Chapter 20-5 and 20-5A, the limits specified by the cooperative or this Materials Procedure. Action will be taken by the Contractor to reduce the pollution to acceptable limits (for such limits, see attachment or section (4.3.2.1). The actions may include, but are not necessarily limited to, the following:(1) Work in the area of influence will be reduced or stopped until the cause, such as rain, has abated to a degree that pollution is within acceptable levels and/or (2) appropriate Best Management Practices will be utilized to reduce the pollution to an acceptable level.

5.1.4 If the Contractor does not take action to control the pollution, the Engineer may stop construction work other than pollution control work, on the project until adequate measures are taken to control the pollution.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 642.03.50 Steward – Environmental and Coatings Section
RLS:P
ATTACHMENT

Limits As Per West Virginia Administrative Regulations,
State Water Resource Board, Chapters 20-5 and 20-5A

pH - No value below 6.0 nor above 9.0

Turbidity - No point or non-point source to West Virginia's waters shall contribute a net load of suspended matter such that the turbidity exceeds 10 NTU over background turbidity when the background is 50 NTU or less, or have more than a 10 percent increase in turbidity (plus 10 NTU minimum) when the background turbidity is more than 50 NTU.

This limitation shall apply to all earth disturbance activities and shall be determined by measuring stream quality directly above and below the area where drainage from such activity enters the affected stream. Any earth disturbance activity continuously or intermittently carried on by the same or associated persons on the same stream or tributary segment shall be allowed a single net loading increase.

This regulation shall not apply to those activities at which Best Management Practices in accordance with the State's adopted 208 Water Quality Management Plan are being utilized on a site specific basis as determined by the appropriate 208 cooperative with concurrence of the chief or an approved Federal or State Surface Mining Permit is in effect. This exemption shall not apply to trout waters.

ENVIRONMENTAL WATER: QUALITY CHECK

PROJECT__________________COUNTY____________________DISTRICT_______________

LAB. NUMBER _______________________________________

DATE SAMPLED/TESTED ______________________________

SAMPLED BY ____

SAMPLING OBSERVED BY DISTRICT: YES NO RAINFALL (24 HRS.)_______"

	SITE#	SITE#	SITE#	SITE#	SITE#
STATION	______	______	______	______	______
OFFSET	______	______	______	______	______
TURBIDITY	______	______	______	______	______
pH	______	______	______	______	______
IRON	______	______	______	______	______
WATER TEMP. °C	______	______	______	______	______
AIR TEMP. °C	______	______	______	______	______

REMARKS:

____
____
____
____

____
Technician's
Signature

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

ANALYSIS OF WATER

1. PURPOSE

1.1 To set forth methods of collection, preservation, and chemical, biological, and physical analysis of water.

2. SCOPE

2.1 The methods set forth in this procedure shall be used for all water analysis except physical testing of water used in concrete.

3. APPLICABLE DOCUMENTS

3.1 AASHTO (American Association of State Highway and Transportation Officials) T 263 and T264.

3.2 Standard Methods for the Examination of Water and Wastewater, American Public Health Association.

4. COLLECTION AND PRESERVATION

4.1 Collection and preservation of water samples shall be conducted by AASHTO T 264.

5. CHEMICAL, BIOLOGICAL, AND PHYSICAL ANALYSIS

5.1 The chemical, biological, and physical analysis of water shall be conducted by AASHTO T 263 with the following exceptions.

5.1.1 Nitrate - Standard Methods of Water and Wastewater, Test 418B

5.1.2 Oil and Grease - Standard Methods, Test 503A

5.1.3 Total Kjeldahl nitrogen - Standard Methods, Test 420A

6. GENERAL

6.1 Any test not listed in the above procedures shall be performed according to Standard Methods for the Examination of Water and Wastewater or American Society for Testing Materials methods.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 642.40.20 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF TENSIONING AND REPORTING TORQUE OF BOLTS FOR NEW AND REPLACEMENT BREAKAWAY SIGN SUPPORTS

1. PURPOSE

1.1 To set forth the material requirements, define the method of testing and outline a method of recording the torque results so obtained.

2. SCOPE

2.1 The procedures set forth herein are intended to provide basic guidance for project field personnel, district materials personnel, Contractor personnel, as well as all maintenance personnel.

3. EQUIPMENT

3.1 The equipment required for this tensioning consists of one (1) 305 mm adjustable wrench (Crescent Type), one (1) accurately adjusted torque wrench, capable of being applied to 12.7 mm, 16 mm and 19 mm ASTM A325 nuts and one (1) set of small center punches.

4. DESCRIPTION

4.1 The operation of breakaway sign supports is entirely dependent upon the tension applied to the A325 bolts used in the assembly. The design is such that the hinge plate bolts must be tightened to approximately their full "Proof Load" rating to serve their intended purpose. A check of Standard Sheet TE1-3A will show the two types of hinge plates used while a check of Standard Sheet TE1-3B will show that the hinge plate is mounted 100mm below the bottom edge of the sign. This sheet also shows that only one (1) hinge plate is used on the "S" shapes, which are cut nearly all the way through while two (2) plates are used on "W" shapes, which are cut completely into two (2) pieces.

4.1.1 The purpose of the hinge plate is twofold. First to stiffen the sign support so that high winds will not blow it over, hence the extreme tightening of the bolts; and second to slip from under the two bolts of the notched hinge plate or break the hinge plate for "W" shapes, upon the impact of an automobile.

4.1.2 The most particular of all bolts, with regard to tightening, are the bolts fastening the upright onto the stub which is embedded into the concrete base. These bolts are tightened to approximately one fifth (1/5) of their proof load which, from testing and experience, has been found to be the proper tension for the support to breakaway from the impact of an automobile, without serious injury to the car or occupants. In fact, it often happens that the support itself is not seriously damaged from being knocked down.

5. PROCEDURE

5.1 In all cases when installing or replacing breakaway sign supports, a representative from the District Materials Section is to be present to check and document the required torque.

5.2 The first operation before the support is erected is to check the tightening of the hinge plate bolts. This should be accomplished by the method shown on Standard Sheet TE1-3B.

5.2.1 Tighten bolts in systematic order to the prescribed torque.

5.2.2 Loosen each bolt and retighten to prescribed torque in the same order as initial tightening. (The above operations shall be accomplished with a 305 mm adjustable wrench, tightening as tight as possible).

5.2.3 Burr threads at junction with nut, using a center punch.

5.3 The procedure for bolting the upright to the stub is found on Standard Sheet TE1-3A.

5.3.1 Assemble post to stub with bolts and with one flat washer on each bolt between plates.

5.3.2 Shim as required to plumb post.

5.3.3 Tighten all bolts the maximum possible with the 305 mm adjustable wrench, to bed washer and shims and to clean bolt threads, then loosen each bolt in sequence and retighten in the same sequence to the prescribed torque. (See Table).

5.3.4 Burr threads at junction with nut, using a center punch, to prevent loosening.

5.3.5 Base Bolt Torque Table

Bolt Size	Newton - Meters Torque
12.7 mm x 64 mm	10.85 to 14.91
16 mm x 70 mm	25.76 to 37.96
19 mm x 89 mm	42.03 to 62.37

Because of the importance of proper torque on these base bolts, the above table is repeated here as given on Standard Sheet TE1-3A.

5.3.6 The size bolt to be used with the various post sizes should always be rechecked from Standard Sheet TE1-3A before the bolt is torqued.

5.3.7 The torque wrench used to determine the torque on these base bolts must be calibrated before use each day and for each succeeding days use.

5.4 It shall be the responsibility of the representative of the District Materials Section to keep a log of the torque reading of each base bolt on breakaways installed in the District and also to record a brief description of any accident involving a breakaway sign support, including damage due to wind storms.

5.4.1 One copy of the appropriate data from the above record shall be submitted to the Materials Control, Soils and Testing Division, Charleston, West Virginia, in computer format. (See attached sample).

5.4.2 These data shall consist of the following:

5.4.3 Number of project.

5.4.4 Date installation completed.

5.4.5 Sign number.

5.4.6 Torque of each base bolt.

5.4.7 Report on hinge plate bolts.

5.4.8 Date of report.

5.4.9 Report of all accidents.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 657.00.50 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
MATERIALS PROCEDURE

CHEMICAL ANALYSIS OF ALUMINUM ALLOYS

1. PURPOSE

1.1 To provide a method to determine the chemical analysis of Aluminum Alloys by Atomic Absorption and Gravimetric analysis.

2. SCOPE

2.1 This procedure is applicable to Aluminum Alloys furnished under Sections 661.2.1.1.1, 661.2.1.1.2, 661.2.1.2, 661.2.1.3 and 661.2.1.4 of the West Virginia Division of Highways Standard Specifications for Roads and Bridges.

3. REFERENCES

3.1 *ASTM E1024*
3.2 *ASTM E34*
3.3 *ASTM C114*
3.4 *Ravenswood Aluminum Technical Method Number 100; SheetNumber 1100.00 thru Number 1100.12.*

4. ATOMIC ABSORPTION SPECTROPHOTOMETER METHOD

4.1 With the exception of Silicon, which will be determined by Gravimetric Analysis (Section 4.2), all required chemical analysis under this procedure will be conducted by using the Atomic Absorption Spectro- photometer calibrated in accordance with ASTM E1024. This method covers the analysis and percentage determination of the following metals in accordance with ASTM E34; Fe (Iron), Cu (Copper),Mn (Manganese), Cr (Chromium), Zn (zinc), Ti (Titanium), Mg (Magnesium), and Ni (Nickel).

4.2 Reagents Needed

4.2.1 Hydrochloric Acid (HCI), specific gravity 1.19

4.2.2 Hydrogen Peroxide (H_20_2), 30 percent solution.

4.3 Preparation of Standards

4.3.1 NBS and Alcoa Aluminum Standards are prepared that will bracketalloys received in the laboratory for analysis.

4.3.2 Weigh out 1.0000 plus or minus 0.0005 grams of alloy, place in a 1,000 mL volumetric flask, add 40 mLs 1 plus 1 HCL. After violent reaction ceases, add 2 mLs H_20_2 to the flask, place on pad on hot plate and finish dissolution (5 minutes).

Cool, dilute to mark, mix thoroughly, and analyze on Atomic Absorption using working standards.

5. GRAVIMETRIC ANALYSIS METHOD

5.1 This method covers the analysis and percentage determination of Silicone. The method used for the analysis is in accordance with the Ravenswood Aluminum Technical Method Number 100; SheetNumber 1100.11 thru Number 1100.12.

5.2 Reagents and Equipment Needed

5.2.1 Mixed Acid Solution – Mix in order given: 700 mL H_20, plus 500 ml 1:1 sulfuric acid (H_2SO_4), 400 ml nitric acid (HNO_3), 400 ml hydro- chloric acid (HC1). Let cool after each acid addition. Store in plastic bottles.

5.2.2 Sulfuric Acid (H_2SO_4) - 10%

5.2.3 Hydrogen Peroxide (H_2O_2) – 3%

5.2.4 Number 40 Whatman (or equivalent) filter paper

5.2.5 Porcelain Crucible – 15 to 30 mL capacity

5.2.6 Muffle furnace conforming to ASTM C114, Section 4.2.7

5.3 PROCEDURE

5.3.1 Weigh one gram sample into a 250 mL Erlenmeyer wide mouth flask.

5.3.2 Add 35 ml mixed acid solution slowly (for ½ g sample use 17.5 ml and for 2 g sample use 70 ml of mixed acid solution).

NOTE: Carry through a reagent blank.

5.3.3 Evaporate to fumes after sample is completely in solution. Continueto fume until all heavy fumes have been driven from the bottom of the flask.

NOTE: Blank will go to complete dryness, only if started early.

5.3.4 Remove from hot plate and cool to touch.

5.3.5 Add 50 ml 10% H_2SO_4 (80 ml 10% H_2SO_4 for 2 g sample).

5.3.6 Add several drops 3% H_2O_2.

5.3.7 Place on hot plate and heat until all soluble salts are in solution. (Everything is in solution now but silicon.)

5.3.8 Filter through Number 40 Whatman (or equivalent) filter paper.

5.3.9 Wash flasks three times with hot water (police if necessary) andpour through filter also.

5.3.10 Wash filter papers about ten times with hot water. Wash the papers approximately another five times or until the papers are acid free tothe taste.

5.3.11 Place filter papers in clean porcelain crucibles.

NOTE: Crucibles should have no pits or traces of previous ignitions.

5.3.12 Burn for 45 minutes in a muffle furnace at 982ºC.

5.3.13 Cool crucibles to room temperature. Carefully empty ash onkeyboard, balance pan, and weigh.

5.4 CALCULATION

The percent of the silicon content will be calculated as follows:

$$\%Si = \frac{(\text{weight } SiO_2 - \text{blank})\ (0.4672)\ (100)}{\text{Sample Weight}}$$

or use Silicon chart (1.0 G samples only). See Table 1

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 661.00.00 Steward – Metals Section
RLS:P
ATTACHMENT

TABLE 1
SILICON

WT ASH	%Si	WT ASH	%Si	WT ASH	% Si	WT ASH	%Si	WT ASH	%Si	WT ASH	%Si
.0010	.05	.0031	.14	.0052	.24	.0073	.34	.0094	.44	.0115	.54
.0011	.05	.0032	.15	.0053	.25	.0074	.35	.0095	.44	.0116	.54
.0012	.06	.0033	.15	.0054	.25	.0075	.35	.0096	.45	.0117	.55
.0013	.06	.0034	.16	.0055	.26	.0076	.36	.0097	.45	.0118	.55
.0014	.07	.0035	.16	.0056	.26	.0077	.36	.0098	.46	.0119	.56
.0015	.07	.0036	.17	.0057	.27	.0078	.36	.0099	.46	.0120	.56
.0016	.08	.0037	.17	.0058	.27	.0079	.37	.0100	.47	.0121	.57
.0017	.08	.0038	.18	.0059	.28	.0080	.37	.0101	.47	.0122	.57
.0018	.08	.0039	.18	.0060	.28	.0081	.38	.0102	.48	.0123	.57
.0019	.09	.0040	.19	.0061	.28	.0082	.38	.0103	.48	.0124	.58
.0020	.09	.0041	.19	.0062	.29	.0083	.39	.0104	.49	.0125	.58
.0021	.10	.0042	.20	.0063	.29	.0084	.39	.0105	.49	.0126	.59
.0022	.10	.0043	.20	.0064	.30	.0085	.40	.0106	.50	.0127	.59
.0023	.11	.0044	.21	.0065	.30	.0086	.40	.0107	.50	.0128	.60
.0024	.11	.0045	.21	.0066	.31	.0087	.41	.0108	.50	.0129	.60
.0025	.12	.0046	.22	.0067	.31	.0088	.41	.0109	.51	.0130	.61
.0026	.12	.0047	.22	.0068	.32	.0089	.42	.0110	.51	.0131	.61
.0027	.13	.0048	.22	.0069	.32	.0090	.42	.0111	.52	.0132	.62
.0028	.13	.0049	.23	.0070	.33	.0091	.43	.0112	.52	.0133	.62
.0029	.14	.0050	.23	.0071	.33	.0092	.43	.0113	.53	.0134	.63
.0030	.14	.0051	.24	.0072	.34	.0093	.43	.0114	.53	.0135	.63

$$\%Si = \frac{(Wt.\ Ash)\ (.4672)\ (100)}{Wt.\ Sample}$$

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SAMPLING, INSPECTION AND ACCEPTANCE OF SIGNING MATERIAL

1. PURPOSE

1.1 This procedure sets forth the guidelines for the sampling, inspection and acceptance of traffic signs and accessories.

2. SCOPE

2.1 This procedure is applicable to project markers, flat sheet signs, extruded signs, blanks, and hardware.

3. APPLICABLE DOCUMENTS

3.1 *Section 661 of the West Virginia Division of Highways (WVDOH) Standard Specifications for Roads and Bridges.*

3.2 *Shop Drawings*

3.3 *Standard Details*

4. SAMPLING PROCEDURE

4.1 The Division's representative shall sample or witness all sampling. No samples will be accepted which have been precut or pre-sampled.

4.2 Orders representing at least ten signs or 9 m^2 shall have all aluminum, sign legend, delineators/reflectors, and hardware sampled. Should pre-approved materials be used, no sampling is required, providing that the sign manufacturer can provide documentation showing approval by the WVDOH.

4.2.1 Orders for less than ten signs or 9 m^2 do not require sampling.

4.3 When sampling from a coil of aluminum, a 300 mm x 300 mm sample shall be cut from an area that is a minimum of 1.3 m from the beginning of the coil.

4.4 When sampling from precut blanks, a 300 mm x 300 mm sample shall be cut from each size.

4.5 When sampling from extrusions, a 300 mm length sample of the extrusion shall be cut from a randomly chosen piece.

4.6 When sampling hardware, five pieces of each component of the assembly shall be randomly selected per 2000 pieces represented.

4.7 When sampling sign legend, the number of samples required is specified in Section 711.14 of the Standard Specifications for Roads and Bridges.

4.8 When sampling delineators/reflectors, 50 pieces of each color shall be randomly selected.

4.9 A Materials Control, Soils and Testing Division T-702 sampling form shall be completed on each sample of aluminum, sign legend, each component of the hardware assembly, and each color of delineators/reflectors. The information required on this form is as follows:

4.9.1 Material Description

4.9.2 WVDOH Materials Code Number

4.9.3 Project Number

4.9.4 Date Sampled

4.9.5 Sampler's Name and Agency Code Number (if sampled by a consultant agency)

4.9.6 Field Sample Number - This can be a batch or LOT number, coil number, or an individual identifying number selected by the inspector.

4.9.7 Test Required

4.9.8 WVDOH Source Code Number

4.9.9 Source Name and Location

4.9.10 Quantity represented in the order being sampled.

4.10 The samples, along with the T-702 sampling forms, shall be submitted to the WVDOH laboratory at the following address:

West Virginia Division of Highways
Materials Control, Soils and Testing Division
190 Dry Branch Drive
Charleston, WV 25306

4.11 Material represented by failing test results shall not be used for any West Virginia project.

5. INSPECTION PROCEDURES FOR FABRICATED SIGNS

5.1 The Division's representative will conduct all inspection procedures by performing the following:

5.1.1 Verify component approval numbers if pre-approved.

5.1.2 Verify the aluminum thickness.

5.1.3 Check the quality of workmanship (no ink smudges, sheeting applied properly, no air bubbles or waviness).

5.1.4 Verify the hole locations in relation to the standard details.

5.1.5 Check the signs of flatness.

5.1.6 Check the edges for roughness.

5.1.7 Check the spacing of letters (sign legend on extruded signs), border widths, margin widths, corner radiuses.

5.1.8 Verify the quantity of each type of hardware against that specified in the order. This includes bolts, nuts, flat washers, lock washers, clamps, post clips, rivets, and any other hardware which may be needed to attach the sign to a structure. If the quantity differs from that ordered, it shall be documented on the inspection report and shipping invoice.

5.1.8.1 Verify that the hardware is the type specified in the order (steel or aluminum nuts, bolts and washers; nylon, steel, or aluminum washers; galvanizing or cadmium plating).

6. REQUIRED DOCUMENTATION

6.1 The following documentation from the manufacturer shall be given to the WVDOH representative when samples are obtained. If no samples are required, this information shall be provided during the inspection of the fabricated signs.

6.1.1 Reflective sheeting certification containing all of the information required in the Second Paragraph of Sub-Section 715.40 of the Standard Specifications.

6.1.2 Mill test data for the hardware including both physical and chemical tests or a list of the WV approval numbers if they were tested by the WVDOH.

6.1.3 Mill test data for the aluminum used in the signs or a list of the WV approval numbers if it was tested by the WVDOH.

6.1.4 Letter of certification that the aluminum is of domestic origin. This document is to be signed by a person of authority at the place of manufacture.

6.1.5 Letter explaining the process by which the sign panels were chemically treated prior to inking or application of reflective sheeting.

6.1.6 Certified test data for the sign legend used on extruded signs or the West Virginia approval number if it was tested by the WVDOH.

6.2 The following documentation from the Division's representative shall be provided to the Division at the completion of each inspection:

6.2.1 A written report listing the results of the inspection and include the documents listed in Section 6.1.

6.2.2 Each inspection report is to be issued an individual MCS&T laboratory number.

6.2.3 Each report is to list the type and gage of sign, quantity of each, and square meters represented for each. It shall also list the hardware, brackets, and any other material inspected which will be used to attach the signs to a structure.

6.2.4 All rejected material is to be identified in the inspection report as well as the reason for rejection.

6.2.5 In the event that all components of an order are not ready for inspection, material not inspected shall be identified on the inspection report.

7. ACCEPTANCE PROCEDURE

7.1 All approved components of the signs and accessories will be accepted by the issue of a final sign report by MCS&T Division.

7.2 Any material not meeting the inspection requirements will be rejected.

7.2.1 Rejected signs/accessories shall be replaced with new material and re-tested and/or re-inspected for conformance to the specification requirements.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 661.02.40 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING THE TORQUE
ON TAMPER RESISTANT HARDWARE

1. PURPOSE

1.1 To set forth a procedure for determining the torque on tamper resistant hardware.

2. SCOPE

2.1 The procedure is applicable for tamper resistant hardware furnished under Section 661.2.2 of the West Virginia Division of Highways Standard Specifications for Roads and Bridges.

3. EQUIPMENT

3.1 Calibrated torque wrench which will read in inch-pounds or foot pounds.

3.2 304.8 mm section of 1.362 kilograms per meter u-channel post.

3.3 152.4 mm x 228.6 mm plate manufactured of 2.032 mm aluminum meeting the requirements of ASTM B-209, alloy 5052-H38. The plate shall contain two 9.525 mm holes drilled 38.1 mm from either end and be centered from both ends.

3.4 101.6 mm x 101.6 mm shim manufactured of 2.023 mm aluminum meeting the requirements of ASTM B-209, alloy 5052-H38. The shim shall contain one 9.525 mm hole drilled offset 38.1 mm on the center of the shim.

3.5 Screwdriver

4. SAMPLE REQUIREMENTS

4.1 Samples are to be selected in accordance with Section 4.6 of MP 661.02.40.

5. PROCEDURE

5.1 Place the shim on the flange side of the u-channel post.

5.2 Place the plate on top of the shim and line up the holes.

5.3 Place the steel washer, then the nylon on the bolt and push through the plate, shim and back of the u-channel.

5.4 Hand tighten the nut on to the bolt until it touches the back of the u-channel.

5.5 Set the reading on the torque wrench to zero.

5.6 Using the torque wrench, slowly turn the nut until the hex shaped drive head separates from it. Hold the bolt head with the screwdriver to prevent any movement during the torquing operation.

5.7 Read the torque wrench to determine the breaking point. Results are to be reported in foot-pounds.

Ronald L. Stanevich, PE, Director
Materials Control, Soils & Testing Division

MP 661.20.00 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
MATERIALS PROCEDURE

PERCENT OF SOLIDS IN THE LATEX USED IN LATEX MODIFIED COMPOSITIONS

1. PURPOSE

1.1 To set forth a procedure for determining the solids content of the latex for use in latex modified compositions.

2. SCOPE

2.1 This procedure shall be used to determine the solids content of all latex materials used in latex modified compositions.

3. EQUIPMENT

3.1 Aluminum weighing dishes (approximately six centimeters in diameter and two centimeters deep), Fisher 8-732 or equivalent.

3.2 Glass vials with cork stoppers, (one dram capacity), Owens-Illinois 60900 or equivalent.

3.3 Analytical balance (accurate to 0.1 milligram)

4. PROCEDURE

4.1 Weigh three aluminum dishes individually to 0.1 milligram. This is weight A.

4.2 Mix sample thoroughly.

4.3 Place sample into three vials, fill to approximately 2/3 of capacity, stopper immediately.

4.4 Weigh each vial and stopper. This is weight B.

4.5 Place approximately one gram of sample from the vial into the pre-weighed dish. Care should be taken to avoid getting the sample on outside of vial.

4.6 Immediately reweigh the vial and stopper. This is weight C.

4.7 Place samples in the oven at 141 $\pm$ 2^0C for two hours.

4.8 Place samples in desiccator to cool.

4.9 Reweigh samples. This is weight F.

5. CALCULATIONS

5.1 $D = B - C$

Where D = sample weight

5.2 $E = F - A$

Where E = weight of solids

5.3 $S = \frac{E}{D} \times 100$

Where S = total solids in percent

5.4 The solids content of the sample is the average of the three tests.

5.5 If the range of the three tests exceeds 1.00 percent, repeat the test procedure.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 679.03.00 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SAMPLING AND TESTING OF MATERIALS AT THE SOURCE

1. PURPOSE

1.1 To provide definitions and general guidelines of source sampling and testing to minimize non specification material arriving at the project site.

2. SCOPE

2.1 This procedure applies to materials sampled at the source (or some intermediate storage area) on a lot-by-lot basis.

3. DEFINITIONS

3.1 Pre sampling - The sampling operation that is completed while the material is at the source, or other intermediate storage area, prior to shipment to the project site. Pre sampled material cannot be used until authorization of approval is received from Materials Control, Soil and Testing Division.

3.2 Pretesting - The testing of pre sampled material. A pretested material is that which has been sampled, tested, and evaluated prior to shipment to the project site. Such material may be used upon arrival at the project site.

4. PROCEDURE

4.1 Sampling Frequency

4.1.1 Frequency of sampling shall be in accordance with applicable directives for specific items.

4.2 Sampling

4.2.1 All material will be sampled by an authorized representative of the Division. Sampling will be conducted in accordance with the applicable directives.

4.3 Identifying Pre sampled Material

4.3.1 When a specific quantity (lot) of material has been sampled, the material shall be set aside (isolated) and marked, sealed, tagged, or otherwise identified during storage as being pre sampled. The material shall be stored with reasonable assurance that it will not be contaminated, included, or mixed with other materials that have not been represented in the sampling plan.

4.3.2 Identifying records shall include the following (where applicable), and must accompany the sample to the laboratory:

a) Name of manufacturer
b) Date of manufacturer
c) Batch or lot identification
d) Quantity represented
e) Date sampled
f) Test required
g) Sampler
h) Project number
i) Any other information necessary to identify the material

4.4 Identifying Pretested Material

4.4.1 Packaged Material - When tests indicate packaged material has met the specification requirements they may be tagged, sealed, stamped, or otherwise identified by the state representative as having been pretested and approved.

4.4.2 Bulk or Miscellaneous Materials - When tests indicate bulk or miscellaneous materials have met specification requirements they may be stored in suitable enclosures until shipped. These enclosures may be tagged, sealed, stamped, or otherwise identified by the state's representative as having been pretested and approved. If appropriate, miscellaneous materials may be individually identified by tag, seal, or stamp as being pretested and approved. When closed conveyances are used to ship pretested materials, these conveyances may be tagged, sealed, stamped, or similarly treated to identify the contents as being pretested and approved for shipment to the project site.

5. DOCUMENTATION

5.1 Documentation of Samples - Samples must be documented setting forth all information necessary for proper identification of the materials in accordance with section 4.3.2.

5.2 Sample Document Distribution - Original documentation shall be transmitted with the sample to the testing laboratory. The sampler will retain a copy of this documentation.

5.3 Documentation of Test Results - The testing laboratory will perform all required tests and document the results on the appropriate form. A concluding statement on the form shall indicate that the material does or does not meet the requirements of the controlling specifications. This form shall also contain all applicable identifying information described in Section 4.3.2.

5.4 Testing Document Distribution

5.4.1 When testing is done by a Division approved laboratory, a copy of the test report will be furnished to Materials Control, Soil and Testing Division.

5.4.2 Test reports will be reviewed, assigned a laboratory number, and distributed by Materials Control, Soil and Testing Division as required.

5.5 Shipping Documentation - When test results indicate the material has met the specification requirements, authorization is given for shipment to the project site. The supplier shall prepare a shipping document and shall include as a minimum the following:

a) All information applicable in Section 4.3.2
   (1) Information applicable for the shipment of aggregate, asphalt, and concrete include all items except c, e, f, and g of the above referenced section.
   (2) Information applicable to shipment of paint include all items except e, g, and h of the above referenced section.

b) Date of shipment

c) The laboratory number assigned to the approval document

When the material is from stock identified by a Master Laboratory Number, a copy of the shipping document will be transmitted to the Finalization Section of the Division. A copy of the shipping document will always accompany the shipment and be included in the project file.

5.6 Final Acceptance of Pretested Material - Tests completed on materials at the source may be used by the Division for acceptance. However, the Division reserves the right to resample and retest the materials at the source or after the materials have arrived at the project.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.01 Steward – Materials Control Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING AN ADJUSTED PAY QUANTITY RESULTING FROM EXCESS MOISTURE IN AGGREGATES

1. PURPOSE

1.1 To provide a method to determine adjusted pay quantity to be used in those cases where excess moisture in aggregate has been confirmed. In this method, the pay quantity will be considered to be the net weight of the aggregate determined in Megagrams delivered.

2. SCOPE

2.1 This procedure is applicable to aggregate furnished under Maintenance Purchasing Requisitions.

3. DEFINITION OF TERMS

3.1 Normal Moisture Content - the moisture content (on the basis of ASTM Method C-566) of stocked aggregate as it would generally exist under field conditions over an extended period of time.

4. PROCEDURE

4.1 In the event it has been determined by ASTM Method C-566 that an aggregate type has a moisture content in excess of that which is listed and designated as "Normal Moisture Content" for that type in Table 1, the pay quantity represented shall be adjusted in accordance with 4.2.

TABLE 1- NORMAL MOISTURE CONTENT MOISTURE PERCENTAGE

TYPE	CLASS 1 & 2	GRADED**	FINE
Limestone	5.0	1.0	5.0
Gravel	3.5	1.0	
Sand			5.0
Sandstone	5.0	1.0	5.0
Slag*	6.0	2.1	7.0
Cinders			10.0
Boiler Slag			10.0
Steel Stag	4.0	1.0	5.0

*Blast Furnace Slag
**AASHTO Sizes No. 1 through No. 9, Class 7 Gabions and Shot Rock

4.2 The adjusted pay quantity shall be calculated by comparing the normal moisture content with the actual moisture content.

The adjusted pay quantity calculation would be:

$$APQ = \text{Megagrams} \frac{(1 + M_N)}{(1 + M_a)}$$

Where : APQ = Adjusted pay quantity

Megagrams = Net weight delivered

$$M_a = \frac{\text{Actual Moisture Content}}{100}$$

$$M_N = \frac{\text{Normal Moisture Content}}{100}$$

4.3 Example

Net weight of graded limestone delivered = 13.6 Megagrams

Actual moisture content = 3 percent

Normal moisture content = 1 percent

$$APQ = 13.6 \frac{(1 + .01)}{(1 + .03)}$$

$$APQ = \frac{13.6\ (1.01)}{1.03}$$

$$APQ = \frac{13.736}{1.03}$$

APQ = 13.3 Mg

In this case the adjusted pay quantity would be 13.3 Megagrams instead of the 13.6 Megagrams.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.22 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

NUCLEAR DENSITY TEST BY THE ROLLER PASS METHOD

1. PURPOSE

1.1 The purpose of this procedure is to determine the density of construction materials by the roller pass method. The procedure consists of two parts, with Part I to determine the required maximum density and Part II to compare field densities to the required maximum density.

2. SCOPE

2.1 This test method or method of testing is applicable to aggregate base courses, select material for backfilling, crushed aggregate backfill, granular subgrade, and random material having 40% or more of +3/4 inch (+19 mm) material as specified in MP 717.04.21.

3. REFERENCES

3.1 MP 712.21.26

3.2 MP 717.04.21

4. EQUIPMENT

4.1 One complete nuclear density gauge unit meeting the requirements specified in MP 717.04.21. This would include the manufacturer's printout of standard counts.

4.2 One measuring tape, approximately 50 feet (15 m)

4.3 Lime or other suitable material to mark test sites

4.4 Dry silica sand

4.5 Supply of data sheets

4.6 One vehicle meeting the safety and security requirements of the Nuclear Regulatory Commission for transporting nuclear gauges

5. PERSONNEL TRAINING

5.1 All personnel performing the testing must meet the minimum training requirements specified in MP 717.04.21.

5.2 All personnel must know and follow the requirements of the Nuclear Regulatory Commission.

6. ROUNDING OF DATA

6.1 Test values and calculations are to be rounded according to the following procedure:

6.1.1 If the figure following the last significant number to be retained is larger than five, increase the last significant number to be retained by one.

6.1.2 If the figure following the last significant number to be retained is five and there are no figures beyond five except zeros, the last significant number to be retained is increased by one if odd or left unchanged if even.

6.1.3 If the figure following the last significant number to be retained is five and there are figures following the five, the last significant number to be retained is increased by one.

6.1.4 If the figure following the last significant number to be retained is less than five, the last significant number is left unchanged.

6.2 Test values and calculations shall be rounded to the following nearest significant digit:

6.2.1 Form T-313 (test Section)

Lift thickness compacted	0.1 in. (10 mm)
Depth below grade	1 ft (0.1 m)
Length of test section	1 ft (1 m)
Width of test section	1 ft (0.1 m)
Station number	1 ft (0.1 m)
Offset	1 ft (0.1 m)
Dry density (DA)	I lb ft3 (1 kg/m^3)
Average density (DB)	1 lb /ft3 (1 kg/m^3)
Maximum density (DC)	1 lb/ft3 (1 kg/m3)

6.2.2 Form T-317 (Quality Control Tests)

Station number	1 ft (0.1 m)
Offset	1 ft (0.1 m)
Depth below grade	1 ft (0.1 m)
Lift thickness compacted	0.1 in. (10 mm)
Maximum density (DC)	1 lb/ft3 (1 kg/m^3)
Dry density (DE)	1 lb/ft3 (1 kg/m^3)
Relative density (DF)	1%
Average DF (X)	0.1%
Target (f)	1%
Quality index (QL)	0.01
Within tolerance (DG)	1%
Minimum percent for 100% Pay (DH)	1%

7. PREPARATION FOR TESTING

7.1 Standardization of the Nuclear Gauge

7.1.1 Warm up the gauge according to the manufacturer's recommendations.

7.1.2 Standardization of the gauge must be performed away from metal and other objects.

7.1.3 Clean the top of the standard block and the bottom of the gauge with a cloth.

7.1.4 Standardize according to manufacturer's recommendations.

7.1.5 Compare the standard counts to the manufacturer's standard counts using tolerances acceptable to the Division. For the Troxler 3430 gauge, the standard counts must be within ± 2% for density and ± 4% for moisture from the manufacturer's standards.

7.1.6 If the gauge is not within the specified tolerances for either moisture or density, repeat section 7.1.4 -7.1.5. If the gauge will not standardize for either moisture or density after 4 attempts, there is probably something wrong with the gauge. There may be electronics problems, the gauge needs calibrated or a stability check needs to be performed. Refer to MP 717.04.21 for a more detailed explanation. In any case, do not use a gauge for testing that will not standardize.

7.1.7 A gauge must be standardized before testing and at least every four hours during testing.

7.1.8 When a gauge is to be used for testing pipe or structure backfill in a trench, first check the standardization of the gauge according to sections 7.1 - 7.1.5. If the gauge is functioning properly, standardize the gauge in the trench. The standard counts in the trench would be used for testing in the trench only and the tolerances would not be applied to the standard counts taken in the trench. When the gauge is moved to a non-trench condition for testing, new standard counts would be required.

8. PART I PROCEDURE FOR DETERMINING THE MAXIMUM DENSITY

8.1 All data and calculations for Part I of this procedure will be recorded on form T-313 (copy attached). Record the project number, lab number etc. before starting the test.

8.2 The test is to be performed at the beginning of placement of an item. However, any problems with the material, placement or compaction equipment shall be corrected prior to performing the test.

8.3 The test section will be 100 feet (30 m) long by the width being placed in one operation except in restricted areas.

8.3.1 In restricted areas, where the 100-foot (30 m) length cannot be obtained, check the project's records to determine if a maximum density for the material has been determined on the project. The maximum density shall be used for Part II of this procedure, if available. A maximum density determined in a restricted area shall not be used in a non-restricted area. If a maximum density is not available for the material, obtain as large a test section as possible. For pipe backfill, a lift on both sides of the pipe can be used.

8.4 Divide the test section into 5 equal subsections and number the subsections. Randomly locate a test site within each of the subsections according to MP 712.21.26.

8.5 Water shall be added to untreated aggregates, if necessary, in a quantity satisfactory to the Engineer. The aggregate must visually appear wet in order to properly compact.

8.6 Once the material had been placed in the test section, the material shall be rolled with compaction equipment meeting the following requirements:

8.6.1 All compaction equipment must be in good working condition.

8.6.2 The materials shall be compacted with rollers providing a minimum applied force of 10 tons (9 Mg).

8.6.3 In restricted areas, inaccessible to conventional rollers, the compaction equipment must be satisfactory to the Engineer to provide the desired compactive effort. The Division may request verification that the above compaction equipment meets the specified requirements.

8.7 The test section shall be rolled with 12 roller passes. A roller pass is one complete coverage over the material. In restricted areas, where conventional rollers can not be used, the material shall be compacted until it appears well densified.

8.8 If the material shears or breaks down during rolling, the number of roller passes may need to be reduced. The designated number of roller passes must not be changed without the approval of the Engineer.

8.9 Once the material has been rolled, testing will be performed on test sites numbers 1 and 2.

8.10 Smooth the test site and fill any voids with fines scraped from the surface, no more than 1/8 inch (3 mm).

8.10.1 Place the guide plate on the test site. Next place the drive rod in the guide plate and while standing on the plate, drive the rod at least two inches (50 mm) deeper than the location where the end of the gauge source rod will be when testing. The gauge source rod can be extended in two-inch (50 mm) increments. The source rod must be as deep as possible within the lift but must not extend beyond the lift. For example, a five-inch (125 mm) lift would be tested with the source rod in the four-inch (100 mm) position and the hole would be six (150 mm) inches deep. Carefully remove the drive rod to prevent material from falling into the hole.

8.10.2 Place the gauge over the test site and insert the source rod to the desired depth. Pull the gauge tight against the side of the hole toward the scaler. Make sure the gauge is sitting flush on the material. Mark the outline of the gauge with lime or other suitable material so the test sites can be relocated.

8.10.3 Take a one-minute density reading.

8.10.3.1 Record the dry density (DA) in Section A of form T-313. Perform the same testing on site 2.

8.11 Average the two dry densities (DA) obtained in 8.10.3.1.

8.12 Roll the material in the test section two additional roller passes. In restricted areas, the compaction equipment would pass over the material the above indicated number of passes.

8.13 After the material has been rolled the additional number of passes, perform tests again on sites 1 and 2 according to 8.10 through 8.10.3 and record the values in section B.

8.14 Average the two densities according to 8.11.

8.15 Compare the value in 8.14 to the value obtained in 8.11. If the increase in density is 1 Ib/ft^3 (16 kg/m^3) or less, the material is considered to have achieved its maximum density. If the increase in density is greater than 1 lb/ft^3 (16 kg/m), roll the material two additional passes according to 8.12 and repeat the testing on sites 1 and 2. Continue the rolling and testing sequence until the increase in density between two consecutive rolling sequences is 1 lb/ft3 (16 kg/m^3) or less. The Division may request the contractor to cease rolling even though the increase is more than 1 lb/ft3 (16 kg/m^3) if the material is breaking down.

8.16 Once the increase in density is 1 lb/ft3 (16 kg/m^3) or less, move the last two density readings to the maximum density determination section on form T-313. Then take density measurements on sites 3, 4, and 5.

8.17 The average of the five density readings is the maximum density (DC) for the material.

8.17.1 The maximum density will be used to control the material for Part II of this procedure.

8.17.2 Division personnel may request that Part I be repeated if the test was not performed properly or the maximum density obtained does not appear to be realistic.

9. PART II QUALITY CONTROL TESTING

9.1 All test data and calculations for Part II of this procedure will be recorded on form T-317 (copy attached). Record the project number, item number, etc. on the form before starting the testing.

9.2 The lot number would have a prefix letter based on the following designations for the use of the material being tested:

Embankment :	F
Subgrade:	S
Base:	B
Pipe/Structure Backfill:	p

9.3 Transfer the maximum density (DC) and the lab number from form T-313 to form T-317. Record the lab number in the section for reference lab number.

9.4 Randomly locate the test site according to MP 712.21.26.

9.5 Determine the dry density (DE) with the nuclear gauge according to the procedure described in sections 8.10 through 8.10.3. The test sites do not have to be marked on the roadway.

9.6 Calculate the percent relative density (DF) by using the equation on form T-317.

9.7 Perform the remaining four tests in the lot. Five tests are always required to evaluate a lot.

9.8 Calculate the average relative density (X) for the five tests in the lot.

9.9 Obtain the target percentage of dry density (T) from the project's governing specifications.

9.10 Determine the range (R) of the relative densities (DF) by subtracting the smallest value from the largest.

9.11 Calculate the quality index (QL) by using the equation on form T-317.

9.12 Use the Table for Estimating the Percent of a Lot Within Tolerance (copy attached) and determine the percent within tolerance (DG) that corresponds to the QL value calculated in 9.11 above.

9.13 Obtain the minimum percent for 100% pay (DH) from the project's governing specifications.

9.14 In order for a lot to meet specifications, the percent within tolerance (DG) must be equal to or greater than the minimum percent for 100% pay (DH).

---

10. GENERAL

10.1 Independent tests for similarity checks can be recorded on form T-317. Use only the applicable sections of the form.

10.2 If the material changes or the material is supplied from a new source, repeat Part I to obtain new control data.

10.3 If the percent relative densities are consistently above 105 percent or below 95 percent, and there is no apparent cause for the high or low values, repeat Part I to obtain new control data.

10.4 Test data for several lots can be recorded on form T-317.

____
Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.00.24 Steward – Asphalt Section
RLS:J
ATTACHMENTS

TABLE FOR ESTIMATING PERCENT OF LOT WITHIN TOLERANCE

Quality Index (QL) Positive Values	Percent Within Tolerance	Quality Index (QL) Negative Values	Percent Within Tolerance
.66	99	.00	50
.65	98	.01	49
.62	97	.02	48
.60	96	.04	47
.58	95	.05	46
.57	94	.06	45
.55	93	.07	44
.53	92	.08	43
.51	91	.09	42
.50	90	.10	41
.48	89	.11	40
.46	88	.13	39
.45	87	.14	38
.44	86	.15	37
.42	85	.16	36
.41	84	.17	35
.40	83	.18	34
.38	82	.19	33
.37	81	.21	32
.36	80	.22	31
.34	79	.23	30
.33	78	.24	29
.32	77	.25	28
.30	76	.27	27
.29	75	.28	26
.28	74	.29	25
.27	73	.30	24
.25	72	.32	23
.24	71	.33	22
.23	70	.34	21
.22	69	.36	20
.21	68	.37	19
.19	67	.38	18
.18	66	.40	17
.17	65	.41	16
.16	64	.42	15
.15	63	.44	14
.14	62	.45	13
.13	61	.46	12
.11	60	.48	11
.10	59	.50	10
.09	58	.51	9
.08	57	.53	8
.07	56	.55	7
.06	55	.57	6
.05	54	.58	5
.04	53	.60	4
.02	52	.62	3
.01	51	.63	2
.00	50	.66	1

West Virginia Division of Highways
Materials Control Soil and Testing Division

Lab Number ______________
Auth. Number ______________
Project Number ______________
District Number ______________
Item Number ______________
Date ______________

FORM T-313
MP 700.00.24
REV. 08-08

Source of Material:			Length of Test Section:	
Roller Type:			Width of Test Section:	
Roller Weight	Static:	Working:	Gauge Number	
Lift Thickness Compacted:			Manufacturer's Standards	
Depth Below Grade:			Density:	Moisture:
Depth of Gauge Source:			Standard Counts	
Observed	Yes	No	Density:	Moisture:

Test Site Number	1	2	3	4	5
Station Number					
Offset					

A	Number of Passes		
	Test Site	DA	Dry Density
	1		
	2		
DB	Average		

B	Number of Passes		
	Test Site	DA	Dry Density
	1		
	2		
DB	Average		

C	Number of Passes		
	Test Site	DA	Dry Density
	1		
	2		
DB	Average		

D	Number of Passes		
	Test Site	DA	Dry Density
	1		
	2		
DB	Average		

DB = $\sum$ DA / 2

DC = $\sum$ DA / 5

Maximum Denisty Determination			
	Test Site	DA	Dry Density
	1		
	2		
	3		
	4		
	5		
DC	**Max. Density**		

Inspector's Name: ______________
Inspector's Signature: ______________
Project's Evaluation
Checked By: ______________
Date: ______________

WEST VIRGINIA DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

LAB NUMBER ____________________
AUTH. NUMBER ____________________
PROJECT NUMBER ____________________
DISTRICT ____________________
ITEM NUMBER ____________________

FORM T-317
MP 700.00.24
REV. 08-08

GAUGE #	DATE					
MANUFACTURER'S DENSITY STANDARD	LOT NUMBER					
	BEGINNING STATION					
	ENDING STATION					
MANUFACTURER'S MOISTURE STANDARD	OFFSET					
	DEPTH BELOW GRADE					
	DEPTH OF GAUGE SOURCE					
	LIFT THICKNESS COMPACTED					
DC FROM TEST SECTION	DENSITY STANDARD					
	MOISTURE STANDARD					

$$DF = \frac{DE\ (100)}{DC}$$

$$\overline{X} = \frac{\Sigma\ DF}{5}$$

$$QL = \frac{\overline{X} - T}{R}$$

DC	**MAXIMUM DENSITY**					
	REFERENCE LAB NUMBER					

TEST NUMBER 1	**DE**	DRY DENSITY					
	DF	% RELATIVE DENSITY					
TEST NUMBER 2	**DE**	DRY DENSITY					
	DF	% RELATIVE DENSITY					
TEST NUMBER 3	**DE**	DRY DENSITY					
	DF	% RELATIVE DENSITY					
TEST NUMBER 4	**DE**	DRY DENSITY					
	DF	% RELATIVE DENSITY					
TEST NUMBER 5	**DE**	DRY DENSITY					
	DF	% RELATIVE DENSITY					
LOT EVALUATION	$\overline{X}$	AVERAGE **DF**					
	T	TARGET					
	QL	QUALITY INDEX					
	DG	% WITHIN TOLERANCE					
	DH	MIN. FOR 100% PAY					
	DI	PASS / FAIL					

INSPECTOR'S NAME: ____________________
INSPECTOR'S SIGNATURE: ____________________
PROJECT'S EVALUATION
CHECKED BY: ____________________ DATE: ____________

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CERTIFICATION OF BATCH SCALES AND CALIBRATION OF STANDARD 50 POUND TEST WEIGHTS

1. PURPOSE

1.1 To provide instructions and establish frequency for having batch scales checked and approved.

1.2 To provide procedural instructions for having standard 50-pound test weights checked and approved.

2. SCOPE

2.1 This procedure will apply to all batch plants furnishing Portland cement concrete or bituminous concrete to State Highway projects.

3. INSTRUCTIONS

3.1 Batch scales shall be checked and approved by the Division of Labor at least once a year.

3.2 Standard, 50-pound, test weights shall be certified as correct by the Division of Labor at the time and location designated by their directives.

3.3 Certification of standard test weights by the West Virginia Division of Labor will be evidenced by the letters WV and a two digit number stamped on the lead plug in each of the standard weights, the two digits representing the year in which certification is made.

3.4 Standard test weights should be treated in the following manner prior to delivery to the calibration station.

3.4.1 Wire brush to remove all dirt and rust, and paint with a light coat of aluminum paint.

4. FACILITIES LOCATED OUTSIDE OF WEST VIRGINIA

4.1 The Division may, at its option, accept inspection and sealing by out of state agencies.

4.2 The frequency of such inspection shall conform to West Virginia's Division of Labor requirements.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.00.30 Steward – Lab Support Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD FOR ACCEPTANCE OF COMPACTION TESTING

1. PURPOSE

1.1 To provide a procedure for the acceptance of compaction testing.

2. SCOPE

2.1 This procedure is applicable to all materials that require evaluation of compaction tests.

3. TESTING

3.1 The minimum frequency for acceptance testing shall be 10% of the contractor's individual tests. Five tests shall be performed in a lot for acceptance testing.

3.2 Acceptance testing shall be distributed throughout the placement of material.

3.3 The material should be categorized according to the base, subgrade, pipe backfill, embankment, etc.

4. EVALUATION

4.1 Calculations shall be rounded to the following significant digits according to AASHTO Method R-11.

Average (X)	0.1%
Standard Deviation	0.01
Range	1%

4.2 Determine the number of lots tested by the contractor for a particular material since the last monitoring including the lot just tested. Record the percent relative densities on the attached form.

4.3 Calculate the standard deviation (S) for the percent relative densities.

4.4 Calculate the range (R) for plus and minus 1.65 standard deviations (S) from the average (X) for the contractor's tests ($R = X \pm 1.65\ S$).

4.5 Compare the acceptance tests to the calculated range.

4.5.1 If all the acceptance tests are within the range, the testing is similar. When the testing is similar, the degree of compaction for the lots of material represented by the acceptance evaluation can be accepted.

4.5.2 If any of the 5 acceptance tests are outside the range, calculate 3 standard deviations for the contractor's tests ($R = X \pm 3 S$).

4.5.3 If all acceptance tests are within the range, the testing is considered similar, however, the quality control practices by the contractor should be reviewed for possible problems.

4.5.4 Any test outside the standard 3 deviation range indicates that there are probably problems with the quality control system and no additional material should be placed until the problem is resolved. The investigation would include checking such areas as equipment, test procedures, location of tests, variability of materials, compaction techniques, etc. The results of the investigation shall be documented in the project files.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.50 Steward – Asphalt Section
RLS:J
ATTACHMENT

PROJECT NUMBER: ______________________________

ITEM NUMBER (S): ______________________________

TYPE OF MATERIAL: ______________________________ DATE: _________

QUALITY CONTROL
TESTS

LOT NUMBER				
	1 2 3 4 5			
	AVERAGE (X)		STANDARD DEVIATION	
ACCEPTANCE TESTS				
TEST NUMBER	1 2 3 4 5	X + 1.65 (S) = X - 1.65 (S) = WITHIN LIMITS	YES NO	= UPPER LIMIT = LOWER LIMIT (SIMILAR) (DISSIMILAR)
		X + + 3 (S) = X - - 3 (S) = WITHIN LIMITS	YES NO	= UPPER LIMIT = LOWER LIMIT (SIMILAR) (DISSIMILAR)

EVALUATED BY: __________ CHECKED BY: _______________

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR QUALITY CONTROL AND ACCEPTANCE PLANS FOR PURCHASE ORDER CONTRACTS FOR STONE AND AGGREGATE

1. PURPOSE

1.1 Testing of highway construction materials has traditionally been a two phased activity; that is, that done by industry in their Quality Control Program and that done by the purchaser to determine the acceptability of the material. In Purchase Order contracts for stone and aggregate, the vendor (whether or not he or she is actually the producer) is by positive statement in the contract specifications responsible for the gradation of all items except abrasives; and the Division of Highways, as purchaser, is responsible for material acceptance. The purpose of this Materials Procedure is to present guideline for adequate Quality Control and Acceptance Plans.

2. QUALITY CONTROL PLAN

2.1 A quality Control Plan shall be prepared by the vendor and submitted to the Division prior to delivery of any material. The Plan shall clearly describe the methods by which the Quality Control Program will be conducted. As a minimum, the Quality Control Plan should include the following:

2.1.1 Name of company official responsible for Quality Control, and name and qualifications of technician conducting the tests.

2.1.2 Listing of items to be controlled and tests to be performed. Each item should be listed separately.

2.1.3 The Plan should detail the vendor's proposed sampling location, sampling and testing procedure and testing frequency. In the event the vendor is not the producer, sampling location, sampling and testing procedure and test frequency proposed by the producer shall be included.

2.1.4 The Documentation Plan: The methods by which the vendor will document and distribute test results shall be described:

2.1.4.1 Forms and Distribution: All forms used to record the vendor's test data shall be approved prior to use by the Division. Gradation test data will be recorded on Form T300 in the manner intended. In the event the vendor elects to use a form other than T300 said form must be approved by the Division prior to use. The laboratory number (supplied by the Division) assigned to the vendor's test data document will always begin with a "C" for all quality control sample results. In the event the vendor is not the producer, the vendor shall provide the completed test data forms provided by the producer, and in the proper sequence (consecutive tests) including quantities thereof. All test data forms shall include the vendor's (and/or the producer's) identification and be legibly signed by the technician that conducted the test. A copy of all forms shall be delivered by the vendor to the Division. Tests results must be delivered as they are finished to assure that all the results for material delivered are completed and distributed by the fulfillment of the State Contract Purchase Order (SCO).

2.1.5 A detailed plan of action regarding the disposition of non-specification material: Such a plan shall provide for immediate notification of all parties involved in the event failing material is detected.

3. ACCEPTANCE PLAN

3.1 The contract specification states the vendor is responsible for providing test results to the gradation of the materials delivered (except abrasives); acceptance may be on the basis of these test results, provided and certified by the vendor. Acceptance may also be accomplished by an independent sampling and testing program conducted by the Division and at the appropriate sampling frequency given in the contract specifications, or a combination of both the vendor's test results and the Division's test results. In this case (combination acceptance), the Divisions independent samples and tests may be directly compared to the vendor's results only if all sampling locations and testing procedures are the same.

3.2 Sampling and testing for quality (LA, soundness, etc.) of all items is the responsibility of the Division.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.00.51 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR SOURCE RATING SYSTEM RELATIVE TO MAINTENANCE CONTRACTS

1. PURPOSE

1.1 To set forth a standard method of source rating that will directly influence sampling and testing frequency requirements.

2. SCOPE

2.1 This procedure will apply only to aggregate and bituminous concrete sources when supplying material for Division pickup relative to Maintenance Contracts.

3. GENERAL COMMENTS

3.1 The capability to perform a sustained level of Quality Control in most producer plants has been established. In this regard, it is desirable to pursue a Quality Assurance Program that recognizes this level of Quality Control.

4. DEFINITIONS

4.1 A-1 Source

4.1.1 This source must have at least 20 pieces of data (on any combination of items) within one-year preceding evaluation date and have a compliance rating (based on the most recent 20 pieces of data) of at least 90%.

4.1.2 The sampling and testing frequency shall be one sample per each week of shipment per item.

4.2 A-2 Source

4.2.1 All production plants within the scope of this procedure that do not satisfy the requirements of 4.1.1.

4.2.2 The sampling and testing frequency shall be as per current specifications.

5. EVALUATION GUIDELINES

5.1 The evaluation of the level of Quality Control established by each plant will be performed and maintained current by Materials Control, Soils and Testing Division. Evaluation will be monthly and will be based on the availability of data and its compliance to controlling limits of acceptability.

5.2 Two lists will be generated each month:

5.2.1 Aggregate suppliers designated A-1

5.2.2 Bituminous suppliers designated A-1

5.3 Distribution of the lists will be made to the District Materials Sections. Further distribution will be as necessitated.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.52 Steward – Asphalt Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

ACCEPTANCE PROCEDURE FOR EVALUATING INDEPENDENT ASSURANCE SAMPLES WITH SAMPLES USED FOR ACCEPTANCE

1. PURPOSE

1.1 To provide a procedure for the immediate evaluation of Independent Assurance (IA) Samples with samples used for acceptance.

2. SCOPE

2.1 This procedure is intended to apply to the following:

2.2 Aggregate Gradations

2.3 Hot Mix Asphalt

2.3.1 Asphalt Content

2.3.2 Air Voids

2.4 Portland Cement Concrete

2.4.1 Air Content

2.4.2 Consistency (Slump)

3. DEFINITIONS

3.1 Verification Samples and Tests - All of the samples and tests performed by the State Highway Agency (SHA) or its designated agent used to validate the quality and acceptability of the materials and workmanship which have been used or are being incorporated in the project.

3.2 Quality Control Samples and Tests - All of the samples and tests performed by the contractor that are performed or conducted to fulfill the contract requirements.

3.3 Independent Assurance Samples and Tests - Independent and unbiased samples or other activities performed by the SHA or its designated agent who do not normally have direct responsibility for quality control or verification sampling and testing. IA samples and tests are taken to evaluate the sampling and testing procedures used in the acceptance program.

3.4 Split Sample - One of two selected samples that have been halved , quartered, etc. from a single sample taken in the field. The field sample must be of adequate size to render each "split sample" sufficient material fortest.

3.5 Adjacent Sample - One of two field samples taken in close proximity to each other in both time and space. Adjacent samples must represent the same material, production process, and other activity through the point ofsampling.

3.6 Proficiency Sample - A single (homogeneous) sample that has been tested by two or more laboratories and used to assure that the quality control testing is performed correctly and that the equipment is in calibration.

4. PROCEDURE - SAMPLING AND TESTING

4.1 This procedure provides a method to compare IA sample results with applicable quality control and verification sample results for similarity on a one-on-one basis. As outlined in the following sections, and depending upon its application, the IA sample may be a split sample, an adjacent sample, or a proficiency sample.

4.2 Sampling for one-on-one comparison should be accomplished with both the IA sampler and quality control sampler present (where applicable), or the IA sampler and the verification sampler present. Coordination of these activities must be accomplished between the Division and the District Materials.

4.3 Verification Sampling and Testing

4.3.1 The frequency established for verification samples is equal to approximately ten (10) percent of the frequency for testing given in the contractor's Quality Control Plan for applicable items. Likewise the frequency of IA sampling under this procedure will be approximately ten (10) percent of the prescribed verification sampling frequency, but not necessarily on a project by project basis. In this case "prescribed" refers to the number of verification samples scheduled in accordance with the acceptance criteria and would not necessarily include any additional samples that may be scheduled by the District (for whatever reason) in excess of their approximately ten (10)percent.

4.3.2 Identifying criteria, other than the normal, such as time of sampling, split or adjacent sample, etc., must accompany the records of each sample for proper testing andcomparison.

4.3.3 In all cases the IA sample and the verification sample will be taken and tested in accordance with applicable standards. If splitting is involved, this may be accomplished at the sampling site or other appropriate facility, such as the District laboratory.

4.3.4 All verification samples that have been tested for sieve analysis under this procedure will be retained by the District materials until such time that the comparison has been made and any dissimilarities resolved.

4.3.5 After completion of the testing of the verification sample, a copy of the test results with identifying criteria will be forwarded to the Division. Immediately after receipt of the verification sample results, they will be compared to the companion IA sample test results for similarity in the manner described in applicable sections of Section 5.0.

4.4 Quality Control Sampling and Testing

4.4.1 The frequency for quality control sampling and testing is established in the contractor's approved Quality Control Plan. For gradations, the contractor is required as a part of the Quality Control Plan to save all completed samples at the testing site by provisions established in Materials Letter (ML) 25. The frequency of IA samples under this procedure will be the random selection of at least one "saved" ML 25 sample from each testing facility quarterly. A testing site, in this case, is defined as one that is participating in testing aggregates for National Highway System (NHS) projects. This procedure will result in a proficiency sample, as defined, that will be independent of the number of samples tested and saved at any one testing site, and will not necessarily be project related. For other items, not applicable to the provisions of ML 25 but applicable to the validation process, the frequency of IA sampling will be approximately one percent of the applicable quality control testing given in the contractor's Quality Control Plan. it is the intent of this procedure to obtain one or more IA samples per applicable item per NHS testing site and/or project, whichever is applicable.

4.4.2 Identifying criteria, other than the normal, such as time and place of sampling, proficiency sample, split, etc., must accompany the record of each sample for propercomparison.

4.4.3 In all cases the IA sample and quality control sample will be taken and tested in accordance with applicable standards. If splitting is involved, this may be accomplished at the sampling site or other appropriate facility.

4.4.4 With regard to gradation samples, other provisions provide a method allowing the contractor to discard his/her ML 25 samples at appropriate times. When, however, an IA proficiency sample has been selected from a testing facility as defined, all samples thereby represented during the selection process will be saved until the comparison as stated in Section 5.0 is satisfied. Note that this procedure is not intended to impede other provisions relative to the ML 25 program, but to take place, in most cases, concurrently with the District's ML 25 samplingactivities.

4.4.5 In this way additional "saving" time of the remaining samples, if any, will be minimal. Coordination of this activity will be accomplished between the Division and the District Materials. Final release of the saved samples will be provided by the District Materials in accordance with otherprovisions.

4.4.6 After completing the testing of the proficiency sample, it will be compared to the quality control sample results as provided in Section 5.2.

4.4.7 After completing the testing of other applicable quality control samples by the contractor, a copy of the test results, after being submitted to the District with identifying criteria, will be forwarded to the Division. Immediately after receipt of the quality control sample results, they will be compared to the companion IA sample result for similarity in the manner described in applicable sections of Section 5.0.

5. COMPARISON PROCEDURE

5.1 Aggregate Gradations - Split or AdjacentSample

5.1.1 Determine the average percent passing for each specified sieve of the IA and verification sample test values (see sample computation sheet, Attachment 1, Column"D").

5.1.2 Depending upon whether the average represents a split or adjacent sample, individually locate each average value to the appropriate interval column in Table 1 (Attachment2).

5.1.3 From the appropriate interval column, re ad the corresponding value in the "Maximum Difference From Average" (md) column. These values represent the maximum difference allowed between the average value and either of the two results that make up the average.

5.1.4 Calculate the actual difference (ad) between each average and either of the two values that make up the average. It makes no difference which value is chosen since both are equal distance from their average. In either case, the absolute value (no sign) is calculated.

5.1.5 If the actual difference (ad) is less than the maximum difference (md), the results on that particular sieve size will be considered similar.

5.1.6 If the actual difference (ad) is greater than the maximum difference (md), the results on that particular sieve size will be considered dissimilar.

5.1.7 If all the represented sieve size results are considered similar, then the sample evaluation is consideredsimilar.

5.2 Aggregate Gradation - Proficiency Sample

5.2.1 The proficiency sample test results will be compared to the original test results of the quality control sample in the following manner:

5.2.1.1 Determine the difference in test values for each of the specification sieves by subtracting the smaller test value from the larger test value (see sample computation sheet on Attachment 3).

5.2.1.2 Obtain the sum of the "differences" of the test values determined in Section 5.2.1.1 above.

5.2.1.3 Determine the average difference in test values by dividing the sum of the differences as described in Section 5.2.1.2 above by the number of specification sieves used in the gradation test. The value thus obtained will be called the AVERAGE TEST DIFFERENCE (ATD).

5.2.1.4 If the value is less than or equal to 1.8 (ATD $\leq$ 1.8), the comparison will be considered similar and no further analysis is necessary. Discarding the "saved" samples will be in accordance with Section 4.4.4 above.

5.2.1.5 If the value of the ATD is greater than 1.8 (ATD > 1.8), the IA proficiency sample will be considereddissimilar.

5.3 Hot Mix Asphalt; Asphalt Content - Split or Adjacent

5.3.1 Determine the difference in asphalt content between the two test values. If the difference (d) determined is less than or equal to 0.8 (d $\leq$ 0.8), then the two samples will be considered similar. If the difference determined is greater than 0.8 (d > 0.8), then the two sample are considered dissimilar (see sample computation sheet on Attachment 1: AsphaltContent).

5.4 Hot Mix Asphalt; Air Voids - Split or Adjacent

5.4.1 Determine the difference in air voids between the two test values. If the difference (d) is less than or equal to 3.0 (d $\leq$ 3.0), then the two samples are considered to be similar. If the difference determined is greater than 3.0 (d > 3.0), then the two samples are considered to be dissimilar (see sample computation sheet on Attachment 1: Air Voids).

5.5 Portland Cement Concrete

5.5.1 After completion of the IA sample (tested for air and/or slump at the project site), the IA sampler will record all test data on the IA form (Attachment 4). For air content determine the difference between the IA sample and the project sample. If the difference (d) is less than or equal to 1.5 percent (d $\leq$ 1.5%), then the two air contents are considered to be similar. If the difference is greater than 1.5 percent (d > 1.5%), then the two air contents are considered to be dissimilar. For consistency (slump) determine the difference between the two tests. If the difference (d) is less than or equal to 1.5 inches (d $\leq$ 1.5"), then the two consistencies are considered similar. If the difference is greater than 1.5 inches (d > 1.5"), then the two consistencies are considered to bedissimilar.

6. REPORTING

6.1 Verification Samples

6.1.1 If the comparison of any of the above is similar , then proof of the similarity, including all applicable calculations specified in Section 5.0 and using a format similar to that illustrated on the sample computation sheets, will be forwarded to the applicable District Materials Section.

6.1.2 Since the testing of Portland Cement Concrete is a field test, and if it is found to be similar, the completed form (Attachment 4) will be included with the IA samplers normal documentation to the Division. If, however, the IA sample is found to be dissimilar, the IA sampler will take action in accordance with Section 6.1.2.1. Note that a calculated dissimilarity does not mean a materials failure, only that a close examination of procedures and/or equipment may be necessary.

6.1.2.1 When the calculations performed on the form show a dissimilarity, the IA sampler will take steps to try to determine the cause, and in this way attempting to resolve the dissimilarity while still at the project site. These steps may be, but not limited to, the following:

1. Note any differences in equipment used between the IA sampler and project technician.
2. Review procedures used.
3. If necessary, take check comparison sample from the same batch or from the next batch. This includes both an additional IA sample and project sample.
4. Note any information that may add clarity to the dissimilarity.

6.1.2.2 All information gained from the review will be included on the form prior to submittal to the Division. If the IA sampler could find no reason for the dissimilarity and a check sample was taken that proved similar, then the dissimilarity will be considered resolved and having occurred because of some random local material or testing abnormality not originally detected. If the IA sampler could find no reason for the dissimilarity, and a check sample was taken that also was dissimilar and the IA sampler has confirmed the project technician's testing procedures, then further action is necessary in accordance with Section 6.3. (Note, it is not the intent of the IA sampling procedure to impede the progress of the contractor; however, any unresolved dissimilarity will be reported to the Project Engineer.)

6.2 Quality Control Samples

6.2.1 If the comparison of any of the above is similar, then proof of the similarity, including all applicable calculations specified in Section 5.0 and using a format similar to that illustrated on the sample computation sheets, will be forwarded to the applicable District Materials Section.

6.2.2 For Portland Cement Concrete see Section 6.1.2.

6.3 Dissimilarities

6.3.1 If the comparison of any of the above is dissimilar, the following action will be taken.

6.3.1.1 The Division will immediately notify the applicable District Materials Section of the IA dissimilarity. The Division in conjunction with the applicable District Materials Section will immediately begin an investigation in an attempt to determine the cause of the dissimilarity. The findings of this investigation will subsequently be documented in a Materials Inspection Report (MIR).

6.3.1.2 Results of the investigation as documented in the MIR will be submitted to the Federal Highway Administration. One copy will be submitted to the applicable District and one copy will be maintained in the Division's file.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.00.53 Steward – Materials Control Section
RLS:B
ATTACHMENT

SAMPLE GRADATION COMPUTATION SHEET

SPLIT OR ADJACENT SAMPLE

A	B	C	D	E	F	G	H
Sieve Size	IA Sample Gradation	Verification Sample Gradation	X(bar) $\frac{B + C}{2}$	"md" MAXIMUM Diff.	"ad" ACTUAL Diff.	Similar ad ≤ md	Dissimilar ad > md
1.5"	100	100	100	2.0	0	YES	
¾"	86	73	79.5	5.0	6.5		YES
#4	26	25	25.5	4.5	0.5	YES	
#40	1	1	1	2.0	0	YES	
#200	0.1	0.1	0.1	2.0	0	YES	

Sample Represents a split __X__ adjacent _____
Samples similar _____ Dissimilar __X__

ASPHALT CONTENT

IA Result	Verification or Quality Control Result	Difference Allowed	Actual Difference	Similar	Dissimilar
6.3	6.5	0.8	0.2	YES	

Sample Represents a split __X__ adjacent _____

AIR VOIDS

IA Result	Verification or Quality Control Result	Difference Allowed	Actual Difference	Similar	Dissimilar
3.6	4.1	3.0	0.5	YES	

Sample Represents a split __X__ adjacent _____

INDEPENDENT ASSURANCE SAMPLE
MAXIMUM DIFFERENCE VALUES
GRADATION ANALYSIS COMPARISON PER SIEVE

TABLE 1

Split Samples		Adjacent Samples	
Average % Passing Column 1	(md) Max. Difference From Average Column 2	Average % Passing Column 3	(md) Max. Difference From Average Column 4
0 ---> 7.0	2.0	0 ---> 4.5	2.5
7.5 ---> 11.5	2.5	5.0 ---> 7.5	3.0
12.0 ---> 16.0	3.0	8.0 ---> 10.5	3.5
16.5 ---> 19.5	3.5	11.0 ---> 13.5	4.0
20.0 ---> 23.5	4.0	14.0 ---> 16.0	4.5
24.0 ---> 27.0	4.5	16.5 ---> 18.5	5.0
27.5 ---> 31.5	5.0	19.0 ---> 21.0	5.5
32.0 ---> 36.0	5.5	21.5 ---> 23.5	6.0
36.5 ---> 42.5	6.0	24.0 ---> 26.0	6.5
43.0 ---> 65.0	6.5	26.5 ---> 28.5	7.0
65.5 ---> 71.5	6.0	29.0 ---> 31.0	7.5
72.0 ---> 76.0	5.5	31.5 ---> 34.0	8.0
76.5 ---> 80.0	5.0	34.5 ---> 37.0	8.5
80.5 ---> 83.5	4.5	37.5 ---> 40.5	9.0
84.0 ---> 87.0	4.0	41.0 ---> 44.5	9.5
87.5 ---> 90.0	3.5	45.0 ---> 50.0	10.0
90.5 ---> 93.5	3.0	50.5 ---> 66.5	10.5
94.0 ---> 97.0	2.5	67.0 ---> 71.5	10.0
97.5 ---> 100	2.0	72.0 ---> 79.5	9.5
		80.0 ---> 81.5	8.0
		82.0 ---> 83.5	7.5
		84.0 ---> 85.5	7.0
		86.0 ---> 87.0	6.5
		87.5 ---> 88.5	6.0
		89.0 ---> 90.0	5.5
		90.5 ---> 91.5	5.0
		92.0 ---> 93.0	4.5
		93.5 ---> 94.0	4.0
		94.5 ---> 95.5	3.5
		96.0 ---> 96.5	3.0
		97.0 ---> 97.5	2.5
		98.0 ---> 99.0	2.0
		99.5 ---> 100	1.5

To Use Table

1) Calculate the average percent passing for each sieve size for the IA and Verification sample.

2) Individually locate each average to the appropriate interval in the Table in Column 1 or 3 depending on sample selection (split or adjacent).

3) For the maximum difference (md) between the sample result(s) and the average, read the values listed in column 2 or 4 depending upon the sample selection.

4) If the difference between the result(s) and the average is equal to or less than the listed value, the individual sieve size will be considered similar. If the difference is greater than the listed value, the individual sieve size will be considered dissimilar.

SAMPLE GRADATION COMPUTATION SHEET

PROFICIENCY SAMPLE

A	B	C	D
Sieve Size	IA Sample Gradtaion	QC Sample Gradation	Difference B-C
1.5"	100	100	0
¾"	86	84	2
#4	26	23	3
#40	1	2	1
#200	0.1	0.4	0.3

Sum of the differences = 6.3

$$\frac{\text{Sum of the differences} = 6.3}{\text{No. of Sieves} = 5} = 1.26 \text{ (ATD)}$$

ATD	Difference Allowed	Similar	Dissimilar
1.26	1.8	YES	

IA FIELD TEST
DOCUMENTATION
FOR AIR AND SLUMP COMPARISONS

IA Sampler: ______________________________

Project: ______________________________

Date of Test: ______________________________

Type of Test: ______________________________

Batch ID: ______________________________

IA Sample ID: ______________________________

Verification sample ID: ____________________

Quality Control Sample ID: ____________________

IA Test Result: ____________________

Comparison Test Result: ____________________

Check Spaces - Use Only if
Check Comparisons are Made

[Check ________________________]

[Check ________________________]

[Check ________________________]

[Check ________________________]

[Check ________________________]

[Check ________________________]

Calculations:

Largest: ____________ - Smallest _____________ = _____________ Difference

Check: Largest: ____________ - Smallest _____________ = _____________ Difference

Similar? For Slump The Difference Must Be 1.5 inches or Less

Yes _______ No _______ [Check: Yes _______ No ______]

For Air Content The Difference Must Be 1.5 % or Less

Yes _______ No _______ [Check: Yes _______ No ______]

If Dissimilar, Use This Space for IA Samplers Comments:

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR EVALUATING QUALITY CONTROL SAMPLETEST RESULTS WITH VERIFICATION SAMPLE TEST RESULTS

1. PURPOSE

1.1 To provide a procedure for the comparison of quality control sample test results with verification sample testresults.

2. SCOPE

2.1 This procedure is primarily applicable to the contractor's test results when used in the acceptance process. Other tests, not necessarily applicable to the acceptance process but used for control of materials, may also apply.

2.2 Materials and Tests

2.2.1 Aggregate Gradations

2.2.2 Hot Mix Asphalt

1. Asphalt Content
2. Air Voids
3. Stability
4. Flow

2.2.3 Portland Cement Concrete

1. Air Content
2. Consistency

3. PROCEDURE

3.1 The following procedure will be implemented by the District Materials Engineer/Supervisor.

3.2 Immediately after completion of the verification sample, it will be compared to applicable quality control sample test results for the same item. Note that all samples being compared must be taken from the same sampling location, e.g., stockpile, roadway, etc., and sampled and tested in the same manner. The comparison will be made in the following manner (also see sample computation sheets in the attachments).

3.2.1 If there are more than ten quality control samples available, determine the average of the ten consecutive quality control samples (X(bar)10) whose midpoint is nearest chronologically to the verification sample. Should there only be five to ten quality control samples available, determine the average of all the available consecutive quality control test results. When comparing the grading characteristics of an aggregate, the average (X(bar)) for each sieve will be determined.

3.2.2 In the event there are less than five quality control samples available when the verification sample is complete, the District Materials Engineer/Supervisor will make an informal review of the data. If the data is such that a dissimilarity appears obvious (even without a formal comparison) then Section 4.1 of this procedure would apply. If, however, the verification sample results appear to be similar to the quality control sample results then the verification sample would be judged at this point by the District Materials Engineer/Supervisor to be similar, and the applicable portions of Section 5.1 of this procedure would apply with the following statement: "This verification sample (verification sample number recorded here) has been judged to be similar in accordance with Section 3.2.2 of MP700.00.54."

3.2.3 Determine the range (R) of the quality control samples used in Section 3.2.1 by subtracting the smallest test value from the largest test value. When comparing the grading characteristics of aggregate, the range (R) for each sieve will be determined.

3.2.4 Compute the interval (I) by substituting the values calculated in Sections 3.2.1 and 3.2.3 into the proper equation below. When comparing the grading characteristics of aggregate, the interval(I) for each sieve will be determined.

No. of Samples Used in Calculating the Average in Section 3.2.1	Equation for Computing the Interval (I)
10	I = X(bar) 10 +0.91R
9	I = X(bar) 9 +0.97R
8	I = X(bar) 8 +1.05R
7	I = X(bar) 7 +1.17R
6	I = X(bar) 6 +1.33R
5	I = X(bar) 5 +1.61R

3.2.5 The interval (I) is determined by first adding the average (X(bar) n) to the product of the range (R) times the given constant (This determines the upper limit of the interval). Note that for gradings, if the result obtained is greater than 100, it will be recorded as 100. And second, subtract the product of the range (R) times the given constant from the average (X (bar)n). This determines the lower limit of the interval. Note here that if the result is less than zero, it will be recorded as zero.

3.2.6 Compare the verification sample test result with the calculated interval. When comparing the grading characteristics of aggregates, a comparison for each sieve will bedetermined.

3.3 If the verification sample is an aggregate and all sieve results coincide with or lie between the upper and lower limits of the interval, the quality control sample test results will be considered similar to the verification sample testresults.

3.4 If the verification sample is an aggregate and any one of the compared values (on any sieve) is not similar to the quality control data, the quality control samples will be considered dissimilar to the verification sample.

3.5 If the verification sample is an asphalt mix, and the asphalt content and air voids coincide with or lie between the upper and lower limits of their interval, the quality control samples will be considered to be similar to the verification sample.

3.6 If the verification sample is an asphalt mix, and any one of the compared values is not similar to the quality control data, the quality control samples will be considered to be dissimilar to the verification sample.

3.7 If the verification sample (test) is Portland Cement concrete, and both the air content and consistency coincide with or lie between the upper and lower limits of their interval, the quality control samples (tests) will be considered to be similar to the verification sample.

4. EVALUATION

4.1 If the quality control sample data is dissimilar to the verification sample the following action will be taken whereappropriate.

4.1.1 Review the quality control samplingprocedure.

4.1.2 Review the quality control testing procedures.

4.1.3 Check testing equipment

4.1.4 Review computations.

4.1.5 Review documentation.

4.1.6 Perform any additional investigations that may clarify the dissimilarity.

5. REPORTING

5.1 If the quality control samples are found to be similar to the verification sample, proof of the similarity will be shown on the back of, or attached to, the original verification sample test report. The proof will include all of the calculations specified in Section 3.2.1 through 3.2.6 using the format similar to that shown on the appropriate sample computation sheet (attached). The report should be signed by the District Materials Engineer/Supervisor and distributed as specified in Sections 5.5 and 5.6.

5.2 If the quality control samples are dissimilar to the verification sample, the investigation described in Section 4.0 will be documented on the reverse side, or attached to, the original verification sample test report as described below, omitting the words in parenthesis which do not apply. A copy of all calculations specified in Section 3.2.1 to using the format similar to that shown on the appropriate sample computation sheet will also accompany the testreport.

1. Quality control sampling procedures (are, are not) in accordance with applicable directives.
2. Quality control testing procedures (are, are not) in accordance with applicable directives.
3. Testing equipment (is, is not) in proper working order.
4. Computations (are, are not) correctly performed.
5. Documentation (is, is not) properly performed.
6. Report any other information that may have been determined in accordance with Section 4.1.6.

5.3 All negative replies noted above will be explained. This will include a brief statement of the action taken to correct the deficiency. In the event other documentation is needed, such as a District Materials Inspection Report, to explain and/or support the final resolution of the dissimilarity, the dissimilar verification sample number should be referenced therein.

5.4 Results of the investigation as reported will be signed by the District Materials Engineer/Supervisor.

5.5 On the test report at the bottom will be typed the following: "Issued by District (Number) per MP 700.00.54,(Date)."

5.6 The signed, issued report should be prepared in duplicate and distributed as follows:

5.6.1 The original copy will be submitted to the Division.

5.6.2 On copy should be maintained in the District Materials file.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.00.54 Steward – Materials Control Section
RLS:B
ATTACHMENT

COMPUTATION SAMPLE SHEET ASPHALT

Quality Control Lab. Number	Date	Asphalt Content (%)	Air Voids (%)	Stability Newtons)	Flow (0.25mm)
C7-68439	9-15-98	3.8	3.7	9586	11.3
C7-68676	9-16-98	4.3	3.2	9512	9.8
C7-68922	9-16-98	3.5	4.1	9688	10.6
C7-69314	9-17-98	4.0	4.4	9450	11.5
C7-69658	9-17-98	4.2	3.8	9498	10.2
C7-69770	9-18-98	4.0	5.0	9725	9.1
C7-69879	9-22-98	4.0	4.6	9531	10.3
C7-69891	9-22-98	4.0	3.7	9706	11.1
C7-70126	9-23-98	4.5	3.0	9825	11.6
C7-70245	9-24-98	4.3	4.6	9412	10.8
X(bar)	=	4.06	4.01	9593.3	10.63

Property	Average X(bar)10 ±	Constant (0.91)	Range x (R)	Interval (I)	V.S.[1] Result	Similar Yes/No
Asphalt Content	4.06	0.91	1.0	5.0/3.2[2]	4.5	Yes
Air Voids	4.01	0.91	3.0	6.7/1.3[2]	3.9	Yes
Flow	10.63	0.91	2.5	12.9/8.4[2]	10.3	Yes
Stability	9593.3	0.91	413	9969/9217[3]	9650	Yes

Note: All four of these tests may not apply to any one sample. For those tests that do apply and all replies in the “Similar” column are “ Yes” , take action specified in Section 5.1. If one or more of the applicable test replies in the “Similar” column are “No”, take action specified in Section 5.2.

1 - Verification Sample.

2 - Round calculated intervals to nearest 0.1 percent.

3 - Round calculated interval to nearest whole Newton.

COMPUTATION SAMPLE SHEET PORTLAND CEMENT CONCRETE

Quality Control ID or Lab. Number	Date	Air Content (%)	Consistency (Slump) (inches)
01	9-15-98	6.2	2.50
02	9-16-98	7.0	2.75
03	9-16-98	5.2	2.50
04	9-17-98	6.4	3.00
05	9-17-98	5.0	2.75
06	9-18-98	5.8	2.25
07	9-22-98	5.4	2.50
08	9-22-98	4.4	2.75
09	9-23-98	6.0	3.00
10	9-24-98	6.0	2.50
	X(ba =	5.74	2.65

Property	Average X(bar)10 ±	Constant (0.91)	Range (R)	Interval (I)	V.S.[1] Result	Similar Yes/No
Air Content	5.74	0.91	2.6	8.1/3.4[2]	7.6	Yes
Consistency (Slump)	2.65	0.91	0.75	3.25/2.00[3]	3.00	Yes

Note: If all replies in the "Similar" column are " Yes" , take action Specified in Section 5.1. If one or both of the replies in the "Similar" column are " No" , take action specified in Section 5.2.

1 - Verification Sample

2 - Round calculated interval to nearest 0.1 percent.

3 - Round calculated interval to nearest 0.25 inches.

COMPUTATION SAMPLE SHEET AGGREGATE GRADATIONS

Quality Control Lab. Number	Date	1 ½”	1”	½”	#4	#8	#200
C7-57698	08-10-98	100	100	25	4	2	0.6
C7-57972	08-10-98	100	100	30	2	2	0.6
C7-58793	08-11-98	100	99	28	2	1	0.4
C7-58845	08-11-98	100	99	49	8	2	1.0
C7-76068	08-12-98	100	100	32	2	1	0.5
C7-76271	08-12-98	100	100	36	1	1	0.6
C7-78174	08-13-98	100	100	42	2	2	0.7
C7-78232	08-13-98	100	100	19	1	1	0.5
C7-78496	08-14-98	100	100	36	2	2	0.3
C7-78541	08-15-98	100	100	43	1	1	0.5
	X(bar)	=	100	99.8	34.0	2.5	1.5	0.57

Sieve Size	Average X(bar)10 ±	Constant (0.91)	x	Rang (R)	Interval (I)	V.S.* Result	Similar Yes/No
1 ½”	100	0.91		0	100/100	100	Yes
1”	99.8	0.91		1	100/99	100	Yes
½”	34.0	0.91		30	61/7	24	Yes
#4	2.5	0.91		7	9/0	2	Yes
#8	1.5	0.91		1	2/0	1	Yes
#200	0.57	0.91		0.7	1.2/0	0.4	Yes

Note: If all replies in the “Similar” column are “Yes”, take action Specified in Section 5.1. If one or more of the replies in this column are “No”, take action specified in Section5.2.

All calculated intervals are to be rounded to the nearest whole number except the #200 sieve which is rounded to the nearest0.1.

* Verification Sample

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDELINES FOR ESTABLISHING AND MAINTAINING APPROVED LISTS OF MATERIALS AND SOURCES

1. PURPOSE

1.1 To establish general guidelines for establishing and maintaining approved lists of materials and sources.

2. SCOPE

2.1 This procedure shall apply to all sources and materials that are suitable for acceptance with a reduced testing frequency. Because of the uniqueness or complexity of some products, additional Materials Procedures may be necessary to supplement the requirements to this procedure.

3. APPLICABLE DOCUMENTS

3.1 West Virginia Division of Highways Standard Specifications, Roads and Bridges

3.2 West Virginia Division of Highways Construction Manual

3.3 West Virginia Division of Highways Standard Details

3.4 West Virginia Division of Highways Standard Bridge Plans

3.5 West Virginia Division of Highways Materials Procedures

4. PREREQUISITES FOR APPROVED LIST CONSIDERATION

4.1 In order to be considered for an approved list, at least one of the following criteria should apply:

4.1.1 A historical record of usage on state projects or the anticipation of significant product usage by the contractor or state personnel.

4.1.2 Consistent satisfactory compliance of the product with the governing specifications.

5. APPROVED CRITERIA

5.1 Approval shall be granted to a product or source providing at least one of the following criteria are met:

5.1.1 The manufacturer of the product has developed and operates under a Division approved Quality Control Plan that sufficiently controls the quality of the product to the extent that the possibility of a substandard product being produced and shipped is substantially reduced if not eliminated.

5.1.2 The record of specification compliance of the material or source is satisfactory to the Division.

5.1.3 The manufacturer has successfully undergone an evaluation of manufacturing and quality control processes that has led to certification or accreditation by a Division recognized accreditation agency.

5.1.4 Acceptance or approval of a particular product by an AASHTO national or regional test program.

5.1.5 Acceptable evaluation by field testing of a product or product design analysis.

6. RETENTION OF APPROVED STATUS

6.1 All approved materials or sources shall be subject to periodic inspection and/or review to determine if the approved product(s) are maintaining the same characteristics and quality as originally approved.

6.1.1 Validation of all approved lists shall be performed at least once every two years. Once the validation process has been completed, each re- approved source will be issued a new approval number. Approval verification shall be based on one or more of the following:

6.1.1.1 Satisfactory results from testing random samples collected at the source, supplier or from a Division project.

6.1.1.2 Re-inspection of the manufacturing and quality control processes.

6.1.1.3 Satisfactory statistical evaluation of routine quality control test data supplied by the manufacturer.

6.1.1.4 Certified statement from the manufacturer that the approved product is being manufactured under the same design, formulation, manufacturing process and/or quality control processes that were in effect when product or source was originally approved.

7. DOCUMENTATION

7.1 All approval numbers assigned to particular materials and sources shall be directly related to the data used to justify approval or re-approval. If the justification is contained in a Materials Inspection Report (MIR), then the MIR number shall also serve as the approval number. When approval or re-approval is based on a test report, the laboratory number assigned to the sample shall also serve as the material or source approval number. If more than one laboratory number is involved, the approval number shall represent a composite laboratory number that cross references all the individual laboratory numbers used in the evaluation of the product or source. If the approval or re-approval is based on a certified statement or certified test data from the manufacturer, then the approval number shall be assigned and affixed to the document.

7.1.1 Approved material numbers or approved source numbers shall be distinguished from regular report and laboratory numbers by the letter "A" immediately following the approval number. All manufacturers of approved materials shall be required to reference their approval number on the shipping documents that accompany the approved material to the project.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.55 Steward – Materials Control Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

FIELD SAMPLING AND TESTING OF SURFACE WATER FOR QUALITY DETERMINATION

1. PURPOSE

1.1 This procedure sets forth guidelines for collecting surface water samples within the limits of Division of Highways projects and in adjacent surface waters that may be affected by construction on these projects.

1.2 The procedure establishes general and specific methods to be utilized in determination of sampling points, duration of sampling and how to collect samples. It also discusses necessary equipment and tests.

2. APPLICABLE DOCUMENTS

2.1 *MP 642.40.20*

2.2 *MP 642.03.50*

3. EQUIPMENT

3.1 Chemically inert glass and/or plastic bottles (depending on the test to be performed) or 1 liter capacity fitted with screw caps will be used for chemical analyses samples.

3.1.1 All containers will be machine or hand washed with a suitable cleaning compound or biodegradable soap. After washing, containers will be well rinsed with clean tap water and finally with distilled water to remove any residue of the cleaning compound or soap.

3.2 Containers used for samples for biological test determination by the Central Laboratory shall be 100 ml plastic bottles with screw caps. The bottles and caps must be able to withstand sterilization procedures.

3.2.1 The bottles and caps shall be sterilized in an autoclave. The sterilized bottles shall be capped in such a way as to prevent contamination before samples are obtained.

3.3 Plastic or rubber gloves when sampling in certain contaminated waters (for example, sewage waters).

3.4 Rubber boots if required for sampling in deep water.

3.5 Materials Control, Soils and Testing (MCS&T) Division personnel will need equipment to determine pH, temperature, dissolved oxygen, specific conductivity, total alkalinity, and total acidity. District personnel will need equipment for determination of pH, temperature, and turbidity.

4. SOURCE OF SAMPLES

4.1 Samples may be obtained from streams, springs, drainage from coal mines and waste, or other sources that may affect water quality.

4.2 Generally, all perennial streams should be sampled. In certain cases, sources that are of an intermittent nature may require sampling when flows are present and if it is likely that the source will have a significant affect on the quality of receiving waters and the stream flow.

4.3 Drainage from coal mines or coal waste piles should be sampled if this drainage is disrupted, channelized by the highway construction, or it is contributing to the flow of water that passes through the project or proposed project, but is not located within project limits.

4.4 Springs or other special sources should be sampled especially if the supply is for human consumption and/or other public, recreational or natural resource uses in the immediate area.

4.5 When possible, samples to be taken prior to construction or in the design phase of a project should be obtained when flows are considered to be in low or normal condition, except as noted in 4.2.

5. POINTS OF SAMPLING

5.1 Samples should not be taken from areas of stagnation, heavy aeration, or agitation unless for special circumstances and tests.

5.2 Samples shall not be taken from the confluence of streams. Samples shall be taken a minimum of 15 m above and 30 m below such points. When mixing has not created visible homogeneous conditions within 30 m below a confluence, sampling will be conducted at the nearest spot where visible homogeneity exists.

5.2.1 When conditions are such that homogeneity does not exist within 305 m downstream from a confluence, sufficient samples should be obtained to delineate any differences. Thesepoints of sampling are to be recorded.

5.3 Under some conditions, to be determined by the sampler, points of sampling may have to be located at a specific spot to determine influx of concentrated substances or isolated source of pollution.

6. FREQUENCYAND DURATION OF SAMPLING

6.1 Samples Collected by MCS&T Division Personnel: Sampling will be conducted in the design phase of a project. At least three (3) samples should be obtained at different times prior to construction at each of the sources outlined in Section 4.1 if encountered in the project area.

6.2 Samples Collected by District Personnel During Construction: Sampling by District personnel will be conducted as an acceptance procedure when MP 642.03.50 is in effect on a project. See MP 642.03.50 for sampling requirements.

6.2.1 In some cases, MP 642.03.50 may not be in effect on a project. Sampling will be conducted if it is determined that construction activity could result in a disturbance of the water source drainage area. Sampling frequency will be daily.

6.2.1.1 When construction is not active, but conditions are such that erosion and pollution can still occur, sampling will be conducted daily.

6.2.1.2 When construction is not active, but conditions are such that erosion and pollution are not likely to occur, sampling will be conducted weekly.

6.3 Monitoring will be continued throughout the life of the project.

7. VOLUME OF SAMPLES

7.1 Samples collected for testing in the MCS&T Division Central Laboratory will be of the quantities as set forth in MP 642.40.20 for each test required.

7.2 The quantity of water for field testing by MCS&T Division personnel shall be 1 liter.

7.3 The quantity of water for District testing shall be a minimum of 500 ml.

7.4 A minimum sample for biological testing will be 100 ml.

7.5 Appropriate preservation methods and quantities for all tests are listed in MP 642.40.20.

8. SAMPLING

8.1 Individual grab samples will be appropriate in most cases.

8.2 Generally, sampling from the stream bank will be acceptable. In certain cases, however, grab or composite samples collected from a boat or structure may be necessary.

8.3 The sample should be taken at least an arm's length in depth or half the stream depth.

8.3.1 In some sources too shallow for submerging the sampling bottle, water will have to be dipped or a hole dug large enough to allow submergence of a sample bottle. When a hole is dug, a minimum of 15 minutes must pass before the sample is taken. However, in some cases where stream flow and volume is low or turbidity is not equalized, a longer waiting period will be necessary.

8.4 The mouth of the sample bottle should be held in such a manner that the flow of water will not pass over the hand before entering the bottle.

8.5 The container used for chemical test samples should be rinsed two or three times with the water to be collected before taking the sample. Rinse water is to be poured out downstream of the site.

8.6 The sample will be capped and sealed as soon as possible after sampling to limit exposure to the atmosphere.

8.7 Containers used for biological test samples will be kept sterile at all times. The bottle will be submerged and the cap taken off underwater when taking the sample. The container will be capped after filling while still underwater.

8.8 Samples shall be handled prior to analysis in a manner that protects the substances to be tested.

9. TESTING

9.1 The following tests will be conducted by MCS&T Division personnel in the field at the sample site: 1) pH, 2) dissolved oxygen, 3) specific conductivity, 4) total alkalinity, 5) total acidity, and 6) water temperature.

9.2 Tests to be conducted in the field by District personnel will be pH and water temperature.

9.2.1 The turbidity of the sample will be determined in the District laboratory.

10. SHIPPING SAMPLES

10.1 Samples collected for testing by the Central Laboratory will be delivered to the MCS&T Division.

10.1.1 Samples shall be scheduled to arrive within the limits of the holding times as indicated in MP 642.40.20.

11. DOCUMENTATION

11.1 Water quality results for samples taken by MCS&T Division personnel will be maintained on the Division's appropriate forms.

11.2 Water quality results for samples taken by District personnel may be maintained on the Division's form entitled "Environmental Water: Quality Check" (see attachment).

12. ASSISTANCE

12.1 Personnel from the MCS&T Division will provide training for District personnel in all aspects of the work made necessary by this MP.

12.2 Assistance in planning and developing a testing program for a particular project or projects will also be provided by this Division.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.01.01 Steward – Environmental and Coatings Section
RLS:P
ATTACHMENT

ENVIRONMENTAL WATER: QUALITY CHECK

PROJECT:____________________COUNTY:__________________DISTRICT:____________

LAB NUMBER: _________________________________

DATE SAMPLED/TESTED: __________________________________

SAMPLED BY: ____

SAMPLING OBSERVED BY DISTRICT? YES NO

RAINFALL (24 HRS)___________________"

	SITE #	SITE #	SITE #	SITE #	SITE #
STATION					
OFFSET					
TURBIDITY					
pH					
IRON					
WATER TEMP °C					
AIR TEMP °C					

REMARKS: ____

$^{o}F = (1.8 \times {}^{o}C) + 32^{o}$

$^{o}C = ({}^{o}F - 32^{o}) - 1.8$

____
TECHNICIAN'SSIGNATURE

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR ITEM MATERIALS CERTIFICATION

1. PURPOSE

1.1 To provide instructions for the preparation and submission of completed items for materials certification using the Division's on-line computer system.

1.2 To establish the procedures to be followed in processing and documentation of these items.

2. SCOPE

2.1 All Districts and Materials Control, Soils and Testing Division (MCS&T) shall employ the procedures set forth.

3. PROCEDURES

3.1 General

3.1.1 Efficient project certification/finalization requires prompt completion and review of the E440 (Project Materials Records) and associated documents. This is required for the preparation of the item's materials certification. Daily updating of the project records and prompt review (Precertification) by the District's Materials Section is essential to the process efficiency. If precertification is done properly, a Letter of Certification will be issued within 2 days of the District's submission of the MC-8.

3.2 Instructions for precertification of items by the District

3.2.1 After the project has reviewed the "Current" Quantity Validation Report with laboratory numbers shown, they will export a file of Validated Daily Reports, currently this is to a floppy disk. The validated files will be forwarded from the project to the District's Construction Office with the "current" voucher estimate and "Current" Quantity Validation Report. The District will upload the file, currently from a floppy disk, to the central mainframe. Subsequent changes to the computer system will allow other methods of upload at a later date.

3.2.2 All upload project files will be incorporated into the online E440 files at least weekly. A list of current uploads and errors found in the data is provided in HWSC to assist the District's Materials Section in error correction.

3.2.3 The District's Materials Section will review the uploaded items. All deficiencies found by the system and a visual review of the updated E440's for missing or erroneous data should be corrected before the next progress estimate (approximately

15 days). All E440's will be initialed and dated in HWSC by the District to indicate precertification has been completed, this includes items on the E440 that have keys attached to the item.

3.2.4 A key page to the item (E440) will permanently link all deficiencies and errors found during the review. Included in the deficiency description will be a statement describing the deficiency, and information as to what action is necessary to resolve the deficiency. The key page attached to a copy of the E440 will be given to the responsible party (project or materials section personnel) to resolve the problem before the next estimate.

3.3 Instruction for submitting request for the item certification

3.3.1 Upon receipt of the Project's Final Inspection Request, the District's Materials Section shall perform a final review of the completed E440's for content and accuracy. The E440's shall reflect all laboratory numbers from the test reports that represent constituent materials of the item. All material deficiencies, either the contractor or the Department will be provided to the project and District Construction office for inclusion in the Final Inspection Report (467).

3.3.2 The E440's should be submitted to MCS&T within 15 days of the receipt of the Contract Completion Report (416).

3.3.3 Upon receipt of by MCST, the E440's will be reviewed and compared with the test reports and data contained in the files of MCS&T. All entries on the E440's will be identified by indication of specification compliance, source, and materials description. If the individual item (E440) is satisfactory, it will be certified.

3.3.4 Items found to require additional clarification or resolution will be noted on a key page linked to the item (E440). These items with deficiencies will be placed in the delinquent item list. The responsible party, either the District or MCS&T, will resolve the problem. MCS&T will contact the responsible party weekly concerning the deficiencies.

3.3.5 MCS&T will permanently link by use of a key page all documentation concerning resolution of material noncompliance with specification requirements to the item (E440).

3.3.6 Upon completion of the certification of all items by MCS&T, the District's Materials Section will verify that all work has been submitted and all items (E440) reflect correct final quantities. The District will perform this activity by using the files contained in HWS7. The District will have 5 days to complete this review and have the computer generate an MC-8 (Report of Materials Tested), which is forwarded to MCS&T. The District will notify MCS&T by email of all MC-8 submissions.

3.3.7 Upon receipt of the MC-8 by MCS&T, a final review of and comparison with all project reports and records contained in the electronic files of MCS&T will be conducted.

3.3.8 MCS&T will draft a Letter of Certification after the final review. All resolutions of materials noncompliance with the specification requirements will be addressed in the Letter of Certification.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 700.03.00 Steward – Materials Control Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF MICROSCOPIC DETERMINATION OF AIR-VOID CONTENT

1. PURPOSE

1.1 To obtain quantitative information concerning air voids, matrix, fine aggregate, and coarse aggregate in hardened concrete.

2. SCOPE

2.1 By using the linear traverse method of point counts, we can determine the relative composition of hardened concrete cylinders or cores on a percentage basis.

3. EQUIPMENT

3.1 A large stone saw.

3.2 A lapidary grinding apparatus.

3.3 A linear traveler apparatus.

3.4 A reflecting illumination system.

3.5 A biocular microscope with a cross hair type reticle. (Magnification preferably in the 10x, 30x, and 60x range).

3.6 Miscellaneous: Silicon carbide grinding material, numbers 120, 240, 400 and 600, a set of 4 mechanical specimen counters, a 305 mm ruler and a magic marker.

4. PROCEDURE FOR PREPARATION OF CONCRETE SPECIMENS

4.1 The concrete specimens should be cut on the large stone saw so as to bisect the cylinder along its longitudinal dimension. Care should be taken in avoiding, if possible the steel reinforcing bars encountered in bridge deck cores.

4.2 Select the better half of the specimen and make a cut perpendicular to its long axis, 102 mm below the top surface of bridge deck core specimens. If the specimen is a concrete cylinder a 102 mm section from the middle of the cylinder is cut and used for point counting. These operations are done so that the linear traveler specimen holder can accommodate the specimen.

4.3 All portions of the specimen are retained for possible later inspection.

4.4 That portion of the specimen prepared in Section 4.2 is now polished, first using silicon carbide grit number 120, in order to obtain a uniform surface, and subsequent polishing by silicon carbide grit numbers 240, 400 and 600 to obtain a smooth, highly polished surface.

---

5. OPERATIONAL PROCEDURES USING THE LINEAR TRAVELER

5.1 The polished specimen is placed on the specimen holder of the linear traveler.

5.2 After the specimen is centered on the specimen holder, the specimen should be leveled, so as to minimize refocusing.

5.3 A right vertical margin and a left vertical margin should be drawn on the polished surface of the specimen. The placement of each margin is dependent upon the horizontal limits of the linear traveler and the irregularity of the boundaries of the specimen. If an irregularity exists, the corresponding margin is placed along the inner edge of the irregularity.

5.4 A light source should be directed onto the specimen surface for illumination of the visual field.

5.5 The biocular microscope assembly should be positioned so that the technician can observe the entire distance between margins as the linear traveler moves horizontally.

5.6 Horizontal movement of the linear traveler is accomplished by pushing the horizontal motion control switch. The direction of horizontal motion is controlled by the directional selector lever located to

5.7 the left of the specimen holder and in front of the motor housing.

5.8 Vertical movement of the linear traveler is accomplished by manually cranking the lower left hand wheel located directly beneath the specimen holder.

5.9 By using the controls of the linear traveler, position the specimen while viewing through the microscope at 10x, 30x or 60x magnification, so that the vertical cross hair is on line with one of the vertical margins and the horizontal cross hair is approximately 3.2 mm below the specimen, or 3.2 mm below the deepest penetration of an irregular edge.

5.10 Readjust the light source so as to obtain an adequate field illumination.

5.11 Adjust the directional selector lever so that the technician views that portion of the specimen between the margins as the linear traveler moves horizontally.

5.12 Focus the microscope on the specimen surface (periodic refocusing may be necessary).

5.13 Push the horizontal motion control switch so that the linear traveler moves one unit and stops.

5.14 =At the intersection of the cross hairs, decide whether the material is an air void, matrix, fine aggregate

5.15 (-4.75 mm) or coarse aggregate (+4.75 mm) and record the decision on a mechanical specimen counter properly designated.

5.16 Repeat procedures set forth in Sections 5.12 and 5.13 for the entire width of the specimen between the margins.

5.17 When the vertical cross hair reaches a margin after traversing the specimen, reverse the horizontal direction using the directional selector lever and crank the vertical control wheel two complete revolutions clockwise.

5.18 Repeat procedures set forth in Sections 5.14 and 5.15 until the total number of point counts indicated on the mechanical specimen counter equals 600.

6. COMPOSITION PERCENTAGES

6.1 Each category such as air void content, matrix, fine aggregate (-4.75 mm), and coarse aggregate (+4.75 mm), is expressed as a percentage of total number of point counts.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.03.50 Steward – Cement and Concrete Section

RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

TRIAXIAL COMPRESSIVE STRENGTH OF COMPACTED AGGREGATE SPECIMENS

1. INTRODUCTION

1.1 This test is designed for determining the friction angle of compacted aggregate specimens where large specimen size is desired due to large top size of material (to 63.5 mm) or for other reasons.

1.2 To establish a friction angle of a material it is required that this test be performed on three specimens split from the same sample. Due to time involved with each specimen (3 days) a technique must be developed to overlap. One of which is after a specimen is removed from the compaction mold (2nd day) another specimen may be constructed in it and so on for other parts of the operation until completion.

2. EQUIPMENT

2.1 Compaction Mold - 152 mm diameter 305 mm height, split lengthwise in half with flanges affixed so that it can be firmly bolted back together and attached to a base plate.

2.2 Electric Hammer - fitted with tamping device consisting of 149 mm diameter steel plate 19 mm thick welded on end of and 457 mm steel rod that will fit the hammer.

2.3 Triaxial Cell - sufficient size for specimen, fitted with pressure gauge accurately readable in the 0 through 344 Kpa range, and shut off valves in lid and base.

2.4 Triaxial Membranes - 152 mm diameter 38/mm length.

2.5 Membrane Stretcher - consists of 159 mm pipe 305 mm long fitted with shut off valve about midway its length.

2.6 Porous Stones - carborundum stones 152 mm diameter 9.5 mm and 12.7 mm thick.

2.7 Compressive Strength Machine - capable of supplying load at rate of 226.8 kg per minute or slower until failure occurs.

2.8 Freezer - capable of holding specimen in compaction mold at -17? C.

2.9 Vacuum pump with trap

2.10 Drying oven - 110 ± 5° C.

2.11 Heat gun - hand held electric heater - blower

2.12 Glycerin - 7.57 liters

2.13 Miscellaneous implements: scoop, spatula, mixing pans, scales, stopwatch, wastebasket, or pail.

3. SPECIMEN PREPARATION

3.1 Acquire sufficient material to split out three test samples each weighing 15 kg

3.2 ± .5 kg when oven dry.

3.3 Place one sample in pan of sufficient size for mixing sample with water.

3.4 Add 500 ml of water to sample and mix thoroughly; if all water is taken up, add more water in 100 ml increments mixing thoroughly until a small amount of free water occurs in pan. Record the total amount added, which will be used in saturating the remaining samples.

3.5 Pile material in center of pan making an effort to avoid segregation of material sizes.

3.6 Fill mold in three 127 mm lifts, the last will have to be rounded up above top edge of mold to get the 127 mm depth.

3.7 Compact each lift for 15 seconds using electric hammer, holding hammer with just enough force to prevent it from rebounding off the material causing erratic vibration. After compaction is completed, material should fill mold to top edge or slightly above, if not, heap more material and compact another 5 seconds.

3.8 Cover top of specimen to prevent moisture loss and freeze at -17 °C, 10-20 hours.

4. TRIAXIALCELL PREPARATION

4.1 Clean and set out all triaxial chamber components so that a rapid assembly can be made.

4.2 Set chamber base on edge of work surface and support, so that, one chamber hold down bolt can be removed and replaced without having to raise or tilt the base.

4.3 Connect drain lines for upper and lower platens to base and secure out of way.

4.4 Work clean O-rings into lid and base plates, this may require heat gun to warm rings and surface to get rings to fit.

5. ASSEMBLING SPECIMEN INTO CHAMBER

5.1 Remove specimen from freezer.

5.2 Use heat gun to thaw top surface and level it off flush with top edge of mold. Any holes caused by plucking of aggregate should be filled with fine material removed during leveling. Entire top surface must be flat. Weigh specimen in mold and record.

5.3 Place a thick, porous stone (2 thicknesses) and the lower platen on top of the specimen and carefully invert specimen setting it very near edge of working surface (platen on bottom, porous stone, then specimen).

5.4 Use heat gun to thaw mold base plate and remove.

5.5 Remove holding bolts from split mold and use heat gun to thaw sides until halves of mold drop away under own weight or with a slight downward push.

5.6 Place membrane inside stretcher pulling ends out and over edges of the device, thus holding the membrane in place.

5.7 Connect vacuum to stretcher, open valve, and work wrinkles out of membrane as it is pulled against sides of stretcher.

5.8 Once membrane is stretched against sides, close valve on stretcher and remove vacuum line.

5.9 Carefully lower stretcher over specimen until top is even with top of specimen.

5.10 Slip membrane off lower end and fold down around sides of platen.

5.11 Set thin, porous stone on top of specimen and slip membrane off upper end of stretcher.

5.12 Very carefully lift stretcher off specimen now enveloped by membrane.

5.13 Carefully fold membrane down around top end of specimen, place upper platen on specimen and wrap membrane back up around platen. Secure two rubber bands on each platen to hold the membrane in place.

5.14 Carefully lift specimen onto base plate (noting drain hose connection on lower platen should be at 180? from its connection on base plate) and locate on base plate by fitting nub on base plate into indention on platen.

5.15 Connect drain lines to platens.

5.16 Check that O-ring surfaces are clean (lid and base).

5.17 Place triaxial chamber over specimen carefully and turn chamber in back-and-forth motion on base to seat it against O-ring.

5.18 Make sure drain valve on base is closed and viewing ports snug against O- rings.

5.19 Pour glycerin into chamber quickly (if it begins leaking around base, work faster) until top platen is covered by a thin film.

5.20 Quickly position chamber lid in place and begin tightening into place, after finger tight alternate nuts giving each a quarter turn until all are tight.

5.21 Attach pressure gauge to chamber at lid using a rubber hose from the gauge to the T-fitting at the inlet valve securing hose with hose clamp.

5.22 Charge chamber with 69 Kpa using air and close inlet valve to hold pressure.

5.23 Place chamber where it will not be disturbed and check occasionally to make sure pressure is holding.

5.24 Allow chamber to set 18 to 24 hours in order for specimen to thaw.

6. TESTING - BALDWIN COMPRESSIVE STRENGTH MACHINE

6.1 Position chamber on machine.

6.2 Check that pressure has held and adjust to proper level to test (34, 69, or 138 Kpa).

6.3 Set Baldwin machine rate at 3.8 Kg/sec (slower if possible).

6.4 Bring Baldwin head into contact with chamber loading piston.

6.5 Using wax pencil or crayon make a mark on loading piston at top of sleeve (this is a measure amount of compression).

6.6 Commence loading specimen until failure, again mark position of loading piston in sleeve and record load at failure.

6.7 Remove load.

6.8 Return cell to suitable area for clean-up and disassembly.

7. CLEAN-UP AND DISASSEMBLY

7.1 Glycerin can be drained from cell by bleeding off pressure then removing a lower viewing port allowing the glycerin to drain into a suitable container, the remainder can be drained by replacing the viewing port, pressurizing the cell and opening the drain on the base plate again catching the glycerin for reuse.

7.2 Remove lid and cell, rinse down specimen and base with water.

7.3 Place majority of specimen in weighed suitable drying pan, weigh and place in oven until dry and weigh.

7.4 Glycerin can be washed off all equipment with water, equipment dried and stored.

7.5 Used glycerin can be stored in closed containers and reused.

8. CALCULATIONS

8.1 See attached sheet for necessary calculations.

8.2 Mohr's circles can be constructed from the results of three tests run on the same sample at different confining pressures, as follows:

8.2.1 Construct an x-y axis and number to the highest axial stress recorded (from work sheet) beginning at the intersection and numbering to the right.

Construct a half circle on this by locating the circle's center at $\frac{(s\,1-s\,3)}{2}+s3$ with a radius $(s1-s3)/2$

8.2.2 Construct a circle for each test run on the same axis diagram

8.2.3 Locate a best fit line intersecting all three circles and passing through or nearly through the origin of the graph.

8.2.4 The angle this line makes with the x-axis is the friction angle for the material tested. This graph should accompany the work sheet

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 207.06.20 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT

Test No.	d	A?	L?	?L	∈	A	P	p	$\bar{s}_3$	$\bar{s}_1$	$\frac{s_1}{s_3}$	f

d - Specimen diameter -

A? - Crossectional area - Πr^2

L? - Original length - __

?L - Final length - __

∈ - Strain - ?L/L? __ __

A - Average Crossectional area- $\frac{A?}{1-\in}$

f - Friction angle- $\frac{s_1/s_{3-1}}{s_1/s_{3+1}}$

P - Applied force - at failure

p - Applied stress - P/A

s_3 - Confining pressure -

s_1 - Axial stress - $p + s_3$

s_1/s_3 - Intergranular stress $\frac{p \pm s_1}{s_3}$

1) Wt. material wet ________Kg ________Kg ________Kg
2) Wt. material dry ________Kg ________Kg ________Kg
3) Moisture Content ________% ________% ________%
4) Max. Density (dry) ________Kg/m³ ________Kg/m³ ________Kg/m³
5) Actual Density (dry) ________Kg/m³ ________Kg/m³ ________Kg/m³
6) % Compaction ________ ________ ________

1) Weight after test
2) Oven dried after test
3) $\frac{(1)}{(1)-(2)}$ x 100 = %
4) From Humphries or FHWA-RD-72-43 Vibratory Compaction...for Granular Materials
5) (2)X volume of mold
6) (4)/(3) X 100 = %

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

DETERMINING APPLICATION RATE OF GROUND AGRICULTURAL LIMESTONE BASED ON pH TEST

1. PURPOSE

1.1 To provide guidance and instruction in determining the application rate of agricultural limestone to specific areas, based on pH, prior to seeding.

2. SCOPE

2.1 This procedure is applicable to all projects and is intended to be used in the field.

3. DEFINITIONS

3.1 Section - An entire cut, fill, or median area, or any portion thereof, to receive either permanent or temporary seeding.

3.2 pH - The acidity or alkalinity of a substance expressed as a numerical value.

3.3 Average pH - The average of individual pH determinations from each section.

4. PROCEDURE

4.1 All pH determinations shall be made in accordance with instructions that accompany soil reaction kits furnished by this Division to the District Materials Organization.

4.2 For through cuts or through fill slope sections, the average pH will be determined from a total of six individual readings. If both sides of the roadway are seeded concurrently, three of the individual readings shall be made on each side.

4.3 For side hill cut and side hill fill sections, the average pH will be determined from six individual readings from each side of the roadway.

4.4 For medians, the average pH will be determined from six tests for each section.

4.5 For all other miscellaneous sections not listed above, the average pH will be determined from two tests.

5. DETERMINING APPLICATION RATES OF AGRICULTURAL LIMESTONE

5.1 Using the average pH set forth in paragraph 4, each section will be limited at the rates specified in Table 1 for the type of soil and seed mixture.

6. DOCUMENTATION

6.1 Results of pH determinations and locations will be documented on the attached worksheet(s), with one copy being forwarded to the Materials Control, Soils and Testing Division by the District Materials Organization.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.04.10 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT

TABLE 1

RATES FOR APPLYING AGRICULTURAL LIMESTONE

(Pounds per Acre)

Soil pH	Degree of Acidity	Crownvetch and Lawn Mixture (mixtures C_1, C_2 D)		Sericea Lespsdeza and K_{31} Fescue (mixtures A and B)	
		Sandy Soil	All Others	Sandy Soil	All Others
7 +	Neutral to Alkaline	0	0	0	0
6.0 to 6.9	Slightly Acidic	1000	2000	0	0
5.5 to 5.9	Medium	2000	4000	1000	1000
4.5 to 5.4	Strong	3000	5000	1500	2000
3.5 to 4.4	Very Strong	Not Suitable for Crownvetch		3000	4000
<= 3.4	Toxic to most Plants	Not Suitable for Crownvetch		5000	8000

West Virginia Division of Highways

Field Determination of pH

Project:				County:		
Date:				Signature:		
Section Sta. to Sta.	Right and/or left	Cut or fill	pH Values	Average pH	Sandy or Other	Appl. Rate
			1= 2= 3= 4= 5= 6= ∑=			
			1= 2= 3= 4= 5= 6= ∑=			
			1= 2= 3= 4= 5= 6= ∑=			
			1= 2= 3= 4= 5= 6= ∑=			

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

FERTILIZER ACCEPTANCE CRITERIA

1. PURPOSE

1.1 To provide an interpretation of existing specifications governing fertilizers used on Division projects.

2. SCOPE

2.1 The interpretation set forth herein shall apply to all fertilizer operations.

2.2 Provide instructions for use by Division field personnel as to acceptance and documentation of material.

3. CRITERIA FOR ACCEPTANCE

3.1 Specifications governing fertilizers as set forth in West Virginia Division of Highways Standard Specifications for Roads and Bridges shall be interpreted to mean that all fertilizers utilized on Division projects shall be a commercial fertilizer meeting the definitions and requirements of the West Virginia Fertilizer Law as well as any applicable federal laws and regulations.

4. DOCUMENTATION

4.1 Coverage for fertilizers shall be obtained by entering the type, quantity, and brand on the HL-440.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.05.10 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

DETERMINATION OF CHEMICAL CONSTITUENTS IN HYDRAULIC CEMENT

1. PURPOSE

1.1 To set forth procedures for determining the chemical constituents of hydraulic cement by wet chemical and instrumental methods.

2. SCOPE

2.1 Procedures are set forth for the following constituents.

1. Silicon Dioxide (SiO_2)
2. Ammonium Hydroxide Group ($A1_20_3$, Fe_20_3, $Ti0_2$, and P_20_3)
3. Ferric Oxide (Fe_20_3)
4. Calcium Oxide ($Ca0$)
5. Magnesium Oxide (MgO)
6. Insoluble Residue
7. Sulfur Trioxide (So_3)
8. Loss on Ignition
9. Alkali Oxides
10. Sodium Oxide (Na_20)
11. Potassium Oxide (K_20)

3. APPLICABLE DOCUMENTS

3.1 ASTM (American Society of Testing and Materials) C 114 and C 150

4. TEST PROCEDURES

4.1 The test procedures to be used are given in Table 1.

TABLE 1

TEST	TEST PROCEDURES
Silicone Dioxide	ASTM C 114 Reference Method
Ammonium Hydroxide Group	ASTM C 114 Reference Method
Calcium Oxide	ASTM C 114 Reference Method
Insoluble Residue	ASTM C 114 Reference Method
Sulfur Trioxide	ASTM C 114 Reference Method
Loss on Ignition	ASTM C 114 Reference Method (Note 1)
Magnesium Oxide	Atomic Absorption
Ferric Oxide	Atomic Absorption
Sodium Oxide	Atomic Absorption
Potassium Oxide	Atomic Absorption
Aluminum Oxide	Atomic Absorption
Tricalcium Aluminate	Calculated as per Note C of ASTM C 150, Table 1

Note 1 Porcelain crucibles may be used in place of platinum crucibles

Note 2 Qualification data for atomic absorption methods available from CCRL (Cement and Concrete Reference Laboratory) round-robin testing program historical data.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 701.01.11 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

DETERMINING FREE MOISTURE IN FINE AGGREGATE USING A "SPEEDY MOISTURE TESTER"

1. PURPOSE

1.1 To establish a standard method of test for determining free moisture (moisture above saturated surface dry) in fine aggregate using a "Speedy Moisture Tester".

2. SCOPE

2.1 This method of test is applicable to free moisture determination when using either the 20 gram or 26 gram "Speedy Moisture Tester".

3. GENERAL

3.1 Concrete design computations are based on aggregates which are in the SSD condition. Therefore, in this procedure the expression of free moisture is based on the SSD weight of the material.

3.2 The dial reading on the "Speedy Moisture Tester" is the percent total moisture based on the wet weight of the sample. The average absorption for limestone and silica sand is approximately 1.5 percent based on the dry weight of the material. Conversion tables calculated from this average are provided on Attachment I to yield the percent free moisture in the sample from the dial reading of the "Tester".

3.3 If it is known that the absorption should not be based on the 1.5 percent average (when the absorption is less than 1 or greater than 2) then the method for calculating the free moisture from the dial reading is given in Section 6.0.

4. EQUIPMENT

4.1 All equipment is contained in a "Speedy Moisture Tester" kit as obtained from a laboratory equipment supplier and consists of the following:

1. 20 gram or 26 gram tester - body and cap
2. Simple beam type scale
3. Reagent measurer
4. Reagent - calcium carbide
5. Cleaning cloth and brush

5. PROCEDURE

1. Place the scale in operating position and clean the pan.
2. Ensure the inside of the body of the tester is free from all foreign matter.
3. Add three measures of the reagent to the body of the tester.
4. Accurately weigh the sample (20 g or 26 g) on the scale. The accuracy of the scale should be established periodically.
5. Place the weighed sample in the cap of the tester.
6. With the pressure vessel in an approximately horizontal position, insert the cap in the pressure vessel and seal the unit by tightening the clamp, taking care that no reagent comes in contact with the aggregate until a complete seal is achieved.
7. Place the tester in a vertical position (cap end up) so that the aggregate will fall into the pressure vessel.
8. Shake the tester vigorously from end to end. At the first movement of the dial needle, turn the dial end up.
9. When the needle stops moving, read the dial while holding the instrument in a horizontal position at eye level. Read to the nearest
10. percent.
11. The percent free moisture is determined by entering the conversion chart (Attachment I) with the dial reading and obtaining the corresponding value of free moisture in the opposite column, or by substituting the dial reading into the equation shown in Section 6.0 - whichever the case may be.

6. SAMPLE CALCULATION

6.1 The following method for determining free moisture should be used when the absorption capacity of the aggregate is known to be outside the range of 1 percent to 2 percent (average 1.5 percent) of the aggregate dry weight (see Section 3.3).

Symbols	Given
W_D = Dry Weight	AB = 3.0%
W_{SSD} = Saturated Surface Dry Weight	DR = 10.0
W_w = Wet Weight (Sample Weight)	*W_W = 20.0 or 26.0

*Dependent upon size tester used

DR = Dial Reading

AB = Absorption

FM = Free Moisture

1. Determine the sample dry weight:

$$W_D = W_W - \frac{(W_W)\,DR}{100}$$

Substituting:

$$W_D = 26 - \frac{26\,(10)}{100}$$

$$W_D = 26 - 2.6$$

$$W_D = 23.4 \text{ g (dry weight)}$$

2. Determine from the dry weight the SSD weight:

$$W_{SSD} = W_D + \frac{W_D\,(AB)}{100}$$

Substituting:

$$W_{SSD} = 23.4 + \frac{23.4\,(3.0)}{100}$$

$$W_{SSD} = 23.4 + 0.702$$

$$W_{SSD} = 24.1 \text{ g (SSD weight)}$$

3. Determine from the SSD weight the percent free moisture:

$$\%FM = W_{SSD} - \frac{(W_{SSD})\ 100}{W_{SSD}}$$

Substituting:

$$\%FM = \frac{(26 - 24.1)\ 100}{24.1}$$

$$\%FM = \frac{190}{24.1}$$

%FM = 7.9 (percent free moisture)

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 702.00.20 Steward – Aggregate & Soils Section
RLS:M
ATTACHMENT

SPEEDY MOISTURE TESTER CONVERSION CHART

SPEEDY DIAL READING WET BASIS	FREE MOISTURE SATURATED-SURFACE DRY BASIS
1.0%	----
1.5%	----
2.0%	0.5%
2.5%	1.0%
3.0%	1.6%
3.5%	2.1%
4.0%	2.6%
4.5%	3.2%
5.0%	3.7%
5.5%	4.2%
6.0%	4.8%
6.5%	5.4%
7.0%	5.9%
7.5%	6.5%
8.0%	7.1%
8.5%	7.7%
9.0%	8.3%
9.5%	8.9%
10.0%	9.5%
10.5%	10.1%
11.0%	10.7%
11.5%	11.4%
12.0%	12.0%
12.5%	12.6%
13.0%	13.2%
13.5%	13.9%
14.0%	14.6%
14.5%	15.2%
15.0%	15.9%
15.5%	16.6%
16.0%	17.3%
16.5%	18.0%
----	---

SPEEDY DIAL READING WET BASIS	FREE MOISTURE SATURATED-SURFACE DRY BASIS
17.0%	18.7%
17.5%	19.4%
18.0%	20.1%
18.5%	20.8%
19.0%	21.6%
19.5%	22.4%
20.0%	23.1%
20.5%	23.9%
21.0%	24.7%
21.5%	25.5%
22.0%	26.3%
22.5%	27.1%
23.0%	27.9%
23.5%	28.8%
24.0%	29.6%
24.5%	30.4%
25.0%	31.3%
25.5%	32.2%
26.0%	33.1%
26.5%	34.0%
27.0%	34.9%
27.5%	35.8%
28.0%	36.8%
28.5%	37.8%
29.0%	38.7%
29.5%	39.7%
30.0%	40.7%
30.5%	41.8%
31.0%	42.8%
31.5%	43.8%
32.0%	44.9%
32.5%	46.0%
33.0%	47.0%

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR DETERMINING THE PERCENTAGE OF COAL AND LIGHTWEIGHT PARTICLES IN AGGREGATE

1. PURPOSE

1.1 To provide a standard method of testing for coal and lightweight particles in aggregates by means of a sink-float separation in a heavy liquid with a designated specific gravity.

2. SCOPE

2.1 This procedure is applicable to fine and coarse aggregates.

3. APPLICABLE DOCUMENTS

3.1 ASTM C 123 OR AASHTO T 113

3.2 ASTM E 11

3.3 ASTM E 100

3.4 ASTM C 702 OR AASHTO T 248

3.5 MATERIALS PROCEDURE (MP) 700.00.06

3.6 ASTM C 127 OR AASHTO T 85

3.7 ASTM C 128 OR AASHTO T 84

4. APPARATUS

4.1 A No. 4 (4.75 mm) and No. 50 (300 µm) U.S. Standard 8-inch (203 mm) diameter sieve conforming to ASTM E 11 Specifications.

4.2 Balance or scale having a capacity of 500 grams and a sensitivity of at least 0.1 gram for weighing fine aggregates; and a capacity of 10,000 grams with a sensitivity of 1 gram for weighing coarse aggregates.

4.3 Oven capable of being maintained at 230 ± 9^{o}F (110 ± 5^{o}C).

4.4 Containers: Large Nalgene vat (or comparable material) for storage of heavy liquid and compatible mesh bucket for immersion of coarse aggregate into heavy liquid.

4.4.1 Buckets for soaking and pans for surface drying the aggregates. 600 ml Pyrex beakers for fine aggregates.

4.5 Skimmers: Made of No. 50 sieve cloth conforming to ASTM E 11. Fitting one with a handle for scooping floating particles from heavy liquid. The other must be capable of fitting over 600 ml Pyrex beakers.

4.6 Stirring Rods: A glass rod for use with fine aggregates and a large metal rod for coarse aggregates.

4.7 Heavy Liquid: Consisting of a mixture of zinc bromide and water in such proportions so that a designated specific gravity of 2.00 ± 0.01 can be maintained at all times during the test.

4.8 Hydrometer: Conforming to the requirements of ASTM E 100 and capable of measuring the liquid specific gravity to within ± 0.01.

4.9 Safety Equipment: Industrial type rubber gloves, face shield or goggles.

4.9.1 NOTE: Although there is no particular hazard from the fumes of zinc bromide solution, precautions shall be taken to avoid inhalation of fumes and contact with eyes and skin. Goggles and gloves shall be worn and the solution should only be used in a laboratory exhaust hood.

5. SAMPLE PREPARATION

5.1 Secure a field sample of the aggregate in accordance with MP 700.00.06. Samples shall be representative of the sources from which they are obtained and shall be reduced to an appropriate size by use of a sample splitter or by quartering in accordance with ASTM C 702 or AASHTO T 248.

5.2 The samples shall be dried in an oven to a constant mass at a temperature of 230±9^{o}F (110 ± 5^{o}C).

5.2.1 In the following minimum test portions, the oven-dried sample shall be weighed to the nearest one gram and that weight recorded.

Nominal Maximum Size of Aggregate (Sieve Openings)	**Minimum Weight of Test Sample (Grams)**
No. 4 (4.75 mm)	200 grams
¾ in (19.0 mm)	3,000 grams
1 ½ in (37.5 mm)	5,000 grams
3 in (75.0 mm)	10,000 grams

5.3 The fine aggregate oven dry sample shall be cooled to room temperature and sieved over a No. 50 (300 µm) sieve until less than one percent of the retained material passes through the sieve in one minute of continuous sieving. Discard the minus No. 50 (300 µm) sieve material.

5.3.1 Bring the plus No. 50 (300 µm) test portion to a saturated-surface-dry condition as specified in ASTM C 128 or AASHTO T 84. (See Note 1 and Note 2).

Note 1 - If material undergoes degradation in water, the material does not have to be brought to an SSD condition.

Note 2 - Pit derived silica sand commonly contains soft and easily degradable aggregations of sub-bituminous coal. Because of this possible degrading constituent, pit sand will not be subjected to SSD condition under this procedure.

5.4 Coarse aggregates shall be sieved over a No. 4 (4.75 mm) sieve. The plus No. 4 (4.75 mm) material shall be thoroughly washed and oven dried to a constant mass at a temperature of $230 \pm 9^{o}F$ ($110 \pm 5^{o}C$).

5.4.1 Allow oven dry sample to cool to room temperature and weigh a test portion to a minimum test size, to the nearest 1 gram and record weight.

5.4.2 Bring sample to a saturated-surface-dry condition as specified in ASTM C 128 or AASHTO T 84. (See Note 1 and Note 2).

6. PROCEDURE

6.1 Under a ventilation hood or in adequately ventilated area, check the heavy liquid (zinc bromide) for correct specific gravity (2.00 ± 0.01).

6.2 Fine Aggregate - weigh a test portion to a minimum of 200 grams to the nearest 0.1 gram and record weight. This test portion shall be placed in a 600 ml beaker and a volume of heavy liquid poured into the beaker until the liquid level is at least 1 in (25 mm) above the sample level.

6.2.1 Agitate the test portion by means of a glass-stirring rod allowing the lightweight particles to float to the surface.

6.2.2 Pour the liquid and floating lightweight particles into a second beaker, passing through a No. 50 (300 µm) skimmer, making sure that only the floating particles are poured off with the liquid.

6.2.3 Repeat procedure in 6.2.2 until test portion is free from floating particles, then drain heavy liquid from test portion back into vat. Rinse test portion with water to remove heavy liquid from sample and discard.

6.2.4 Wash the decanted particles retained on the No. 50 (300 µm) skimmer with water until all the zinc bromide is removed.

6.2.5 Dry decanted particles to a constant weight and weigh to the nearest 0.1 gram.

6.3 Coarse Aggregate - Place sample into mesh bucket and place into vat of zinc bromide solution.

6.3.1 NOTE: If test portion is sufficiently large, two or more runs may be necessary to complete testing.

6.3.2 Agitate test portion by means of a large metal stirring rod allowing the lightweight particles to float to the surface.

6.3.3 Remove floating pieces from heavy liquid by scooping with a No. 50 (300 μm) skimmer. Repeat process until test portion is free of floating particles.

6.3.4 Raise mesh bucket to drain heavy liquid from test portion into vat. Rinse test portion with water to remove heavy liquid from sample and discard.

6.3.5 Wash lightweight particles with water until all the zinc bromide is removed.

6.3.6 Dry lightweight particles to a constant weight and weigh to the nearest 1.0 gram.

6.4 Slag: Due to the manufacturing process, there is entrapped air in the aggregate. The procedure for slag is the same for any other coarse aggregate; however, a greater number of pieces will come to the surface than with other types of aggregates. The floating particles must be friable before they are considered as deleterious.

7. CALCULATION

7.1 Calculate the percentage of lightweight particles as follows: Fine Aggregates

$$L = \frac{W1}{W2} \times 100$$

Coarse Aggregates L =

$$\frac{W1}{W3} \times 100$$

Where:

L = Percentage of lightweight particles
W1 = Dry weight of lightweight particles
W2 = Dry weight of fine aggregate test portion
W3 = Dry weight of coarse aggregate test portion

7.2 Report results to nearest 0.1 percent.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 702.01.20 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF TEST FOR DETERMINING MORTAR STRENGTH

1. PURPOSE

1.1 To provide a method of testing to determine the effects of organic impurities in fine aggregate on mortar strength.

2. SCOPE

2.1 This procedure is applicable to fine aggregate to be used in concrete that has been tested and deemed darker than the standard in accordance to the guidelines established in AASHTO T21 and Section 702.1.4 of the West Virginia Standard Specifications.

3. APPLICABLE PROCEDURES

3.1 AASHTO T21

3.2 AASHTO T84

3.3 ASTM C109

3.4 ASTM C230

3.5 ASTM C305

3.6 ASTM C511

3.7 ASTM C778

4. APPARATUS

4.1 Nonabsorbent pan of sufficient size to hold and manipulate the sample.

4.2 Drying device with variable temperature control capable of producing a flowing stream of warm air.

4.3 Cone and tamping rod conforming to the requirements of Section 6.2.1 of AASHTO T84.

4.4 Balance having a capacity 5000 grams and sensitive to the nearest 0.1 gram.

4.5 A variable speed planetary and revolving motion mixer with paddle blades conforming to the requirements of ASTM C305.

4.6 Flow Table, conical mold, and calipers conforming to the requirements of ASTM C230.

4.7 Specimen molds and tamper conforming to requirements ASTM C109.

4.8 Moisture cabinet conforming to the requirements of C511.

4.9 Compression apparatus capable of at least a 20,000-pound load.

4.10 Nonabsorbent containers for holding excess fine aggregate and cement.

4.11 Distilled water.

5. PROCEDURE

5.1 Approximately 5000 grams is obtained from field sample.

5.2 Dry sample to SSD condition, remove and weigh out a portion to be used in the test. This is an estimate of the amount needed to bring the mix to the right consistency. Weigh out additional sand to be added if needed. Place each in an airtight container. Cover remaining sample with a damp cloth.

5.3 Pre-measure 360 ml of distilled water into a total drain (TD) beaker. Add the

5.4 360 ml of distilled water into the mixing bowl and let beaker drain for 30 seconds.

5.5 Add 600 grams of Type III cement to water in mixing bowl. Start mixer and mix at slow speed (140 +/- 10 r/min) for 30 seconds.

5.6 Slowly add the fine aggregate over the next 30 seconds while continuing mixing at slow speed.

5.7 Switch mixer to medium speed (285 +/- 10 r/min) and mix for 30 seconds.

5.8 Stop mixer and let stand for 90 seconds. During the first 15 seconds quickly scrape the material collected to the side of the bowl into the batch. Cover the bowl.

5.9 Remove the cover and mix for 60 seconds at medium speed. If the mix appears too wet, add additional fine aggregate during the first 30 seconds. At the end of 60 seconds stop mixer and remove bowl.

5.10 Perform flow test on the mixture in accordance with ASTM C109 with the exception that the table will be dropped 10 times to achieve desired flow of 100 +/- 5 mm.

5.11 If the flow is less than the target tolerance, the sample will be discarded and the test started over.

5.12 If the flow is greater than the desired target, place the sample back into the bowl and place the bowl in the mixer, add additional sand as needed, then remix for 30 seconds.

5.13 Check flow as described in 5.9. If the flow is within the target tolerance a set of compressive strength cubes will be made in accordance with ASTM C109. The cubes will be tested for compressive strength at three days.

5.14 A control sample will be prepared of Ottawa sand. Compressive strength cubes will be made in accordance with ASTM C109 with the exception that the sand will not be taken to SSD. New control shall be performed with each shipment of cement.

6. CALCULATION

6.1 The average of the compressive strength breaks of the control samples will be divided into the average of the breaks of the fine aggregate being tested.

$(\bar{X}_t / \bar{X}_c) =$ relative compressive strength of test sample.

where: $\bar{X}_c =$ average test results of control sample.

$\bar{X}_t =$ average test results of test sample.

7. REPORTING

7.1 The results will be reported out to the nearest 0.1

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 702.01.25 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SOURCE CONTROL OF AGGREGATES

1. PURPOSE

1.1 To assure continued quality of aggregates from Division-approved sources.

2. PROCEDURE

2.1 Division inspectors are urged to be alert at all times to the possibility that a commercial aggregate supplier may, through haste, lack of planning, negligence, etc., ship non-specification material to Division projects.

2.2 Under present quality assurance procedures, a quality check of all commercial sources supplying aggregates to the Division is conducted periodically. This check indicates the potential of a source to produce specification materials. Thus, when the material from a particular source is approved, it is with the understanding that the supplier will continue to utilize the potential of his source. It is the obligation of the supplier to see that this potential is being developed. However, due to carelessness and other unforeseen events, the quality of a particular material may be subject to change.

2.3 Field personnel who are responsible for quality assurance, therefore, should be observant of the general appearance of material supplied to their particular projects. If the quality of the material being supplied to their particular projects. If the quality of the material should not be used until the quality is verified. If a situation occurs which cannot be resolved by the district personnel, the Materials Control, Soils and Testing Division should be requested to conduct an investigation. After the investigation is completed a materials report will be issued making any necessary recommendations to the Construct Division and the supplier. In the event the investigation reveals that material currently being produced at a commercial source is not of sound quality, the source will be removed from the list of approved sources until action is taken by the producer to ensure that material produced for Division projects is of specification quality.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF DETERMINING EXPANSION PRESSURE OF COMPACTED AGGREGATE SPECIMENS

1. PURPOSE

1.1 To set forth a method of test for determining the amount of expansion pressure (KPa) exerted by compacted aggregate.

2. SCOPE

2.1 This method of test is applicable when compacted aggregate is planned for use where expansion could be detrimental.

3. EQUIPMENT

3.1 A manually or mechanically operated rammer with compatible 102 mm molds and collar assemblies as described in AASHTO T 99.

3.2 An expansion pressure device with accessories, including a perforated bronze disc, and deflection gauge as described in AASHTO T 190.

3.3 Drying Oven, capable of maintaining 110° ± 5°C.

3.4 U.S. Standard 19.0 mm.

3.5 Humidity Oven, capable of maintaining 60°C at 95% humidity.

4. TEST PROCEDURE

4.1 Dry the sample aggregate at 110° ± 5°C to a constant weight.

4.2 Sieve the oven dried material over a 19.0 mm sieve, discarding all material retained on the 19.0 mm sieve.

4.3 Determine optimum moisture and maximum density.

4.4 Add sufficient water to the test sample of 1200 grams to 1500 grams, to bring it to optimum moisture.

4.5 Compact the sample in three layers in a standard 4 inch compaction mold to approximately half full by 25 uniformly distributed blows per layer from the rammer described in AASHTO T 99.

4.5.1 If difficulty is encountered in sufficiently compacting the material to remain in the mold unaided, a thin piece of rubber may be cut so as to fit the bottom of the mold which can be held in place with a seal of Vaseline.

4.6 Insert the perforated bronze disc on top of the compacted material.

4.7 Place the mold, housing the compacted material and perforated plate into a calibrated expansion device. By rotating the turntable on which the mold rests, elevate the specimen until the stem on the base plate contacts the spring steel bar on the expansion device and causes deflection on the deflection gauge of 0.025 inch on the negative side of the zero.

4.8 After carefully placing the expansion device, mold, plate, and specimen in a humidity oven calibrated at 60°C and 95% humidity, complete the zeroing process by inserting the allen wrench in the adjustable gauge plug (located on the top of the device) and turning it until the gauge readszero.

4.9 Obtain at least daily readings from the deflection gauge and record through a minimum of 300 hours of continuous testing.

5. CALCULATIONS

5.1 To convert the deflection gauge reading to KPa, multiply the gauge reading by 2618 which is the deflection coefficient as derived from the Soils Manual for Design of Asphalt Pavement Structures published by the Asphalt Institute.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 703.00.28 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

METHOD OF PREPARATION AND EVALUATION OF AGGREGATE FOR SOAK TEST

1. PURPOSE

1.1 Various rock types may react differently to the presence of interstitial water. Material that is above the phreatic zone in the crust may undergo physical changes when subjected to a saturated environment and, if used in portland cement concrete, these changes might be injurious to the strength of the concrete. This test is strictly qualitative, in that only physical and megascopic changes are noted. Since test results are descriptive, no decision on the acceptability of the material can be made without corroborating qualitative test results. This test gives an indication of what happens to the aggregate in a saturated environment and what may happen to the aggregate when mixed in portland cement concrete.

NOTE: Portland cement concrete does not represent a saturated environment but since water is used in the mixing process, the external surface may become saturated and physical changes may take place. Such changes as increased friability may occur and, subsequently, this could change the percent of fines in the mix and the gradation of the aggregate, both of which could affect the strength of the concrete.

2. SCOPE

2.1 This method of preparation and evaluation is applicable to all material to be used for coarse aggregate in portland cement concrete. The test is usually performed on limestone and sandstone samples since these types are usually above the phreatic zone when quarried or mined. River gravel is excluded because it is usually found in a saturated environment; (either in a river, (as in dredging operations) or very near a river a river, (as in a pit operation)). The test is applied when required by the governing specifications and is a standard quarry investigation test.

3. EQUIPMENT

3.1 Containers - Pans or buckets large enough to accommodate the aggregate, which will be filled withwater.

4. SAMPLES

4.1 Washed and oven dried samples are received from the Preparation Laboratory when the soak test is required for crusher run aggregate. For quarry investigations, samples of ledge rock (rock barrow) taken at the quarry site at the time of the investigation are used.

4.2 There is no definite sample weight to be used, but a sample of 3000-5000 grams will be sufficient for a representative sample.

5. PROCEDURE

5.1 Make a lithologic description of the material including such things as color, hardness, toughness, friability, presence of fracture and bedding planes, presence of inclusion or clastic material, etc. After the description, place the material in the bucket and fill with water until the water level is about 2 inches above the aggregate. Set aside and let soak for 24 hours.

5.2 After the soaking period is finished, drain the water and note any changes in the physical character of the material as described in Section 5.1.

6. EVALUATION

6.1 Results of the test are to be reported on the appropriate Division form. No conclusion about the applicability or non-applicability should be made. For quarry investigation the test results should be put in quarry investigation file for later incorporation into the final report. This result, along with other quality test results will be used in making recommendations for the applicability of the material for highway use.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 703.00.30 Steward – Aggregate & Soils Section
RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

QUALITY CONTROL OF STEEL SIGN POSTS CHANNEL BAR TYPE

1. PURPOSE

1.1 To describe the sampling, inspection, testing and acceptance procedures to be followed in assuring the quality of steel channel bar type posts for signs and delineators.

1.2 To establish two basic designations for suppliers, certified andnon-certified.

2. SCOPE

2.1 Set forth the requirements for classification as a certified supplier and the method for handling material from a non-certified supplier.

3. PROCEDURE

3.1 In order to be classified as a certified manufacturer, the manufacturer must have supplied channel bar type posts used on Division projects for a period of time. An evaluation of test data of previously supplied material, from this manufacturer, must indicate substantial compliance with specification requirements.

3.1.1 The manufacturer must submit a notarized certification that his material meets the specification of the West Virginia Division of Highways for Channel Bar Supports. The galvanizer must submit a notarized certification that galvanizing meets the requirements of ASTM A123. Certifications must be signed by a responsible officer of the company and submitted to Materials Control, Soils and Testing Division, or their authorized representative.

3.2 Samples of each weight of post must be obtained by the Division personnel, at least once per year; samples to be taken after galvanizing.

3.2.1 Results of laboratory testing of these samples, certification of manufacturers and galvanizer, shall all be given the same laboratory number for identification purposes.

3.3 In case of an intermediate supplier, his certification of the source of his supply must be added to the results and certifications as set forth in paragraph 3.2.1, above.

3.3.1 Each source, whether manufacturer or intermediate supplier, must be assigned an individual laboratory number.

3.4 Certified manufacturers or suppliers may ship channel bar type posts to Division projects without Division inspection and without being tagged for shipment.

3.5 At least once a year, or as often as there are additions or deletions; the MCS&T Division will prepare and distribute to each District, a list of certified manufacturers and suppliers. This list shall include the laboratory number to be used to identify the documentation for each source listed.

3.5.1 Upon receipt at the project of channel bar posts from a certified source, the project supervisor shall record the following on form HL-440:

1. Material - Channel Bar Posts
2. Quantity - For each length
3. Certified source -
4. Laboratory Number - (From approved list covering the time period during which posts received).
5. Thickness of Zinc Coating - Average of random sampling using elecometer or similar instrument, where available.

3.6 Provided that the channel bar posts are shipped from a certified source, the information given in accordance with paragraph 3.5.1 shall constitute coverage for these items

4. NON-CERTIFIED MANUFACTURER OR SUPPLIER

4.1 Manufacturers of suppliers who do not meet the criteria for certification may supply Channel Bar Posts under the following procedures.

4.1.1 Presampling - Pretesting at source or intermediate points.

4.1.2 Presampling procedures set forth in MP 700.00.01 may be used. In this event the supplier will be notified when tests are completed on the presampled and CS (White) tagged material. If the test results comply with specifications; the manufacturer/supplier may then ship the CS (White) tagged material. The manufacturer/supplier shall enter the CS (White) tag numbers as well as the master number on the bill of lading and forward one copy of same to the Materials Control, Soils and Testing Division.

4.1.3 Other applicable procedures may be used as specified by the Division.

4.2 Coverage for Posts from Non-Certified Sources.

4.2.1 The district shall initiate forms T-702 and HS-30 in requesting coverage, listing CS (White) tag numbers, master laboratory report number and all usual pertinent information.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 707.02.13 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

ACCEPTANCE CRITERIA FOR EPOXY COATED REINFORCING STEEL

---

1. SCOPE

1.1 To establish a procedure to qualify approved and non-approved coating manufactures of epoxy coated reinforcement steel bars for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

1.3 To establish a procedure for transmitting such information to the districts and to contractors of WVDOH projects.

1.4 This procedure shall apply to epoxy coated steel furnished to West Virginia Division of Highways (WVDOH) projects and purchase orders. The Division may elect to use other control procedures when special conditions dictate.

---

2. APPLICABLE DOCUMENTS

2.1 AASHTO M31 Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement, most recent edition.

2.2 ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars, most recent edition.

2.3 AASHTO MP18 Standard Specifications for Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowel, most recent edition.

---

3. ACCEPTANCE PROCEDURE

3.1 With each shipment, the coating manufacture shall provide shipping documents which contain either the coating manufacture's "Approved Source" number or the approval number that was assigned to the material as per Section 6.

---

4. ACCEPTANCE PROCEDURE FOR APPROVED SOURCE

4.1 For a manufacture to be considered as a source of epoxy coated reinforcing steel bars, the manufacture must submit a certification statement indicating their intention to be included on the WVDOH approved source list as an approved source of epoxy coated reinforcing steel.

4.2 The prospective source shall submit a certified statement that all material shipped to Division projects will conform to WVDOH specifications. This certified statement shall be signed by a representative of the coating manufacture who has the authority to bind the company.

4.3 The prospective source shall have an acceptable historical record of compliance with WVDOH Specifications.

4.4 All plain steel reinforcement to be coated shall be selected from an approved source list of plain reinforcement steel maintained by the WVDOH

4.5 All epoxy powders used shall be selected from an approved source list of epoxy powders maintained by the WVDOH.

4.6 A copy of the coating manufacture's Concrete Reinforcing Steel Institute (CRSI) certificate must be submitted indicating conformance to CRSI specifications.

4.7 Samples of epoxy coated reinforcement steel shall be obtained by WVDOH department authorized personnel and shall have the epoxy component tested to ASTM A775 in WVDOH laboratories, unless other methods of verification such as material certifications are used should unforeseen circumstances arise.

4.8 An inspection of the coating facility may be conducted at any time to reinforce confidence in the ability of the facility to produce a quality product.

4.9 Once the above requirements are met, a laboratory approval number will be assigned to the coating facility to indicate WVDOH requirement conformance. This approval number shall be active for up to two years. Acceptance of a coaters facility can be verified by accessing the WVDOH online approved source lists.

4.10 Revocation of approved source status may result from revocation or expiration of CRSI Certification or furnishing material that does not comply with Specifications.

5. ACCEPTANCE PROCEDURE FOR NON APPROVED SOURCE

5.1 Epoxy coated steel bars that have been coated by a non- approved coating manufacture shall require evaluation on a lot by lot basis under direct coverage provided the material meets the following requirements.

5.2 A copy of the coating manufacture's CRSI certificate must be submitted indicating current conformance to CRSI specifications.

5.3 Samples of epoxy coated reinforcement steel shall be obtained by WVDOH department authorized personnel to be tested in WVDOH laboratories, unless other methods of verification such as material certifications are used.

5.4 The metallic component of epoxy coated steel bars shall be tested to conform to the requirements of AASHTO M31 or AASHTO MP18.

5.5 The epoxy component of epoxy coated steel bars shall be tested to conform to the requirement s of ASTM A775.

5.6 If the results of the testing reveal that the material is in full compliance with Specifications, an approval number will be issued by the Division that shall be affixed to the shipping documents.

6. DOCUMENTATION REPORT

6.1 An updated list of approved epoxy coated reinforcing steel once a year, but no longer than two, and can be updated at any time with a new facility, or with a removal of a facility.

6.2 A current approved list of epoxy coated reinforcing steel shall be available to all contractors, fabricators, and suppliers by accessing the West Virginia Department of Transportation Approved Source.[1]

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 709.01.51 Steward – Environmental and Coatings Section
RLS:P
ATTACHMENT

[1] http://transportation.wv.gov/highways/mcst/Pages/Listings_Sorted.aspx

EPOXY COATED REINFORCING STEEL

PROJECT #:____

COATER:___________________________LOCATION:________________________________

WV COATER APPROVAL #:___________ WV STEEL APPROVAL #:_____________ EPOXY

POWDER SOURCE:__________________________EPOXY POWDER TYPE:_____________ WV

EPOXY POWDER APPROVAL #:____________________

PRODUCTION DATES: ____

==

QUANTITY OF REBAR:

SIZE:_____________POUNDS:______________FEET:____________

___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________
___________	___________	___________ TOTALS:

___________ _____________

IF SHIPPED TO FABRICATOR, NAME:____

SHIPPED BY:____________________DATE SHIPPED:_______________________________

SIGNED:____DATE:________________________

EPOXY COATED REINFORCING STEEL (METRIC)

PROJECT #:_______________________________________

COATER:___________________________LOCATION:_______________________________

WV COATER APPROVAL #:___________ WV STEEL APPROVAL #:_____________ EPOXY

POWDER SOURCE:__________________________EPOXY POWDER TYPE:_____________ WV

EPOXY POWDER APPROVAL #:____________________

PRODUCTION DATES: ____

==

QUANTITY OF REBAR:

SIZE:	KILOGRAMS:	METERS:

QUANTITY OF REBAR (CONTINUED):

SIZE:____________KILOGRAMS:__________METERS:__________

__________ __________ __________

__________ __________ __________

__________ __________ __________ TOTALS:

__________ __________

== IF

SHIPPED TO FABRICATOR, NAME:____

SHIPPED BY:____________________DATE SHIPPED:______________________________

SIGNED:____DATE:________________________

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CERTIFICATION OF FABRICATORS OF CORROSION RESISTANT COATED DOWEL BARS IN BASKET ASSEMBLY

1. PURPOSE

1.1 To establish a procedure for Certification of Fabricators of corrosion resistant coated dowel bars in basket assembly, to set forth conditions for certification and to establish inspection and procedures for certified fabricators.

2. SCOPE

2.1 This procedure shall apply to fabricators of corrosion resistant coated dowel bars in basket assembly who furnish material to projects and purchase orders.

3. SPECIFICATIONS

3.1 The coated dowel bars in basket assembly shall meet the requirements of Section 709.15 of West Virginia Division of Highways Standard Specifications for Road and Bridges as amended by the Supplemental Specifications.

4. DOCUMENTATION OF CERTIFIED COATER

4.1 The fabricator shall obtain the following information from the certified coater.

4.1.1 Source of Steel

4.1.2 WV Laboratory Number for the Steel

4.1.3 Source of Coating

4.1.4 Type of Coating

4.1.5 WV Laboratory Number for the Coating

4.1.6 Dry Film Thickness of the Coating

4.1.7 Total Number of Lineal Meters

5. WORKMANSHIP

5.1 The load transfer unit shall be made in accordance with West Virginia Division of Highways Standard Detail Sheet.

5.2 The fabricator shall inspect the coating for the following items.

5.2.1 Saw cut ends of the dowel shall be free of burrs and projections.

5.2.2 Flaws, such as perforations, cracks and holidays.

5.2.3 Damage from welding or mechanical fixation shall not extend more than 26 millimeters from the weld or point offixation.

6. DIVISION SAMPLING AND TESTING

6.1 The Division may obtain samples at the fabricator's shop and/or at the project site to ensure specifications compliance.

6.2 If for any reason a plant fails to meet the requirements as set forth above, the plant will be removed from the approved status until such time as corrective action is taken to meet the acceptance criteria.

7. DOCUMENTATION

7.1 The fabricator will submit the information contained on attachment #1 with each shipment. Two copies will be required. One copy is sent with the shipment to the project; the other is sent to the Materials Division.

7.2 Upon receipt of the coated dowel bars in basket assembly from a certified source, coverage will be obtained by entering on Form HL-440 the laboratory number for that source which is found on the list of approved suppliers.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 709.15.50 Steward – Metals Section
RLS:H
ATTACHMENT

COATED DOWEL BARS IN BASKET ASSEMBLY

PROJECT:

FABRICATOR:

LOCATION:

SOURCE OF STEEL BARS:

WV LABORATORY APPROVAL

NO. SOURCE OF STEEL WIRE:

WV LABORATORY APPROVAL

NO. COATER:

LOCATION:

SOURCE OF COATING:

WV LABORATORY APPROVAL

NUMBER: QUANTITY OF BASKET

ASSEMBLIES NO. OF LINEAL METERS

SHIPPED TO:

DATE SHIPPED:

SIGNED______________________________

DATE________________________________

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

ACCEPTANCE CRITERIA FOR STEEL WIRE REINFORCEMENT USED IN CONCRETE

1. PURPOSE

1.1 To establish a procedure to qualify approved and non-approved manufactures that produce drawn bright finish wire reinforcement for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of such information.

1.3 To establish a procedure for transmitting such information to the districts and to contractors of WVDOH projects.

2. SCOPE

2.1 This procedure shall apply to all producers who “manufacture” from a rough casted steel rod material to a drawn smooth bright finish wire product, or produce a welded wire reinforcement product “WWR” from smooth bright finish wire.

2.2 This procedure shall apply to all steel wire reinforcement for concrete furnished to West Virginia Division of Highways (WVDOH) projects and purchase orders. The Division may elect to use other control procedures when special conditions dictate.

3. APPLICABLE DOCUMENTS

3.1 *ASTM A1064*

3.2 *NTPEP Committee work plan (RS)(2016)*

3.3 *NTPEP Certificate of conformance from manufacture*

4. ACCEPTANCE PROCEDURE

4.1 With each shipment, the wire manufacture shall provide shipping documents which contain either the steel wire approved source number, or the approval number that was assigned to the material as per Section 6.1

5. ACCEPTANCE PROCEDURE

5.1 For a producer to be considered an approved source manufacture of steel reinforcement wire, either welded or non-welded, the manufacture must comply with the following requirements:

5.2 The Manufacture is to submit a written statement to the WVDOH Materials Control, Soils and Testing Division indicating intention to be included on the WVDOH approved source list as an approved source of steel wire reinforcement for concrete.

5.3 The prospective source shall produce a certificate indicating the prospective source is an active member in compliance with the National Transportation Product Evaluation Program. "NTPEP"

5.4 The prospective source shall additionally submit a certified statement that all material shipped to the Division will conform to Specification ASTM A1064 or AASHTO M32 the certified statement shall be signed by a representative of the manufacture that has the authority to bind the company.

5.5 An evaluation and sampling of material at the manufacturing facility be conducted by department personnel or by its designee for conformance to ASTM A1064 to reinforce confidence in the ability of the facility to produce a quality product within WVDOH specifications. Five samples shall be tested of different sizes or lots shall be tested in department laboratories to confirm compliance.

5.6 Once the above requirements are met, a laboratory approval number will be assigned to the manufacture to indicate WVDOH requirement conformance, this approval number shall be active for one year. Acceptance of a manufactures facility can be verified by accessing the WVDOH online approved source list.

5.7 Revocation of approved source status may result from non-conformance to NTPEP or tested material that does not comply with the specifications listed above.

5.8 "Approved Source" approval may be reinstated at the discretion of the Materials Control, Soils and Testing Division based on the findings of an investigation. The reinstatement process will commence upon the receipt of a letter of request from the manufacturer to the Materials Control, Soils and Testing Division. The letter of request should indicate reasons for reinstatement, and documentation to substantiate such reasons.

6. ACCEPTANCE PROCEDURES (NON-APPROVED SOURCE)

6.1 Steel wire used for concrete reinforcement will require testing and evaluation on a lot-by- lot basis by direct coverage provided the material meets the following requirements:

6.2 The wire source shall produce a certificate indicating the manufacturing source of basic bright finish wire is an active member in compliance with the National Transportation Product Evaluation Program. "NTPEP

6.3 An five foot length of basic bright finish steel reinforcement representative of the concrete structure to be used shall be obtained by WVDOH department personnel to be tested in WVDOH laboratories.

6.4 The metallic components of the wire shall be tested to conform to the requirements of ASTM A1064 for yield, tensile, and reduction.

6.5 If the results of the testing reveal that the material is in compliance with Specifications, an approval number will be issued by the Division that shall be affixed to the shipping documents of the basic bright finish steel reinforcement.

7. DOCUMENTATION REPORT

7.1 An updated list of steel wire reinforcement for concrete shall be conducted once a year, but no longer than two, and can be updated at any time with a new facility, or with a removal of a facility.

7.2 A current approved list of steel wire reinforcement is available to all contractors, fabricators, and suppliers by accessing the West Virginia Department of Transportation approved source list website.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 710.01.40 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PAINT TESTING METHODS

1. PURPOSE

1.1 To set forth the standard test methods to be used in analyzing paint.

2. SCOPE

2.1 This procedure replaces the following Material Procedures.

2.1.1 MP 708.00.20 through 708.00.27

2.1.2 MP 708.01.20 through 708.01.29

2.1.3 MP 708.02.20 through 708.02.29

2.1.4 MP 708.03.20 through 708.03.29

3. REFERENCES

3.1 American Society for Testing and Materials (ASTM INTERNATIONAL) Section 6, Paint.

3.2 Federal Test Method Standard Number 141B.

4. TESTING METHODS

4.1 Table I contains the following information:

4.1.1 Test

4.1.2 Reference

4.1.3 Test Method Number

5. GENERAL INFORMATION

5.1 Adhesion

(Film thickness greater than 5 mils (125 µm) 3.1 D3359 (METHOD A)

(Film thickness 5 mils (125 µm) or less) 3.2 D3359 (METHOD B)

5.2 Test Panel Preparation

5.2.1 Panels for testing shall meet the requirements Federal Test Method 2011.

5.2.2 Panels that receive hot-dip galvanizing should be blast clean to near white finish (SSPC-SP- 10) and galvanized in accordance with the AASHTO M-111. Average galvanized coating thickness should be 1.8 Mils.

5.2.3 Coating applied over galvanizing will be done in accordance with the manufacturer's product data sheets. If the data sheet does not show how to apply the coating over galvanizing, then the manufacturer shall furnish this information in writing. Failure to provide this information could result in incorrect preparation of the galvanized surface, thus resulting in failure of the paint system.

5.2.4 All coatings shall be applied at the normal field application thickness. Primers will be applied over panels that have been cleaned to a near white (SSPC-SP-10) condition. All coatings, which are part of a coating system, shall be applied over the previous coating in the system.

5.3 Curing Conditions

5.3.1 All coatings except zinc primers shall be cured seven days prior to testing. The curing will be done in the laboratory under normal laboratory conditions of temperature and humidity.

5.3.2 Zinc primers shall be cured, as in 5.3.1 except the cure period will be 10 days. All coatings, which require chemical resistance testing, will be cured an extra 24 hours at 221- 230° F (105-110 C).

5.4 Chemical analyses of pigments shall be conducted by ASTM test methods. In cases where no ASTM test method is available, Federal test methods or a mutually agreed to procedure shall be used.

5.5 Any test method not included in Table I shall be conducted according to ASTM, Federal Test or mutually agreed to procedures.

5.6 Initial approval of a paint requires that all specified tests be conducted. Subsequent batches, at the Division's option, may have randomly selected tests conducted.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 711.00.20 Steward – Environmental and Coatings Section
RLS:P
ATTACHMENT

Table 1

		Reference	Test Methods
1.	Density (Weight/Gallon)	3.1	D1475
2.	Consistency (Viscosity)	3.1	D562
3.	Drying Time	3.1	D1640
4.	Drying (Traffic Paint-No Pick Up)	3.1	D711
5.	Pigment - Vehicle	3.2	4021
6.	Total Solids	3.1	D2369
7.	Nonvolatile Vehicle	3.2	4051
8.	Coarse Particles	3.1	D185
9.	Fineness of Grind	3.1	D1210
10.	Flexibility	3.2	6221
11.	Condition in Container	3.2	3011
12.	Water	3.2	4081
13.	Color	3.1	D2244
14.	Working Properties	3.2	4541, 4321,4331
15.	Compatibility	3.2	4203
16.	Storage Stability	3.1	D1849
17.	Specular Gloss (60°)	3.1	D523
18.	Skinning	3.2	3021
19.	Chemical Resistant (Spot Test)	3.1	D1308
20.	Infrared Scan	3.1	D2621
21.	Salt Spray	3.1	B117
22.	Accelerated Weathering	3.1	G53
23.	Leafing	3.1	D480
24.	Adhesion Section	5.1	This MP
25.	Chemical Analysis of Pigments	3.1	This MP
26.	Sampling	3.1	D3925

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR APPROVING PAINT FORMULATIONS AND PRODUCTION BATCHES

1. PURPOSE

1.1 To establish a procedure for approving paint formulations and to set forth procedures for sampling, testing, and shipping of batches once the formulation is approved.

2. SCOPE

2.1 This procedure shall apply to manufacturers who furnish paint to the Division.

3. APPLICABLE DOCUMENTS

3.1 *WVDOH/DOH Standard Specifications for Roads & Bridges*

3.2 *MP 711.00.20 - Paint Testing Methods*

3.3 *MP 711.20.59 - Inorganic Zinc Primer Quality Assurance Procedures*

3.4 *MP 711.20.60 - Intermediate Field Coat for Zinc Rich Systems*

3.5 *MP 711.22.22 - Inorganic Zinc Rich Low VOC System*

3.6 *ASTM D3925 - Sampling Liquid Paints and Related Pigment Coatings*

4. FORMULATION QUALIFICATION

4.1 The manufacturer shall have test equipment and qualified personnel necessary to test the material for compliance with the specifications.

4.2 The manufacturer shall submit the Division of Highways a one-liter sample of each formulation. The sample should be sent to:

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
190 DRY BRANCH DRIVE
CHARLESTON, WEST VIRGINIA 25306

4.2.1 Accompanying the sample shall be one liter of thinner for each product, along with product data sheets and material safety data sheets for each.

4.2.2 The appropriate specification number should be identified for each material submitted.

4.2.3 The color of topcoat shall be one of those specified in Subsection 711.20.4. Each color or shade of topcoat shall constitute a separate formulation.

4.3 The formulation will be tested in accordance with Section 711 by the Division of Highways laboratory. The Division will notify the manufacturer of the results.

5. BATCH APPROVAL

5.1 Unless otherwise specified, paints will be tested and approved on a batch-to-batch basis. Each batch that meets the specification requirements will receive an individual approval number.

5.2 Sampling shall be conducted in accordance with ASTM D3925. Tests shall be conducted in accordance with Materials Procedure 711.00.20. It is the paint manufacturer's obligation to notify the Division when a batch will be ready for sampling.

5.2.1 Process control tests such as weight per gallon, viscosity, and grind are to be witnessed by the Division's representative prior to shipment of samples to the Division of Highways' laboratory. Failure of any of these tests will result in the batch being rejected at the manufacturer's facility. The batch will then have to be reworked and assigned a revised batch number prior to sampling.

5.2.2 Two one-liter samples of each batch will be obtained by the Division's representative. One is to be retained by the sampler at a location away from the manufacturing facility. The other is to be submitted by the representative to the address in Section 4.2 of this Materials Procedure.

5.2.3 The retained sample may be disposed of once the approval has been obtained on the batch. Disposal is to be in accordance with the local Environmental Protection Agency's policies.

6. APPROVAL OF SMALL QUANTITIES

6.1 When the quantity of material is 200 liters or less, the Division may elect to accept the material based on certified test data from the manufacturer or passing test results from the WVDOH laboratory. No preliminary tests are required.

7. PROCEDURES FOR SHIPPING

7.1 The manufacturer shall include the following information on each shipping document: name and location of the company, type of material, quantity, date shipped, approval number issued by MCS&T Division, batch number, and date ofmanufacture.

7.2 A copy of the shipping document shall be submitted to the Division of Highways at the address shown in Subsection 4.2 of this Materials Procedure.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 711.00.21 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

INORGANIC ZINC PRIMER QUALITY ASSURANCE PROCEDURES

1. PURPOSE

1.1 To establish a procedure for certifying inorganic zinc paint suppliers and to set forth sampling, testing, and shipping procedures for certified and non- certified suppliers.

2. SCOPE

2.1 This procedure shall apply to all suppliers of inorganic zinc paint. Both certified and non-certified sources shall follow the sampling, testing, documentation, and shipping instructions of this materials procedure.

3. APPLICABLE DOCUMENTS

3.1 *MP 711.00.20 - Paint Testing Methods*

3.2 *ASTM D3925 - Sampling Liquid Paints and Related Pigment Coatings*

3.3 *AASHTO M300 - Standard Specification for Inorganic Zinc Rich Primer*

4. PROCEDURE

4.1 Initial Requirements for Certification

4.1.1 The supplier shall submit a written request for certification stating that all material shipped to the Division will conform to specifications. This request is to be signed by an authorized representative of the company.

4.1.2 A Quality Control Program adequate to ensure that the material complies with specifications.

4.1.3 Test equipment and qualified personnel necessary to test the material for compliance with specifications. The laboratory may be at a location other than the place of manufacture. The laboratory shall be approved by the Division.

4.1.4 A satisfactory record of compliance with the specifications.

4.1.5 Once the requirements for certification have been met, the Division will notify the supplier. Shipments may then be made using the procedure given in Paragraph 6.1.

5. SAMPLING AND TESTING

5.1 The sampling and testing is divided into two phases as follows:

5.1.1 Phase One consists of the suppliers Quality Control testing and the Division's optional monitor sample tests.

5.2 Phase One Sampling and Testing: Sampling shall be conducted in accordance with ASTM D3925. Testing shall be conducted by the test methods required by AASHTO M300. When the test method is not mentioned in AASHTO M300, the test shall be conducted by the methods in MP 711.00.20.

5.2.1 The supplier shall test material which is produced to meet the AASHTO M300 specification. All tests required by the M300 specification shall be conducted and the test data shall be sent to the Division. Work sheets and panels shall be maintained for 1 year and be available to the Division's representative upon request.

5.2.2 The supplier shall submit to the Division on a semi-annual basis, test results on a batch of previously qualified product (approved code number).

5.2.3 At the Division's option, monitor samples will be tested at periodic intervals for specification compliance. Actual sampling frequency will vary in accordance with such factors as the past history of the material.

5.3 Phase Two Sampling and Testing: Shall consist of field samples and independent assurance samples. The samples shall be tested by the Division for all requirements of the governing specifications.

6. PROCEDURES FOR SHIPPING

6.1 Certified Source

6.1.1 The supplier shall include the following information on the shipping invoice: Name and location of company, type of material, quantity, date shipped, suppliers certification number, batch code number, date of manufacture, and a statement that the material meets AASHTO M300 Specifications.

6.2 Non-Certified Source

6.2.1 Each batch or LOT shall be sampled and tested. The quantity represented by the sample shall be the quantity in the vat at the time of sampling, or if the material is stored in drums or pails, the quantity of the particular batch on hand at time of sampling.

6.2.2 Tests shall be conducted by a Division approved laboratory. The Division may elect to use the supplier's test results, in combination with their own test results.

6.2.3 If the sample meets specifications, shipments may be made until the entire batch or LOT has been shipped. Notification of shipment is to be made by phone to the Materials Control, Soils and Testing Division prior to shipment.

6.2.4 Material which has been tested and does not meet specifications may not be shipped until it has been reworked, retested, and meets specifications.

6.3 Documentation Required of Non-Certified Suppliers

6.3.1 Shipments will be made in accordance with 6.1.1 of this procedure except that the following additional information will be required on the shipping documents: Batch number and date sampled. If the material has been tested and meets specifications, the invoice shall list the Division's laboratory number assigned to that sample.

7. CERTIFICATION COMPLIANCE

7.1 Samples taken in accordance with Section 5.3, which fail to meet specifications, shall be reviewed by this Division to determine the cause of failure. This investigation shall include a review of the supplier’s test records.

7.2 Two consecutive failing samples shall be cause to remove the supplier from the certified list. The supplier shall show proof by actual test data that the cause of failure has been found prior to recertification.

7.3 During the decertification period, the supplier may have his material sampled and tested on a batch-by-batch basis in accordance with Section 6.2.

7.4 When the quantity of material is 189 Liters or less, the Division may elect to accept the material based on certified test data from the supplier or passing test results from a Division approved laboratory.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 711.20.59 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

INTERMEDIATE FIELD COAT FOR ZINC RICH SYSTEMS

1. PURPOSE

1.1 To establish a procedure for certifying intermediate field coat products and to set forth procedures for sampling, testing, and shipping said products.

2. SCOPE

2.1 This procedure shall apply to all manufacturers of intermediate field coats for Zinc Rich Systems.

3. APPLICABLE DOCUMENTS

3.1 *MP 711.00.20 - Paint Testing Methods*

3.2 *ASTM D 3925 - Sampling Liquid Paints and Related Pigment Coatings*

4. PROCEDURE

4.1 Initial Requirements for Certification

4.1.1 The manufacturer shall have test equipment and qualified personnel necessary to test the material for compliance with the specifications.

4.1.2 The manufacturer shall submit to the Division of Highways a one liter sample of intermediate coat along with one liter of top coat meeting the requirements of 711.20.4. The color of the top coat shall be one of those specified in Subsection 711.20.4. The samples should be sent to:

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION
190 DRY BRANCH DRIVE
CHARLESTON, WEST VIRGINIA 25306

4.1.3 The intermediate field coat shall meet the manufacturer's specifications and shall be compatible with the primer (Subsection 711.6.2 or 711.20.2) and the top coat (711.20.4).

4.1.3.1 Accompanying the sample shall be one liter of thinner for each product, along with product data sheets and material safety data sheets for each.

4.1.3.2 Each color or shade of top coat shall constitute a separate formulation.

4.1.4 Testing of the paint system shall be performed by the Division prior to certification. The Division will notify the manufacturer of the results of testing. If the results are satisfactory, an individual approval number will be assigned for each intermediate coat. If the results are not satisfactory, no certification will be issued.

5. SAMPLING AND TESTING

5.1 Monitor samples will be tested by the Division at periodic intervals for specification compliance. Sampling frequency will be dependent upon the historical compliance of the material with the specifications.

5.2 Sampling shall be conducted in accordance with ASTM D 3925. Tests shall be conducted in accordance with MP 711.00.20.

6. PROCEDURES FOR SHIPPING

6.1 The manufacturer shall include the following information on each shipping document: name and location of the company, type of material, quantity, date shipped, current product certification number issued by MCS&T, batch number, and date of manufacture.

6.2 A copy of the shipping document shall be submitted to the Division of Highways at the address shown in Subsection 4.1.2 of this Materials Procedure.

7. CERTIFICATION COMPLIANCE

7.1 Samples taken in accordance with Section 5. which fail to meet specifications shall be reviewed by this Division to determine the cause of failure. This investigation shall include a review of the manufacturers test records. If this review is positive, then another sample will be tested. If this sample passes, no change in the certification will be necessary.

7.2 Two consecutive failing samples shall be cause to remove the product from the certified list. The manufacturer shall show proof by actual test data that the cause of failure has been found prior to recertification.

7.3 During the decertification period, the manufacturer may have his material sampled and tested on a batch-by-batch basis in accordance with the requirements of Section 5.2.

7.4 When the quantity of material is 200 liters or less, the Division may elect to accept the material based on certified test data from the manufacturer or passing test results from the DOH laboratory.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 711.20.60 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

ZINC RICH LOW VOC SYSTEM

1. PURPOSE

1.1 To establish a procedure for approval of zinc rich low VOC systems, and to set forth procedures for sampling, testing, and shipping said products.

2. SCOPE

2.1 This procedure shall apply to all manufacturers who furnish zinc rich low VOC systems to the Division.

3. APPLICABLE DOCUMENTS

3.1 WVDOT/DOH Standard Specifications for Roads and Bridges.

3.2 MP 711.00.20 - Paint Testing Methods

3.3 ASTM D3925 - Sampling Liquid Paints and Related Pigment Coatings

4. PREREQUISITES FOR CERTIFICATION

4.1 The manufacturer shall submit to the Division of Highways:

4.1.1 A one quart (one liter) sample of primer, formulated to meet the requirements of sub-section 711.22.2 of the Standard Specifications for Roads and Bridges.

4.1.2 A one quart (one liter) sample of intermediate coat (if part of the system), formulated to meet the requirements of sub-section 711.22.3 of the Standard specifications for Roads and Bridges.

4.1.3 A one quart (one liter) sample of top coat, formulated to meet the requirements of sub-section 711.22.4. The color of the topcoat shall be one of those specified in sub-section 711.20.4 of the Standard Specifications for Roads and Bridges.

4.1.4 The samples should be sent to:

West Virginia Division of Highways
Materials Control, Soils and Testing Division
190 Dry Branch Drive
Charleston, WV 25306

4.1.5 A one quart(one liter) container of thinner should accompany the sample for each product, along with product data sheets and material safety data sheets for each.

4.1.6 Each color or shade of topcoat shall constitute a separate formulation for sampling.

4.2 Testing of the paint system shall be performed in the Division of Highways laboratory. The Division will provide the manufacturer the results of the testing. If the results are satisfactory, an individual approval number will be assigned for each low VOC system.

5. SAMPLING AND TESTING

5.1 The Division will take samples of the components of each approved system at periodic intervals and tested for specification compliance. Sampling frequency will be dependent upon the historical compliance of the material with the specifications. The minimum frequency will be every two years.

5.1.1 Sampling shall be conducted in accordance with ASTM D3925.

5.1.2 The Division reserves the right of pull monitor samples from the job site for testing to verify conformance with the specification requirements.

5.2 Tests shall be conducted in accordance with Materials Procedure 711.00.20.

5.2.1 If the test data indicates that the material does not meet the requirements, an investigation shall be conducted to determine the cause of failure of the samples. This investigation shall include, but not be limited to, a review of the manufacturer's quality control test records and may involve re-testing by the Division.

5.2.2 Two consecutive failing samples tested by the Division shall be cause to remove the system from the certified list. Before a system can be considered for re-approval, the manufacturer shall provide data, which demonstrates that the cause of failure has been found and corrected.

5.3 The manufacturer may have material sampled by the Division and tested on a batch-by-batch basis in accordance with the requirements of Section 5.2.

5.4 When the quantity of material is 50 gallons (200 liters) or less, the Division may elect to accept the material based on certified test data from the manufacturer.

6. PROCEDURES FOR SHIPPING

6.1 The manufacturer shall include the following information on each shipping document: name and location of the company, type of material, quantity, date shipped, current product or batch approval number (issued by Division), batch number, and date of manufacture.

6.2 The shipping document shall accompany the system to its final destination and a copy of the shipping document shall be submitted to the Division of Highways at the address shown in sub-section 4.1.4 of this Materials Procedure.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 711.22.22 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

QUALITY ASSURANCE OF GUARDRAIL BEAMS, STEEL GUARDRAIL POSTS AND HARDWARE

1. PURPOSE

1.1 To provide the procedures for the quality assurance of guardrail beams, steel guardrail posts, and hardware.

2. SCOPE

2.1 This procedure shall apply to the guardrail classes and types as defined in Section 3 of AASHTO M180.

3. APPLICABLE SPECIFICATIONS

3.1 All items under this procedure shall meet the requirements of Section 607 of the West Virginia Division of Highways Standard Specifications for Roads and Bridges, the West Virginia Standard Detail Book Volume I, and the West Virginia Standard Bridge Plans.

4. APPLICABLE DOCUMENTS AASHTO M180

4.1 AASHTO M183

4.2 Industrial Fastener Institute Technical Report Number IFI-122

5. PROCEDURE

Fabricators who will provide guardrail beams, posts, and ancillary hardware for use on Division projects will be identified as Approved or Nonapproved Fabricators as outlined below.

5.1 Approved Fabricator

5.1.1 To be considered as an approved fabricator, the fabricator shall do the following:

5.1.2 The fabricator will file with the Division a brand registration and guarantee as stipulated in AASHTO M180.

5.1.3 The fabricator will submit to Materials Control, Soils and Testing Division a Quality Control Plan detailing how the product will be controlled. As a minimum, the plan must include the following:

1) Name of company officer responsible for quality control.
2) Tests to be completed and their minimum frequencies (see Attachment Number 1).
3) Procedure for disposition of non-specification fabrication.

5.1.4 The fabricator will engage an acceptable independent inspection agency to sample and test each component to be supplied to Division project(s). Testing and evaluation will be by applicable specification. All test data will be submitted to Materials Control, Soils and Testing Division for evaluation.

5.1.5 A fabricator who has been supplying Division project(s) will be exempt from Section 5.1.4.

5.1.6 Upon approval of the fabricator's Quality Control Plan, brand registration and independent tests, the fabricator will be assigned a laboratory number and be placed on the approved list. On at least a yearly basis thereafter, the Division or its representative will perform an inspection of the fabricator's facility. The Division inspection may consist of the following:

5.1.6.1 An in-depth review of the fabricator's quality control procedures to assure compliance with the approved Quality Control Plan.

5.1.6.2 Random samples will be selected of materials supplied by the fabricator. Samples of each item group should be as follows:

1) Guardrail Element and Backup Plates - One section at least 584 mm in length of the completed guardrail, after galvanizing from each gauge of material.

2) Guardrail Post - Two samples at least 457 mm in length will be selected, one each from two different completed posts after galvanizing.

3) Splice and Post Bolts and Nuts - Random samples of splice bolt, and post bolt (any length in stock) and nut shall be selected.

4) Standard End Sections, Buffer End Sections, Return End Sections, Terminal Connectors - Random samples of end sections manufactured or supplied by the fabricator.

5) Breakaway Cable Terminal Assembly (BCT) - One complete assembly will be selected at random to include all components fasteners and hardware.

6) Ancillary Items such as Miscellaneous Fasteners, Washers, Pipe Sleeves - Random samples will be selected from all materials the fabricator may supply. To facilitate this sampling, the fabricator will prepare a list of all ancillary hardware items which he may supply to Division projects. Selection of samples will be at the discretion of the Division's representative.

5.1.6.3 All samples will be tested by the Division to determine compliance with applicable specification requirements.

5.1.7 If the documentation of quality control data is not maintained to the satisfaction of the Division, or if inspection or tests reveal noncompliance with the specifications, the fabricator may be removed from the approved list.

5.1.8 Approval may be reinstated at the discretion of the Division, when correction of all deficiencies can be documented and the fabricator has reestablished his quality control to the satisfaction of the Division.

5.1.9 The fabricator and the Division's District Materials offices will be notified of all changes in the status of a fabricator's certification.

5.1.10 Approved fabricators will furnish a bill of material or shipping document (Section 7.0).

5.2 Nonapproved

5.2.1 A fabricator defined as nonapproved may supply guardrail items to Division projects from approved LOTS.

5.2.2 Each LOT must be inspected, tested and approved by an independent inspection agency acceptable to the Division. The inspection and testing will be paid for by the fabricator.

5.2.3 Upon completion of the independent inspection agency's inspection, a copy of the report will be submitted to Materials Control, Soils and Testing Division for evaluation.

5.2.4 If any individual piece from a LOT fails to meet the specification requirement, two additional pieces can be tested. If either of these pieces fail, the LOT will be rejected.

5.2.5 When a LOT has been tested and found to meet all specification requirements, the Division will assign the fabricator a laboratory number for the LOT approval.

5.2.6 When shipments are made from approved LOTS, the fabricator must provide documentation as outlined in Section 7.0 to the project.

6. MARKINGS

6.1 Each guardrail beam must be marked in accordance with AASHTO M180.

7. SHIPPING DOCUMENTATION (APPROVED OR NONAPPROVED)

7.1 The fabricator will furnish to the project with each shipment a bill of material or shipping document. This document must include the following information (whichever is applicable):

1) Date of shipment
2) Federal or State project or Division of Highways purchase order number
3) Fabricator's order number
4) Consignee
5) Number and length of guardrail pieces
6) Shape (W-beam or Other Beam)
7) Class of guardrail

8) Gauge of material
9) Heat number
10) Type of guardrail
11) Quantity and heat number of steel posts
12) Number and type of end sections
13) Quantity of breakaway terminal assemblies
14) Size and quantity of splice and post bolts
15) Quantity of splice plates and steel offset blocks
16) Division assigned laboratory number
17) Description and quantity of any items not listed above

8. PROCEDURES AT THE DELIVERY SITE

8.1 Division personnel will visually inspect each shipment and review information on the shipping document for proper quantities. All shipments that are damaged, incomplete, or otherwise considered non-specification will be rejected.

9. DIVISION DOCUMENTATION

9.1 For project accepted shipments the bill of material or shipping document indicating acceptance will be forwarded to and retained by the District Materials Section.

9.2 The laboratory number assigned to the fabricator (either approved or nonapproved) will be entered on all project records as material acceptance.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 712.04.50 Steward – Metals Section
RLS:H
ATTACHMENT

MINIMUM QUALITY CONTROL PLAN REQUIREMENTS

1. GUARDRAIL, BEAMS, BACKUP PLATES AND END SECTIONS

1.1 The fabricator will verify quality of the base metal by maintaining on file, copies of certified mill test reports from the steel producer. Mill test reports must contain all test data required by AASHTO M180 and shall include the applicable heat number identification. The fabricator will verify that test data is available for all heats used to manufacture guardrail and end sections.

1.2 Heats for which proper mill test reports are not available will be sampled by the fabricator for testing by an independent testing laboratory acceptable to the Division.

1.3 Sampling and testing is to be performed in accordance with AASHTO M180. The fabricator will verify dimensions, zinc coating thickness (weight) and workmanship in accordance with the following minimum frequency:

1.3.1 Guardrail beams - 1 sample (inspection) for each 1/2 day production for each heat of steel.

1.3.2 Guardrail Backup Plates - Same as above.

1.3.3 End Sections - 1 sample (inspection) for each 50 pieces manufactured for each heat of steel.

1.4 Results of all dimensional, zinc coating and visual inspections will be documented on forms prepared by the fabricator. Sample forms will be attached to the Quality Control Plan.

2. GUARDRAIL POSTS

2.1 The fabricator will verify quality of the base metal by maintaining on file, copies of certified mill test reports from the steel producer. Mill test reports must contain all test data required by AASHTO M183 and shall include the applicable heat number identification. The fabricator will verify that test data is available for all heats used to manufacture guardrail posts.

2.2 Heats for which proper mill test reports are not available will be sampled by the fabricator for testing by an independent testing laboratory acceptable to the Division. Sampling and testing is to be performed in accordance with AASHTO M183.

2.3 Upon completion of hot dip galvanizing, the fabricator will maintain copies of properly executed galvanizing certifications from the galvanizing plant for each LOT of post.

2.4 The fabricator's quality control Inspection will verify dimensions, zinc coating thickness (weight) and workmanship in accordance with the following minimum frequency:

2.4.1 Physical dimensions and workmanship prior to galvanizing - 1 sample (inspection) for each 10 posts from each heat of steel.

2.4.2 Zinc coating thickness (weight) and workmanship after galvanizing - 1 sample (inspection) for each 50 posts from each galvanizing LOT. A LOT is defined as all posts from a fabricator's order or shipment which were galvanized using the same technique within five consecutive working days of galvanizing production.

2.5 Results of all dimensional, zinc coating and visual inspections will be documented on forms prepared by the fabricator. Sample forms will be attached to the Quality Control Plan.

3. GUARDRAIL SPLICE BOLTS, POST BOLTS AND NUTS

3.1 The fabricator will purchase the fasteners from domestic manufacturers in compliance with the requirements of AASHTO M180. The fasteners will be marked with the manufacturers identification marks as per the applicable material specifications. The manufacturers identification mark must be registered with and published in the Industrial Fasteners Institute Technical Information Report Number IFI- 122.

3.2 The fabricator will obtain from the fastener manufacturer certified mill test reports for each LOT of fasteners purchased. The fabricator will verify that the mill test report contains all required test data and will maintain LOT identification of the fasteners at his plant.

3.3 LOTS for fasteners for which mill test reports are not available will be sampled by the fabricator and tested for specification compliance by an independent testing laboratory acceptable to the Division.

3.4 The fabricator will make random inspections of all fastener LOTS to assure compliance with the visual, dimensional, zinc coating (weight) and marking requirements of the applicable specifications. The fabricator will record results of the inspections. Sample forms will be attached to the Quality Control Plan.

4. BREAKAWAY CABLE TERMINAL ASSEMBLIES (BCT)

4.1 The fabricator will maintain in his files certified mill test results for all components used to manufacture the assemblies to include proper galvanizing certifications. Individual components of the assembly for which mill test reports are not available will be sampled by the fabricator and tested by an independent testing laboratory acceptable to the Division.

4.2 The fabricator will select at random one complete terminal assembly from each 50 assemblies from each LOT for visual, dimensional, and zinc coating thickness (weight) inspection. Results of the inspection will be documented by the fabricator. Sample forms will be attached to the Quality Control Plan.

5. ANCILLARY ITEMS

5.1 The fabricator will maintain in his files certified mill test reports and/or certifications for all miscellaneous components to be supplied with the guardrail. Individual components for which mill test reports and/or certifications are not available from the producer will be sampled by the fabricator and tested by an independent testing laboratory acceptable to the Division.

5.2 The fabricator will make random inspections of all LOTS of miscellaneous components to assure compliance with the visual, dimensional, and zinc coating (weight) requirements of the applicable specifications. The fabricator will record results of the inspections. Sample forms will be attached to the Quality Control Plan.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR DETERMINING THE RANDOM LOCATION OF COMPACTION TESTS

1. PURPOSE

1.1 This procedure provides methods for determining the random locations for compaction tests.

2. SCOPE

2.1 This procedure is applicable for locating all compaction tests.

3. EQUIPMENT

3.1 Measuring tape, approximately 50 feet (15 m)

4. PROCEDURE

4.1 Compaction test site locations are to be randomly located along the roadway centerline (length) and offset (width) randomly from this reference line. Some test site locations, such as pipe backfill, require random selection of lifts for the tests and a random determination of the side of the pipe backfill to test.

4.2 Selection of random numbers

4.2.1 Determine the number of test sites which will be required for the lot or test section.

4.2.2 The table of random numbers (Table I attached) or a calculator, which will generate random numbers, can be used.

4.2.3 The table of random numbers contains 5 sections with 2 columns of numbers in each section.

4.2.3.1 The first column of numbers in each section is for determining the test site along the centerline. The second column of numbers is for determining the distance from the centerline (offset). Either column of numbers can be used for selecting lifts to be tested.

4.2.3.2 To use the table, select a random point on the table by tossing a pencil upon the page or blindly pointing out a location with the finger. The selection of random numbers will consist of a pair of random numbers. Once the point is located, select the number in the first column for the length and the corresponding number in the right column for the width. When more than one pair of random numbers is needed, continue selecting the pairs of numbers down the page. If the bottom of the page is reached, go to the top of the next section to the right or to the top of the first section on the left side of the page if the bottom of the right most section of the page is reached. When selecting lifts to be tested, only single random numbers are needed and can be obtained from any of the columns of numbers.

4.2.3.3 To use a calculator, which will generate random numbers, select all numbers needed for a test site before selecting numbers for additional test sites.

4.3 Location of test sites

4.3.1 There are many variations in the required number of tests and the physical dimensions of the area to be tested.

4.3.2 Random location of tests on a single lift that rectangular in shape (Example 1 of Attachment).

4.3.2.1 Generally, the Materials Procedure used for testing a material and/or Specifications requires a lot, portion of a lot, or a test section to determine the maximum density of a material to be divided into equal sublots or subsections when more than one test is required.

4.3.2.2 Divide the length of the area along the centerline by the number of tests to determine the length of each sublot or subsection.

4.3.2.3 From the beginning station number, add the length of the subsection or sublot to the station number to determine the station number for the beginning of the next sublot or subsection. Next add the length of the subsection or sublot to this station number to determine the station number at the beginning of the next subsection or sublot. Continue this procedure until the beginning station numbers for all subsections or sublots have been calculated.

4.3.2.4 Select the random numbers according to 4.2 through 4.2.3.3.

4.3.2.5 Multiply the length of the subsections or sublots by the random numbers selected for the length.

4.3.2.6 Add the values to the corresponding station numbers for the beginning of each subsection or sublot. The station numbers locate the test sites along centerline.

4.3.2.7 Next multiply the width of the test section or lot by the random numbers selected for the offset.

4.3.2.8 Determine the offset distance of the lot or test section from the centerline when the centerline is not within the area to be tested. This will usually be a constant value. Always calculate the offset by working from the side nearest the centerline. Add each of the values calculated in 4.4.2.7 to the constant value. The values establish the offset distance of each test site from the centerline. Designate rather the offset is left or right of centerline.

When the centerline is contained within the area to be tested, the offset can be calculated from the left or right side of the test area and test location designated in relation to centerline.

4.3.3 Random location of test sites on a single lift that is irregular in shape (Example 2 attached).

4.3.3.1 Determine the dimensions of the area to be tested.

4.3.3.2 Determine the minimum dimensions of a rectangle that will contain the area to be tested and has two sides parallel to centerline.

4.3.3.3 Divide the rectangle into the desired number of subsections or sublots and randomly locate the test sites locations as in sections 4.3.2 - 4.3.2.8 above. If a test site location falls outside the area to be tested, obtain a new set of random numbers for the test site and recalculate the test site location. Continue this procedure until the test site falls within the area to be tested.

4.3.3.4 Random selection of lifts to be tested (Example 3 attached).

4.3.2.1 When testing certain materials, especially backfill material, where an area to be backfilled will constitute a lot of material to be tested, a random selection of lifts to be tested is required.

4.3.2.2 Determine the projected number of lifts to be contained in the lot. Divide the number of lifts by the number of tests in the lot. If the value is not an even number, assign an additional lift to the first sublot and continue to assign a lift to each consecutive sublot until all remaining lifts have been assigned to a sublot.

4.3.2.3 By starting with the bottom lift, number the lifts in the lot.

4.3.2.4 Select a single random number for each test site.

4.3.2.5 Multiply each random number by the number of lifts in each sublot and round the values to whole numbers. Each value designates which lift in each sublot that will be tested.

4.3.3.5 Once the lifts to be tested have been selected, the random location of the test site on the lift can be determined.

4.3.3.6 Random selection of the side of backfill for pipe culverts.

4.3.3.6.1 When a lot of pipe backfill is being tested, tests should be performed on both sides of the pipe. The side to be tested can be randomly selected by using the random numbers selected for the location of the tests along the pipe. If the random number is less than 0.500, the test is on the left side and greater than 0.500 on the right side of the pipe.

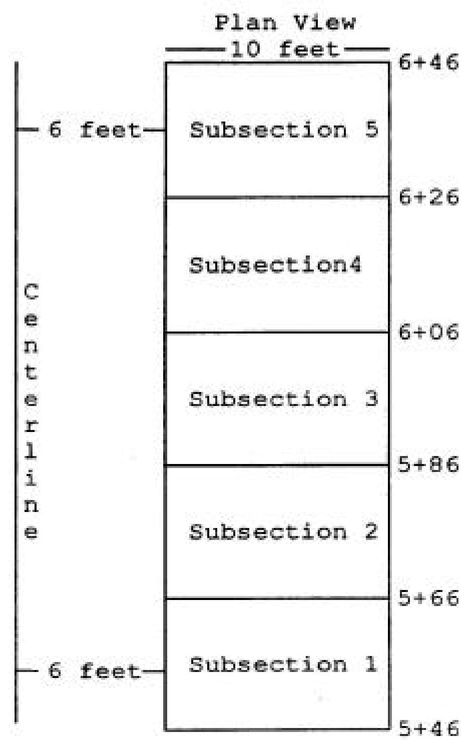
Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 712.21.26 Steward – Asphalt Section
RLS:J
ATTACHMENT

TABLE 1 RANDOM NUMBERS

.858	.082	.886	.125	.263	.176	.551	.711	.355	.698
.576	.417	.242	.316	.960	.819	.444	.323	.331	.179
.687	.288	.835	.636	.596	.174	.866	.685	.066	.170
.068	.391	.739	.002	.159	.423	.629	.631	.979	.399
.140	.324	.215	.358	.663	.193	.215	.667	.627	.595
.574	.601	.623	.855	.339	.486	.065	.627	.458	.137
.966	.529	.757	.308	.025	.836	.200	.055	.510	.656
.608	.910	.944	.281	.539	.371	.217	.882	.324	.284
.215	.355	.645	.460	.719	.057	.237	.146	.135	.903
.761	.883	.771	.388	.928	.654	.815	.570	.539	.600
.869	.222	.115	.447	.658	.989	.921	.924	.560	.447
.562	.036	.302	.673	.911	.512	.972	.576	.838	.014
.481	.791	.454	.731	.770	.500	.980	.183	.385	.012
.599	.966	.356	.183	.797	.503	.180	.657	.077	.165
.464	.747	.299	.530	.675	.646	.385	.109	.780	.699
.675	.654	.221	.777	.172	.738	.324	.669	.079	.587
.279	.707	.372	.486	.340	.680	.928	.397	.337	.564
.338	.917	.942	.985	.838	.805	.278	.898	.906	.939
.316	.935	.403	.629	.130	.575	.195	.887	.142	.488
.011	.283	.762	.988	.102	.068	.902	.850	.569	.977
.683	.441	.572	.486	.732	.721	.275	.023	.088	.402
.493	.155	.530	.125	.841	.171	.794	.850	.797	.367
.059	.502	.963	.055	.128	.655	.043	.293	.792	.739
.996	.729	.370	.139	.306	.858	.183	.464	.457	.863
.240	.972	.495	.696	.350	.642	.188	.135	.470	.765

EXAMPLE I ENGLISH



Length of test section = 100 ft Width of section = 10 ft
Number of tests required = 5
4 equal subsections 100/5 = 20 ft
Test section starts at station 5+46

Station number at the beginning of each subsection

1. 5+46
2. 5+46 + 20 = 5+66
3. 5+66 + 20 = 5+86
4. 5+86 + 20 = 6+06
5. 6+06 + 20 = 6 +26

Random Numbers

	Length	Width
1.	.869	.222
2.	.562	.036
3.	.481	.791
4.	.599	.966
5.	.464	.747

Multiply the length of each subsection by the random numbers for the length.

1. 20 x .869 = 17
2. 20 x .562 = 11
3. 20 x .481 = 10
4. 20 x .599 = 12
5. 20 x .464 = 9

Add the values to the beginning station numbers of each subsection to determine the station number for each test.

1. 5+46 + 17 = 5+63
2. 5+66 + 11 = 5+77
3. 5+86 + 10 = 5+96
4. 6+06 + 12 = 6+18
5. 6+26 + 9 = 6 +35

Multiply the width of each subsection by the random numbers for the width.

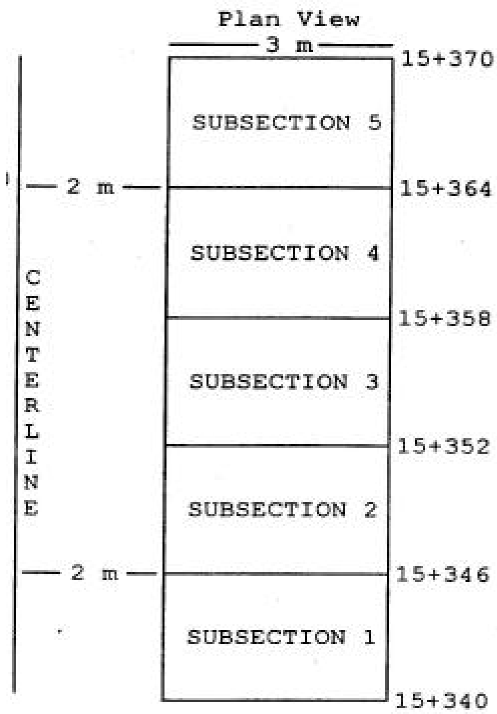
1. 10 x .222 = 2
2. 10 x .036 = 0
3. 10 x .791 = 8
4. 10 x .966 = 10
5. 10 x .747 = 7

Add the values to the constant distance the test section is from the centerline and label the values as right of centerline .

1. 6 + 2 = 8 ft right ofcenterline
2. 6 + 0 = 0 ft right ofcenterline
3. 6 + 8 = 14 ft right ofcenterline
4. 6 + 10= 16 ft right ofcenterline
5. 6 + 7 = 13 ft right ofcenterline

EXAMPLE I
METRIC

Length of test section = 30.00 m
Width of section = 3.00 m Number of tests required = 5
5 equal subsections 30/5 = 6 m Test section starts at station 15+340



Station number at the beginning of each subsection
1. 15+340
2. 15+340 + 6 = 15+346
3. 15+346 + 6 = 15+352
4. 15+352 + 6 = 15+358
5. 15+358 + 6 = 15+364

Random Numbers

Length	Width
1. .869	.222
2. .562	.036
3. .481	.791
4. .599	.966
5. .464	.747

Multiply the length of each subsection by the random numbers for the length.
1. 6.00 x .869 = 5.2
2. 6.00 x .562 = 3.4
3. 6.00 x .481 = 2.9
4. 6.00 x .599 = 3.6
5. 6.00 x .464 = 2.8

Add the values to the beginning station numbers of each subsection to determine the station number for each test site.
1. 15+340 + 5.2 = 15+345.2
2. 15+346 + 3.4 = 15+349.4
3. 15+352 + 2.9 = 15+354.9
4. 15+358 + 3.6 = 15+361.6
5. 15+364 + 2.8 = 15+366.8

Multiply the width of the test section by the random numbers for the width.
1. 3.00 x .222 = 0.7
2. 3.00 x .036 = 0.1
3. 3.00 x .791 = 2.4
4. 3.00 x .966 = 2.9
5. 3.00 x .747 = 2.2

Add the values to the constant distance the test section is from the centerline and label the values as right of centerline.
1. 2.00 + 0.7 = 2.7 m rt of centerline
2. 2.00 + 0.1 = 2.1 m rt of centerline
3. 2.00 + 2.4 = 4.4 m rt of centerline
4. 2.00 + 2.9 + 4.9 m rt of centerline
5. 2.00 + 2.2 = 4.4 m rt of centerline

EXAMPLE 2
METRIC

The shaded area designates the lift to be tested. For this example, 2 sublots are required with 1 test in each sublot.

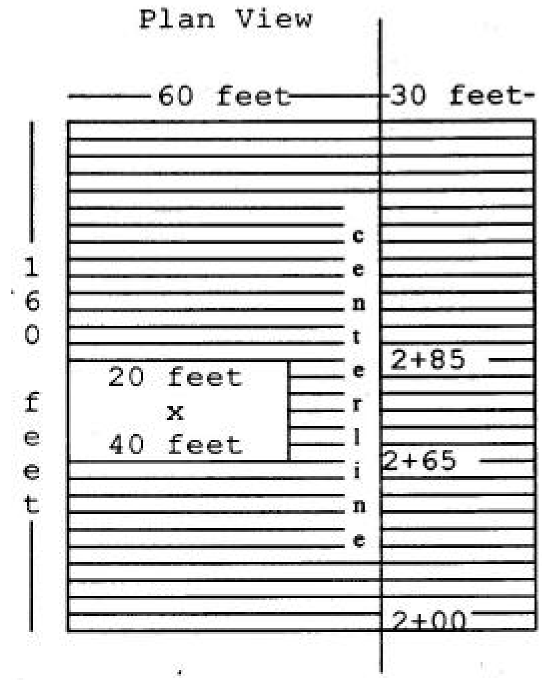
Since the area to be tested is not rectangular in shape, place the smallest rectangle around the area that will include all the shaded area.

Divide the rectangle into 2 equal areas (160 feet long by 90 feet wide).

Since the centerline is located within the area to be tested, the offset can be calculated and measured from either side. For this example, work from the right side.

Determine the station number for the beginning of

each sublot. Sublot No. 1 2.+00
Sublot No. 2 2+00 + 80 = 2+80



Random Numbers

Length	Width
.902	.850
.275	.023
.794	.850

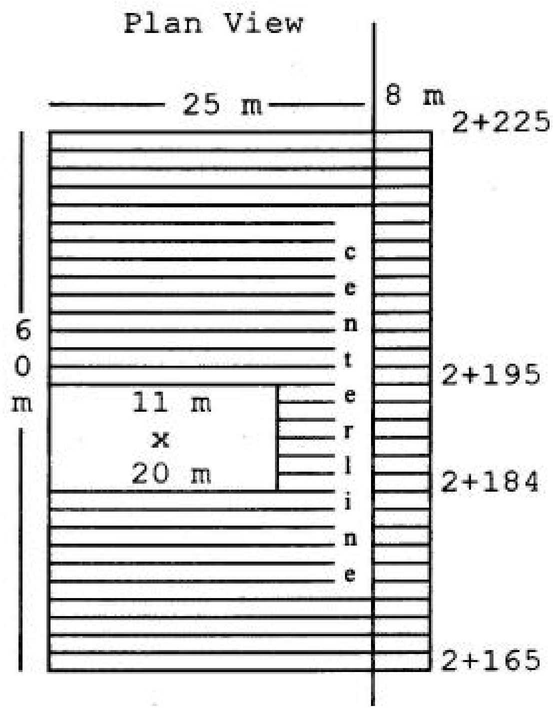
Since there is the possibility that the location of a test site may fall outside the area to be tested, an additional set of random numbers was selected.

Multiply the random number by the length of the sublot (80 x .902 = 72 feet). Add the value of the beginning station number (2+00 + 72 = 2+72). Multiply the width of the sublot by the random number (90 x .850 = 76 feet). By working from the right side, it is 30 feet to the centerline, therefore the test site is 76 – 30 = 46 feet to the left of centerline. The test site falls outside the test area.

By using the next set of random numbers, calculate the test site location. 80 x .275 = 22 feet 90 x .023 = 2 feet
2+00 + 22 = 2+22 30 – 2 feet = 28 feet right of centerline The test site for sublot 1 now falls within the test area.

Calculate the test location for sublot 2.
80 x .794 = 64 feet 90 x .850 = 76 feet
2+80 + 64 = 3+44 76 - 30 = 46 feet left of centerline

EXAMPLE 2
METRIC



The shaded area designates the lift to be tested. For this example, 2 sublots are required with 1 test in each sublot.

Since the area to be tested is not rectangular in shape, place the smallest rectangle around the area that will include all the shaded area.

Divide the rectangle into 2 equal areas (30 m long by 33 m wide).

Since the centerline is located within the area to be tested, the offset can be calculated and measured from either side. For this example, work from the right side.

Determine the station number for the beginning of each sublot.

Sublot No. 1 2.+165
Sublot No. 2 2+165 + 30 = 2+195

Random Numbers
test site may fall outside the area to be

Length	Width
.902	.850
.275	.023
.794	.850

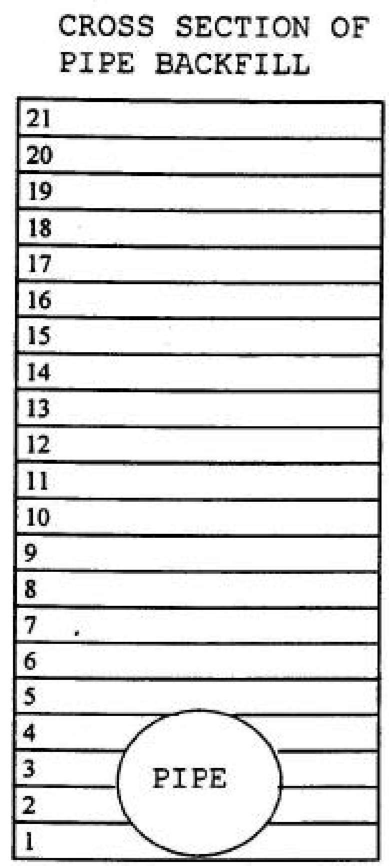
Since there is the possibility that the location of a tested, an additional set of random numbers was selected.

Multiply the random number by the length of the sublot (30 x .902 = 27.1 m). Add the value of the beginning station number (2+165 + 27.1 = 2+192.1). Multiply the width of the sublot by the random number (33 x .850 = 28.1 m). By working from the right side, it is 8 m to the centerline, therefore the test site is 28.1 – 8 = 20.1 m to the left of centerline. The test site falls outside the teSt area.

By using the next set of random numbers, calculate the test site location. 30 x .275 = 8.2 m 33 x .323 = 0.8 m
2+165 + 8.2 = 2+173.2 8 – 0.8 m = 7.2 m right of centerline The test site for sublot 1 now falls within the test area.

Calculate the test location for sublot 2
30 x .794 = 23.8 m 33 x .850 = 28.0 m
2+195 + 23.8 = 2+218.8 28 – 8 = 20 m left of centerline

EXAMPLE 3



21 lifts of material are required to backfill the pipe.

All of the backfill material is included in 1 lot. There are 5 tests required with 1 test in each sublot.

Divide the number of lifts by the number of sublots to determine the number of lifts in each sublot (21/5 = lifts with 1 lift left over). This includes the lift in sublot number 1.

Sublot Number 1	Lifts 1 – 5
Sublot Number 2	Lifts 6 - 9
Sublot Number 3	Lifts 10 - 13
Sublot Number 4	Lifts 14 - 17
Sublot Number 5	Lifts 18 – 21

Random numbers 1.
.599
2. .464
3. .675
4. .279
5. .338

Multiply the number of lifts in the sublot by the random numbers. The values determine which lift in each sublot to test.

1. 5 x .599 = 3	Test lift 3 in sublot number 1, Lift number 3
2. 4 x .464 = 2	Test lift 2 in sublot number 2, Lift number 7
3. 4 x .675 = 3	Test lift 3 in sublot number 3, Lift number 12
4. 4 x .279 = 1	Test lift 1 in sublot number 4, Lift number 14
5. 4 x .338 = 1	Test lift 1 in sublot number 5, Lift number 18

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURE FOR THE QUALITY ASSURANCE OF CORRUGATED METAL PIPE

1. PURPOSE

1.1 To provide the procedure for the quality assurance of corrugated metal pipe. Quality assurance is comprised of both Quality Control and Acceptance activities. Quality Control is the responsibility of the fabricator and acceptance is the responsibility of the Division. Quality control data developed by the fabricator may be used as acceptance.

2. SCOPE

2.1 This procedure shall apply to the following material types:

1) Metallic coated corrugated steel pipe and pipe arch
2) Bituminous coated corrugated steel pipe and pipe arch
3) Bituminous coated paved corrugated steel pipe
4) Corrugated stainless steel culvert and underdrains
5) Corrugated aluminum alloy pipe and pipe arches
6) Polymer precoated, metallic coated steel pipe and underdrain
7) Other assembled items such as metal coupling bands, fittings, rivets, bolts and nuts, connecting plates, and end sections.

3. APPLICABLE SPECIFICATIONS

3.1 All material under this procedure shall meet the requirements of Section 713 of the West Virginia Division of Highways Standard Specifications for Roads and Bridges. This section specifically includes the following AASHTO Specifications for the applicable item:

1) M 36
2) M 190
3) M 196
4) M 218
5) M 245
6) M 246

4. PROCEDURE

4.1 A list of approved fabricators will be developed and maintained by the Materials Control, Soils and Testing Division. Fabricators on the approved list will be authorized to ship materials without specific LOT-by-LOT approval by the Division. Those fabricators not on the approved list will be required at the fabricator's expense to obtain LOT-by-LOT inspection and approval by an independent agency acceptable to the Division.

4.2 To qualify for the approved list, the fabricator must comply with the following:

4.2.1 It is the fabricator's responsibility to assure that all materials used in the process comply with applicable specifications. The fabricator will obtain and maintain ready for review test records from the manufacturers of component materials (and from the precoater, if applicable) necessary to confirm compliance with specifications. The Division will be supplied copies of test data upon request.

4.2.2 The fabricator shall submit to Materials Control, Soils and Testing Division a Quality Control Plan detailing how the product will be controlled. As a minimum, the Plan shall include the following:

1. Name of company employee responsible for Quality Control. Tests to be conducted and their frequencies (see Attachment 1). Procedure for disposition of noncomplying materials.

4.3 Upon approval of the Quality Control Plan by Materials Control, Soils and Testing Division, the fabricator will be assigned a laboratory number and be placed on the approved list. Approved fabricators shall maintain and have ready for review the results of testing conducted in accordance with the Quality Control Plan.

4.4 For fabricators not on the approved list, corrugated metal pipe must be inspected, tested, and approved prior to shipment by an independent inspection agency acceptable to the Division (see Attachment 2 for frequencies). The inspection will be arranged and paid for by the fabricator.

4.5 The acceptance plan for fabricators on the approved list requires submittal of a Certificate of Compliance with each shipment of pipe (see 5.1 for details), and inspection by the Division at the fabricating facility at least once per year. The Division's inspection will cover the following:

4.5.1 The fabricator's Quality Control Program will be reviewed for compliance with his Quality Control Plan.

4.5.2 Samples of base metal will be taken by the Division. Two samples per gauge from each type of metallic coated stock (100mm x width of coil) will be randomly selected for physical and chemical analysis. These samples will be selected from flat sheet or coils of the same material used in fabrication of the pipe. Connecting band base metal will be represented by the base metal samples. Accessories for connecting bands - such as bolts, angles, bars, etc. - will be sampled per item.

4.5.3 Inspection of welded seam pipe will be done at the fabricator's storage site and will be done in accordance with the requirements of AASHTO M 36. The seams will be visually inspected throughout the length of the pipe to determine any visible indications of weld defects. When welded seam pipe is fabricated without reformed ends, the fabricator will conduct, in the presence of the Division's representative, the weld seam cup test procedure as required by AASHTO T 241. The number of pipe selected for this inspection will be three 6.1 m sections of different diameters. These dimensions will be randomly selected.

4.5.4 Inspection of lock seam pipe will be at the fabricator's storage site and will be in accordance to AASHTO M 36. The seams will be visually inspected throughout the length of pipe to determine the workmanship of the seam. Lock seam samples will be taken from available pipe and will be tested by the Division in accordance to AASHTO T 249 and shall meet the requirements of AASHTO M 36.

4.5.5 One polymer precoated stock sample 610 mm by the coil width of one gauge will be selected at random for tests by the Division. The testing will be in accordance with the requirements of AASHTO M 246.

4.5.6 The inspection of the fabricated polymer precoated corrugated steel pipe will be in accordance with the fabrication requirements of AASHTO M 245. A minimum of one 6.1m length of any diameter of this pipe will be randomly selected for this inspection. When applicable, lock seam samples will be taken by the Division.

4.5.7 Asphalt coated corrugated steel pipe will be inspected in accordance with AASHTO M 190, except that a minimum of five pipe sections will be sampled for asphalt stripping. Samples of asphalt taken from the five pipes will be combined into a single test sample. This sample will be tested by the Division in accordance with AASHTO M 190.

4.5.8 The Division representative will conduct an imperviousness test in accordance with AASHTO M 190 on one section of pipe.

4.5.9 If the documentation of Quality Control data is not maintained, or if inspection or tests of pipe reveal noncompliance with the specifications, the fabricator will be removed from the approved list of fabricators. Until correction of all deficiencies can be documented to the satisfaction of the Division, the fabricator will be required to comply with Section 4.3. The fabricator may request that the Division make a reinspection after he has reestablished his Quality Control.

5. SHIPPING DOCUMENTATION

5.1 The fabricator shall furnish with each shipment a signed Certificate of Compliance. The original certificate will accompany the pipe to the project site or other location as applicable. A copy of the certificate will be forwarded directly to Materials Control, Soils and Testing Division. This document attests that the shipment meets the chemical, physical, manufacturing, and fabricating requirements as given in the specifications, and shall include the following information (whichever is applicable):

1) Date of Certification
2) State Project or Purchase Order Number
3) County
4) Fabricator's Order Number
5) Consignee
6) Item Reference (Number and Length of Pieces)
7) Diameter and Size
8) Gauge of Material
9) Heat Number
10) Type of Pipe (To Include Type of Metallic Coating and Asphalt Coating When Applicable)
11) Corrugation Size
12) Quantity (Total Linear Feet)
13) Quantity and Type of Connecting Bands
14) End Sections, Fittings, Etc.
15) Division Assigned Approved List Number (When Applicable)

5.2 Fabricators not on the approve list shall submit, in addition to the information required by Section 5.1, the independent inspection agency test results for each shipment. The original certificate will accompany the pipe to the project site or other location as applicable. A copy of the certificate will be forwarded directly to Materials Control, Soils and Testing Division.

6. PROCEDURES AT THE DELIVERY SITE

6.1 Division personnel will determine if the information on the Certificate of Compliance, as required in Section 5.1, agrees with the shipment it accompanies. If not, a corrected Certificate of Compliance will be required.

6.2 Division personnel will complete a visual inspection of the shipment for evidence of damage during shipment. Material which has been damaged or does not meet the specifications will be rejected.

7. DIVISION DOCUMENTATION

7.1 After the items on the shipment have been verified as in 6.1 and 6.2, a copy of the Certificate of Compliance indicating acceptance by the project will be forwarded to the Materials Control, Soils and Testing Division through the District Materials Section. If from an unapproved source, the documents will be reviewed by the Materials Control, Soils and Testing Division and a laboratory number assigned.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 713.01.50 Steward – Metals Section
RLS:H
ATTACHMENT

CORRUGATED METAL PIPE TESTS AND FREQUENCY FOR UNAPPROVED CMP FABRICATIONPLANTS

Metallic Coated Corrugated Steel Pipe, Corrugated Alloy Pipe and Polymer Precoated Corrugated Pipe

The test and frequencies are based on shipping LOT

Item - Test	Frequency
Sheet or Coil - thickness	3 per heat
Coating on Sheet or Coil - thickness	3 per heat
Pipe dimensions	10%
Pipe - arch dimensions	10%
Corrugation - measurements	10%
Workmanship - visual	50%
Seams Welded - visual & test	10%
Seams Lock - visual	50%
End Finish - visual	10%
Coupling Bands - visual	10%
Thickness - measure	10%
Dimensions - measure	10%
Repair of Damaged Metallic Coating - visual	100%
Degree of Surface Cleaning	When Applicable
Thickness of Repair Coating	100%
Underdrain - visual	20%
Size of Perforations	10%
Rows of Perforations	10%
Slotted Drain - visual	10%
Slot Height - measurements	10%
Slot Width - measurements	10%
Bar Thickness - measurements	10%
Weld Size	10%
Bituminous Coated Products Coating	
Thickness - measurements	10%
Paving Thickness - measurements	10%
Properties of Coatings taken from Pipe	
*1 Sample from 10% of Pipe	*
Imperviousness Test	One/Shipment
Other Items	10%

____
Signed by
Consultant & Firm

The tests and frequencies are based on a daily quality control basis and are considered minimum.

Item – Test	Frequency
Sheet or Coil – thickness	1 per heat
Coating on Sheet or Coil – thickness	1 per heat
Pipe - dimensions Gauge of Pipe Corrugation - arch dimensions Workmanship - visual Seams Welded - visual and test Seams Lock -visual End Finish - visual	Measurements or visual inspection on the applicable items a minimum of once per day for each pipe size as well as for each gauge of metal
Coupling Bands - visual Thickness - measure Dimensions – measure	Measurements or visual inspection on the applicable items once/day for production
Repair of Damaged Metallic Coating – visual Degrees of Surface Cleaning applicable Thickness of Repair Coating	Once per day if
Underdrain - visual Size of Perforations - measurements Rows of Perforations - visual applicable Slotted Drain - visual Slot Height - measurements Slot Width - measurements Bar Thickness - measurements Weld Size	Once per day if
Bituminous Coated Products Coating Thickness - measurement operation Paving Thickness - measurement	Once per each day of
Properties of Coatings taken from Pipe	Quarterly
Imperviousness Test	Once/Year
Other Items	Once per day if applicable

Company to retain this document for two years.

____

Signed by

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SILICONE CONTENT IN AASHTO M-167 AND M-218 MATERIALS

1. PURPOSE

1.1 To establish testing criteria for silicone in AASHTO M-167 and M-218 materials.

2. SCOPE

2.1 To provide a criteria for performing the silicone analyses depending upon concentration of other elements required by the specifications.

3. SPECIFICATION M-167 AND M-218

3.1 Both specifications are identical, the sum of the Carbon, Manganese, Phosphorous, Sulfur and Silica shall not exceed 0.70 percent.

3.2 The silicone test shall not be performed unless the sum of the Carbon, Manganese, Phosphorous and Sulfur exceed 0.65 percent.

Ronald L. Stanevich, PE
Director
Materials Control, Soils & Testing Division

MP 713.20.20 Steward – Environmental and Coatings Section
RLS:P

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR DETERMINING THE QUALITY OF WATER USED WITH HYDRAULIC CEMENT

1. PURPOSE

1.1 To establish a standard method of test and acceptance criteria to be used in determining the quality of water used with hydraulic cement.

2. PURPOSE

2.1 This procedure is applicable to untreated water sources used in combination with mixtures containing hydraulic cement. An untreated water source may be defined as a source other than a treated public water system.

2.2 Treated water systems may be used without testing.

3. APPLICABLE DOCUMENTS

3.1 *MP 642.40.20*

3.2 *AASHTO T 106*

3.3 *AASHTO T 154*

3.4 *AASHTO T 162*

4. PROCEDURE

4.1 Untreated water shall be tested at the source for pH. When the pH of the water is between 4.5 and 8.5 no further testing is necessary.

4.2 If the pH is less than 4.5 or more than 8.5, all tests listed in this procedure will be conducted. A water source whose pH is determined to be within the limits defined above may appear to be contaminated with foreign material which could have an adverse effect on the portland cement concrete. If the sampler has reason to believe that this may be the case, a sample shall be forwarded to the Materials Division for further tests as defined below. The sample shall be accompanied with the required documentation indicating the samplers reasons for requesting test.

5. TEST METHODS

5.1 Total Solids Content

5.1.1.1 Test shall be conducted in accordance with MP 642.40.20.

5.2 Compressive Strength

5.2.1 The water under test shall be compared, in mortar, with distilled water. The proportions of dry materials in the mortar shall be 500 grams of Type III Cement, 1500 grams of graded OTTAWA sand and the amount of water sufficient to produce a flow of 110 ± 5 in 25 drops in accordance with AASHTO T 106 using the sample under test and compared to three specimens made using distilled water.

5.3 Time of Setting by Gillmore Needle

5.3.1 Time of set will be prepared with the test sample and Type III Cement in accordance with AASHTO T 154. A control specimen will be made with distilled water for basis comparison.

6. ACCEPTANCE CRITERIA FOR UNTREATED WATER SOURCES

Total Solids Content	2000 ppm*
Compressive Strength (Min% Control at 1 day)	90
Time of Set, (deviation from control)	-60 to +90 Minutes

*Water containing more than 2000 ppm of total solids may be determined acceptable if compressive strength and time of set tests indicate that the solids will not adversely affect the concrete.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 715.07.20 Steward – Cement and Concrete Section
RLS:T

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

TEST METHODS FOR WOOD CELLULOSE FIBER MULCHES

1. PURPOSE

1.1 This procedure was developed to establish standard test methods to determine the moisture content, net dry weight (mass), water holding capacity, pH, and color of wood cellulose fiber mulch as packaged.

2. SCOPE

2.1 This procedure is applicable to all wood cellulose fiber mulches used for vegetation establishment.

3. APPARATUS AND EQUIPMENT

3.1 Scale capable of weighing 50kg accurately to the nearest 50 grams.

3.2 Scale capable of weighing accurately to the nearest 0.1 gram.

3.3 Oven capable of maintaining a temperature of 100 ± 2ºC.

3.4 Three 4-liter containers.

3.5 Three pieces of 75µm (No. 200) mesh of sufficient size to cover containers.

3.6 One 75µm (No. 200) standard 203.2mm (8 inch.) diameter sieve.

3.7 Aluminum foil to be used to cover sieve.

3.8 One 1-liter graduated glass beaker.

3.9 Pan of sufficient size and depth to partly submerge the 203.2mm (8 inch.) diameter sieve.

3.10 Demineralized water.

3.11 Sink and draft free area to drain sample.

3.12 One 250mL beaker.

3.13 One 100mL graduated cylinder.

3.14 Wooden tongue depressors

4. PROCEDURES

4.1 Moisture Content

4.1.1 Weigh the unopened container (bag) of mulch as received and record the weight. This weight will be used to determine the Net Dry Weight (4.2.2). The moisture content shall be reported as the average of three samples from a single mulch container (bag). One sample will be taken from the top, center, and bottom of the bag.

4.1.2 For each sample, loosely fill a 4 liter container of known weight with mulch to approximately 25mm (1") from the top.

4.1.3 Weigh each sample immediately and cover the containers with a piece of 75µm mesh to prevent loss of mulch from container while drying.

4.1.4 Dry all samples in the oven at 100 ± 2ºC until constant weight is achieved.

4.1.5 Cool the samples to room temperature, then remove the 75µm mesh from each sample and weigh containers and mulch.

4.1.6 The percent (%) moisture (as received) for each sample is determined by the following formula:

$$\% \text{ Moisture} = (A - B / B - C) \times 100$$

where: A = original weight of container and mulch (grams)
B = weight of container and dry mulch (grams)
C = weight of empty container (grams)

4.1.7 Final percent moisture is reported as the average of the three samples.

4.2 Net Dry Weight

4.2.1 The Net Dry Weight (NDW) of the packaged mulch is determined by the following formula:

$$NDW = X - [(X \cdot Y) / 100]$$

where: X = weight of packaged mulch as determined in Section 4.1.1.
Y = percent average moisture as determined in Section 4.1.7

4.2.2 Compare the calculated NDW with the net dry weight printed on the mulch container.

4.2.3 If the NDW is less than the net dry weight as recorded on the mulch container, the contractor shall supply extra material to make up the difference.

4.3 Water Holding Capacity

4.3.1 Determine the average percent moisture content in accordance with Section 4.1.

4.3.2 Obtain and weigh-out a quantity of "as received" mulch equivalent to 12.0 grams of oven-dry mulch. The weight of the "as received" mulch is determine by the following formula:

$$\text{"as received" weight} = 12.0 / [1 - (\%\ \text{Average moisture} / 100)]$$

4.3.3 Weigh "as received" mulch to the nearest 0.1 gram and place mulch in a 1-liter beaker. Add 800ml of demineralized water (room temperature) to the beaker. Stir until the mulch is thoroughly mixed with the water. Allow to stand for 30 minutes.

4.3.4 Thoroughly wet a clean 75µm (No. 200) 203.2mm (8 inch.) standard diameter sieve. Cover the top of the sieve with aluminum foil or other material to prevent evaporation. Prop (or lean) the sieve up against something at an angle of 30º to 45º and allow to "drain" for 10 minutes, after which remove the aluminum foil cover and wipe any excess water from the outside of the sieve and weigh immediately to the nearest 0.1 gram.

4.3.5 Place the sieve in a pan of sufficient depth to allow enough water to be added to cover mesh area. Pour the beaker contents onto the sieve. Use additional water to remove any mulch as necessary from the beaker. To the pan add water as needed to float the mulch inside of the sieve, being careful not to lose any mulch over the side of the sieve. Stir so the mulch will form a uniform mat over the mesh area upon removal from the pan. Carefully cover the sieve with aluminum foil to prevent evaporation and remove sieve from pan.

4.3.6 As before, prop or lean the sieve at an angle of 30º to 45º and allow to "drain" for 10 minutes. Remove cover and wipe any excess water from the outside of sieve and weigh immediately to the nearest 0.1 gram.

4.3.7 Obtain the weight of the wet mulch by subtracting the sieve weight (4.3.4) from the total weight (4.3.6).

4.3.8 Calculate the percent water holding capacity by using the following formula:

$$\%\ \text{Water Holding Capacity} =$$

$$[(\text{Weight of Wet Mulch} - 12) / \text{Weight of Wet Mulch}] \times 100$$

4.4 Potential of Hydrogen (pH)

4.4.1 The pH of the mulch will be determined using a pH meter and electrode capable of determining pH to 0.1 units and having automatic temperature compensation.

4.4.2 For each sample, weigh 10 ± 0.1 grams of mulch into a 250mL beaker. Measure 100mL of demineralized water with the graduated cylinder and pour into beaker containing the mulch.

4.4.3 Using a wood tongue depressor, press the mulch into the water so that the mulch has absorbed the water.

4.4.4 Let set for approximately one hour.

4.4.5 Calibrate the pH meter as per the manufacturer's instructions, place the electrode into the wet mulch and record the pH after the reading has stabilized.

4.5 Color

4.5.1 The determination of mulch color will be by visual inspection only. The color will be recorded on the laboratory worksheet to the nearest primary or secondary color.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 715.27.20 Steward – Metals Section
RLS:H

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SEED ACCEPTANCE CRITERIA

1. PURPOSE

1.1 To provide an interpretation of existing Specifications governing seed used on Division projects.

2. SCOPE

2.1 The interpretation set forth herein shall apply to all seeding operations.

2.2 Provide instructions for use by Division field personnel as to acceptance and documentation of material.

3. CRITERIA FOR ACCEPTANCE

3.1 Specifications governing seed varieties as set forth in the West Virginia Division of Highways Standard Specifications Roads and Bridges shall be interpreted to mean that all seeds utilized on Division projects shall be a commercial variety meeting the definitions and requirements of the West Virginia Seed Law as well as any applicable Federal laws and regulations.

3.2 Each container of any variety of seed used on Division projects will bear a "vendors tab" of analysis. Said tag will contain such information as LOT number, germination, purity, weed seed, etc.

3.3 All stored material shall be inspected. Those containers exhibiting improper storage shall not be used and are to be removed from the project.

3.4 If the claimed analysis, listed on the vendors tag, is below that set forth in Specification requirements, then adjustments to the application rate shall be made. Such adjustments shall be in accordance with Paragraph 4.

4. ADJUSTING FOR APPLICATION RATE

4.1 Subsequent to receipt of seed at job site, the project engineer or supervisor will compare the test results shown on the vendor tags with those of the governing Specification requirements.

4.1.1 If the percent germination and/or percent purity of each seed is below that of the project Specification requirements, the seed weight per hectare l be computed for adjustments as follows. (The equation yielding the maximum kilos of speed per acre shall govern).

4.1.1.1 $$\frac{(G_S)\ (W_S)}{G_t} = W_n$$

GS = Percent germination specified.

Gt = Percent germination on vendor tag.

WS = Kilo of seed per hectare as specified on plans, or special provisions.

Wn = The required kilos of seed per acre.

4.1.1.2 $$\frac{(P_S)\ (W_S)}{P_t} = W_n$$

PS = Percent purity specified.

Pt = Percent purity on vendor tag.

WS = Kilos of seed per hectare as specified on plans or special provisions.

Wn = The required kilos of seed per hectare.

4.1.2 If the percent germination and percent purity indicated on the vendor tags exceed the governing Specification requirements, the above formula do not apply.

4.1.3 If a maximum percent weed seed content is specified, and the percent week seed stamped on the vendor tag exceeds the specified limit, the seed is not to be used, and shall be removed from the project.

5. DOCUMENTATION

5.1 Coverage for seed shall be obtained by entering the following information from the vendors tag on Form HL-440.

5.1.1 Name of vendor.

5.1.2 Lot number.

5.1.3 Type of Seed.

5.1.4 Quantity.

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division